Electrical Engineering

Incorporating Electrical Age and Southern Electrician
ISSUED MONTHLY BY WM. R. GREGORY CO.
1642 Woolworth Bldg., New York
Chicago Office, 814 Westminster Building
CHAS. B. THOMPSON, President
GEO. A. WARDLAW, Editor

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Incorporating Electrical Age and Southern Electrician

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258 Broadway, New York

Chicago Office, 814 Westminster Building

GEO. A. WARDLAW, Editor

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Electrical Odds and Ends: Picked Up Here and There During the Past Month.

From the Factory: Interchangeable Connecting Block, Rosette, and Receptacle; Standard Dome Reflectors; Non-Glare Lamp Shield; Improved Arc Lamp Carbon Holder; Portable Lamp; Kwickfit Holder; Flexible Charging Outfit; Making Temperature Trip the Circuit Breaker; Transfer Relay; Protection Against Reversed Phases; Polyphase Induction Regulators; Meters for Wireless High Frequency Work; Sphere Gap Lightning Arrester; Duplex Instruments; Illuminated Fuse Tester; Heavy Duty Momentary Contact Switch; Piston Vacuum Machine; Motor Driven Rotary Blower; Package Tying Machine; Johnson Ground Clamp; Sprague Single Strip Cable; Seal For Conduit; Compensarc for Motion Picture Projection; Stopping the Leaks; Saving The Cords.

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Electrical Engineering

Incorporating Electrical Age and Southern Electrician

ISSUED MONTHLY BY FRANK A. LENT

258 Broadway, New York

Chicago Office, 814 Westminster Building

GEO. A. WARDLAW, Editor

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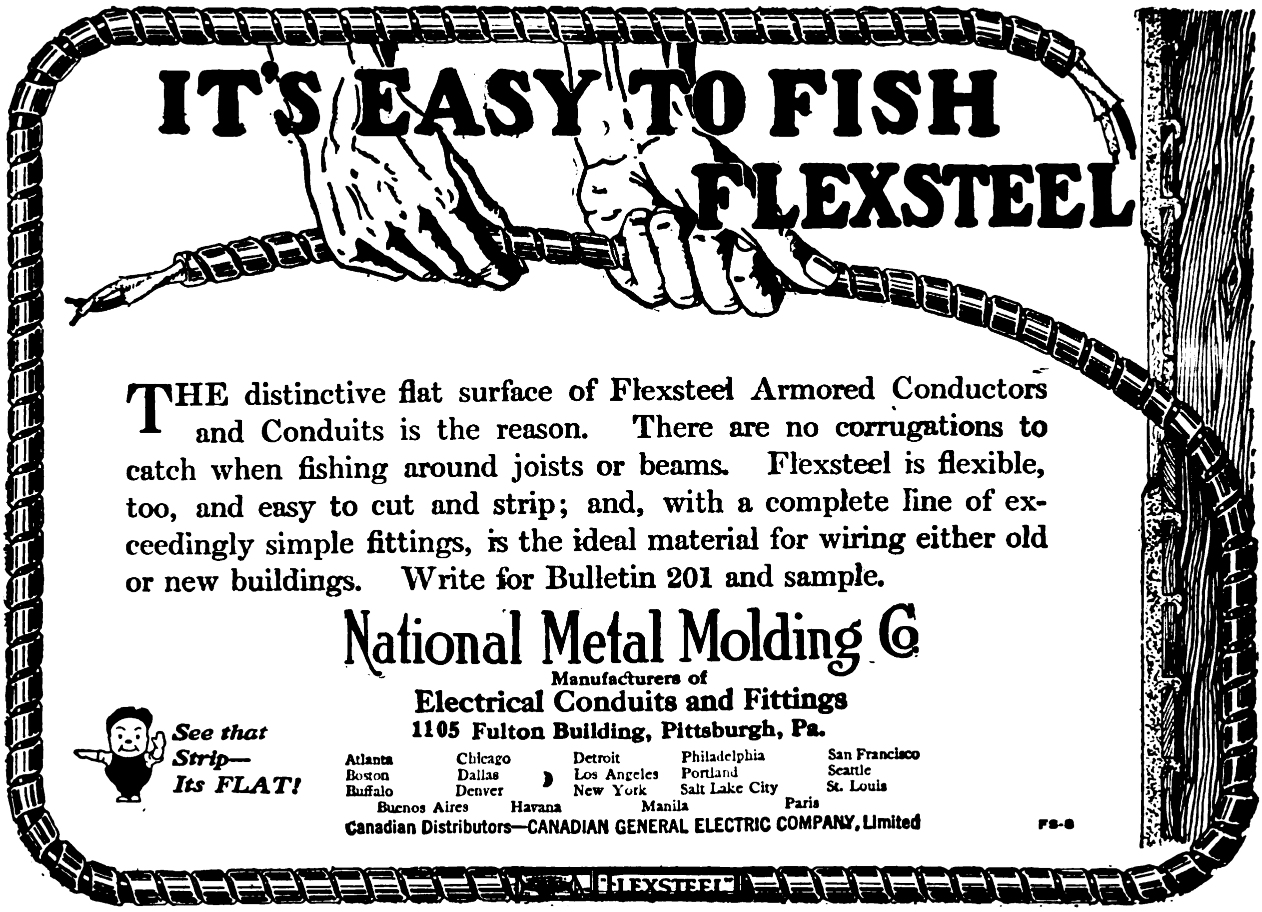

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Electrical Engineering

Treating of the Theory and Practice of Electrical Generation and Transmission, and the Utilization of Electrical Energy.

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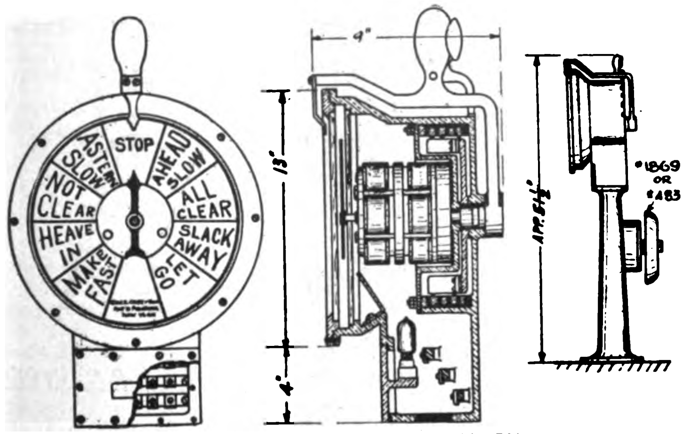
Vol. 52 **JULY, 1918** **No. 1**

ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

By H. A. Hornor

(Continued from page 23, June issue)

On large passenger steamers an elaborate and expensive call-bell system is installed between all the various accommodations and the different pantries. In the cargo ship this resolves itself into a simple annunciator located in the galley with push



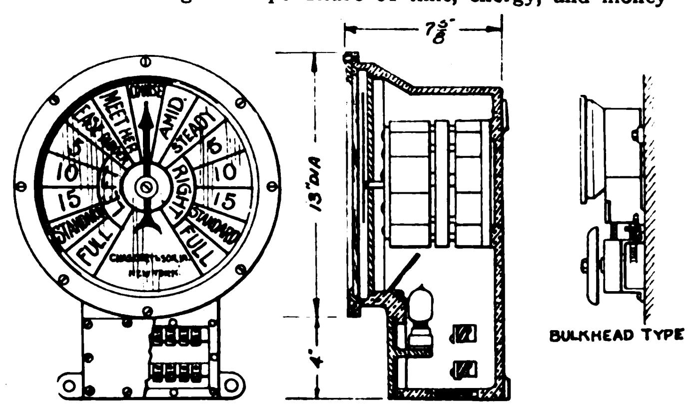
ELECTRIC DOCKING TELEGRAPH

buttons in the officers' mess room and the principal officers' cabins. Alarm bells are required by law for those sleeping quarters where there are no watchmen on duty. These alarm bells are operated from the pilot house and are for emergency purposes. Electrical howlers are also approved.

Cargo vessels do not attempt to detect fires and therefore fire alarm systems are not very often installed, although there is on the market an expensive system requiring the piping of the cargo holds. This system indicates a fire by the smoke moving up through the pipes, and employs the same pipes to smother the fire by injecting live steam into them. Passenger vessels usually install elaborate systems for fire alarms, although this application has received very little consideration. There is also on the market a good method based on the expansion of air due to heat in a pipe of very small diameter, say 1/32 in. This makes a very small pipe, about the size of a bell wire. This pipe can be unobtrusively run on the woodwork or in the bolection molding.

The inception of a fire is quickly indicated on a suitable panel in some important place on the vessel. This panel may take the form of the ship itself in miniature, and the indication given by sounding a bell and lighting a small battery lamp. The installations of this system so far as known have been successful. Other systems are now quite obsolete and are not worth discussing. When large ocean passengers vessels are built in this country this subject will be of extreme interest.

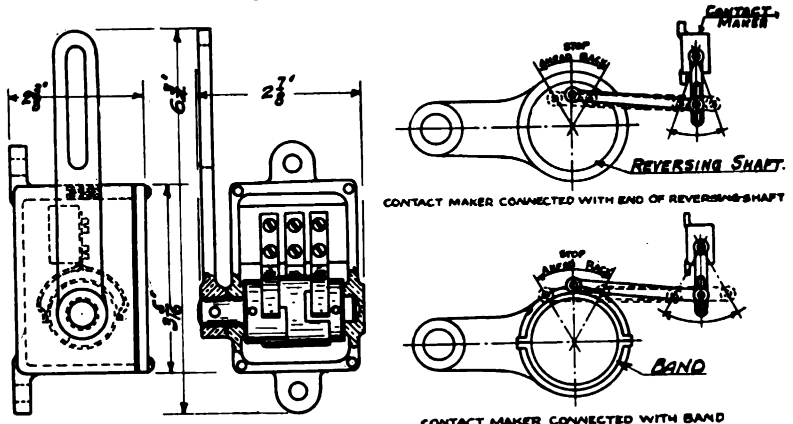
That the mariner today is just as safe in a fog bank off the coast as if the sun were shining and the fair blue of the sky all around him, is due entirely to those men whose conviction in the transmission of sound through water was firm enough to lead them into a great expenditure of time, energy, and money



ELECTRICAL STEERING TELEGRAPH INDICATOR

in order to rid the navigation of coasts of this menace; even more to make it possible for two vessels to communicate to each other under water while they were both travelling on the high seas. Where then is the terror? These men have cast aside the great dangers of the deep. The solution of the first part of this problem is now reduced to such simple terms that the expense would seem unwarrantable. Large submerged bells are swung from lightships or buoys which mark the shoals.

These bells are sounded at intervals or continuously by several different methods; namely, electrically, pneumatically, or by wave motion. Two tanks filled with a brine solution are located in the forward part of the ship well below the water line, port and starboard. Attached to these tanks are telephone transmitters which are wired to a telephone receiver located in the pilot house. The captain by placing one or the other of these receivers to his ear can distinguish the sound of the bell and even detect the approach of another vessel by the noise of the engines. By using both receivers and changing slightly the course of his ship he can take a bearing and so pursue a safe journey. The unbalancing of the intensity of signal readily indicates whether the sound signal approaches from the port or starboard side. The range is evidently satisfactory for practical purposes as all the large maritime nations have equipped their coasts with submarine bells.

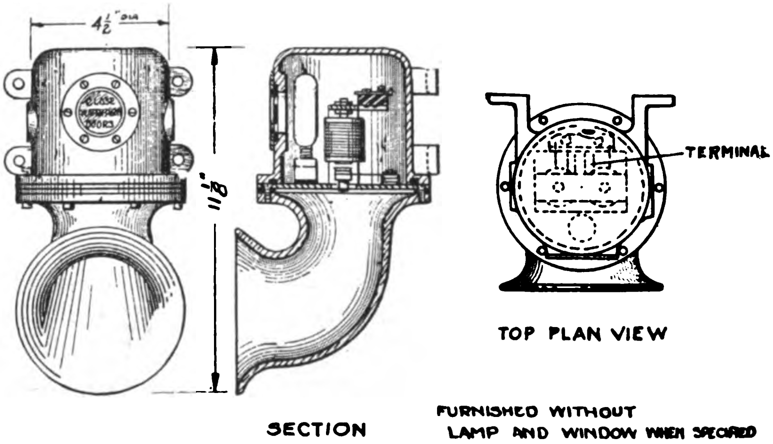


CONTACT MAKER FOR ELECTRICAL ENGINE DIRECTION INDICATOR

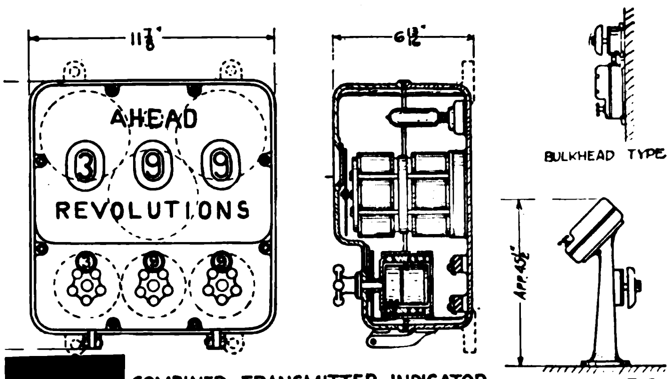
The second part of this problem; namely, the transmission of messages under water between two vessels, or between a vessel and the shore, is more complicated. The apparatus is also too expensive for general adoption in merchant ship practice. It consists broadly of an electrical oscillator which impresses a characteristic impulse in the fashion of a wave under the surface of a body of water. This oscillator acts both as a transmitter and receiver. The oscillator may be actuated through an ordinary telegraph key and the signals detected by means of telephone receivers.

Messages transmitted through water in the manner just outlined are an innovation, and great strides in the development of the apparatus must take place before this method will attain superiority over the radio-telegraph sending electromagnetic waves through the air. The advantages of a water medium can be easily recognized now and will in time be fully utilized. But at present the merchant ship is best protected by its long distance communication via the wireless telegraph. So rapid are the improvements in radio-transmission that it seems magical. It would be presumptious to attempt a description of one or many of the various types of apparatus that are today installed in the merchant service. The advances made have all tended to increase the range and the reliability. The best method for any one who wishes to gain detailed information on this subject is to apply directly to the Government or, for general information, to consult technical journals.

The shipbuilder usually provides the feeder for supplying direct current to the wireless motor-generator set and assists with the fitting up of the apparatus. The owner rents the apparatus, and the wireless company at the direction of the government installs it. In some cases the shipbuilder does the entire work of installation. Because of the danger involved, especially on oil-tank vessels, great care must be given the proper grounding of the system to the steel hull. The practice has been adopted to place shunt grounds at the deck end of all the guy lines from masts or smoke stacks. There can be no bad effects on the wiring installation if the conductor is of the steel-armored type, but in a mixed system of conduit and molding trouble may arise in those circuits run in the wooden molding. For the wooden vessel a copper, or brass plate of large dimensions is secured around the hull about midships and the ground connections are made on this. The use of insulators in the rigging was experimented with a few years ago and found disadvantageous. The great secret of all wireless success has been the excellence of the ground.



ELECTRIC HOWLER FOR WARNING SIGNAL, A.C. TYPE.

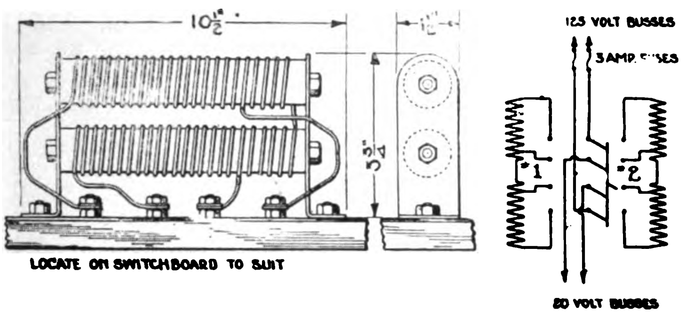


COMBINED TRANSMITTER-INDICATOR ENGINE REV. TELEGRAPH

Gyro Apparatus

A great many years ago a number of scientists turned their powers of observation to the spinning top, then as now a nursery plaything. Straight-line motion had been converted into rotary motion by means of the knuckle joint and crank, similitudes of the animal anatomy. How many great inventions have arisen from a study of the human body—that thing not made by hands. This interest in the top was undoubtedly the first appreciation by man of the value residing in direct rotary motion. About 1852 Leon Foucault, an eminent French physicist made, as he states, "after eight months of assiduous superintendence" the first non-magnetic compass. He named his instrument "gyroscope" because, he says, "it depends upon the rotation of the earth and are but varied manifestations of such rotation." He could only spin his top for a very short period of time, but with great care and skill he had mounted it upon a frame work which in turn was held in a bracket so that he could observe the various changes in power and direction when the angles of inclination were arbitrarily adjusted. What of moment he noted is thus briefly summed up in his quaint language:

"If at the moment we put it in rotation this body by its axis points at a star in the sky during the whole time that the movement (spin) lasts, this axis will remain pointing toward the

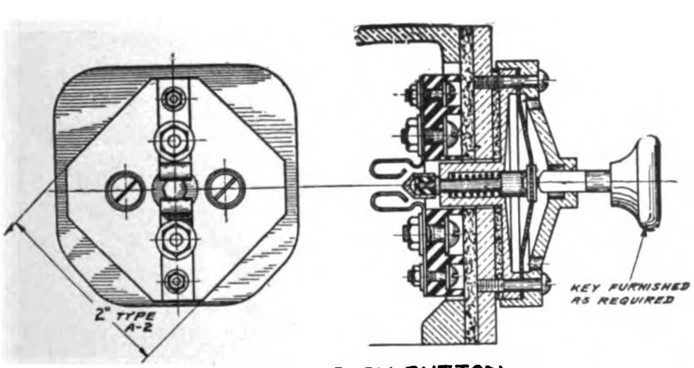


RESISTANCE UNIT FOR LOW VOLTAGE INTERIOR COMMUNICATING APPARATUS.

same point of the firmament, and this in virtue of the inertia of matter, or for the very good reason that it is incapable of displacing itself or of altering its direction by itself. If, therefore, we select a suitable star, or if we aim at one of the points of the heavens which appear to be moving most quickly, the axis of rotation, when carefully examined will be found to share the same apparent displacement and will give emphatic evidence of the earth's movement. Of course, one should not point the axis in the direction of the solar star, because this star, not having any apparent movement, the instrument would act similarly and not indicate the earth's motion."

After these illuminating deductions were made, other men in other fields gradually developed the utilization of electric current and when the agencies of both were combined by skill, the gyroscopic compass was the result. Electricity provided a ready means of maintaining the "spin."

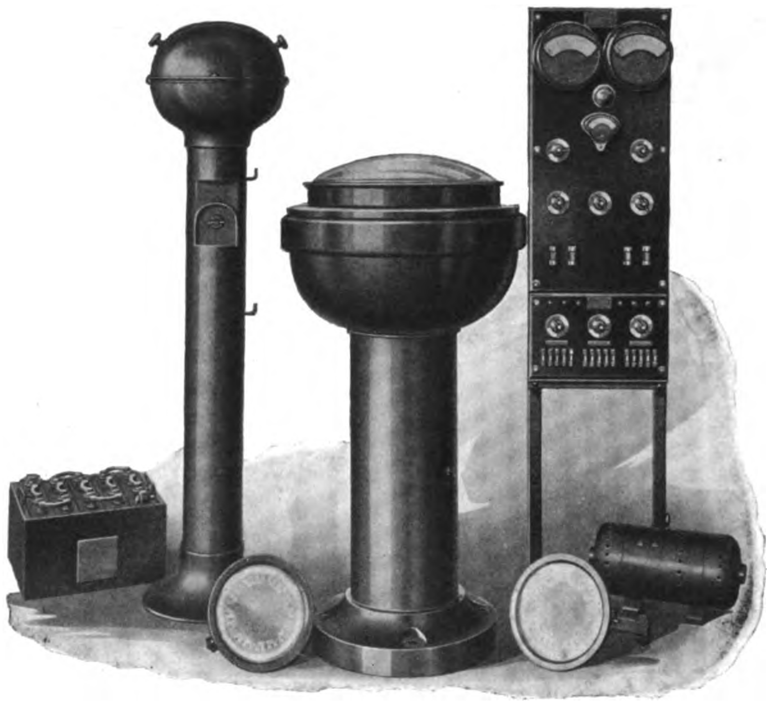
In later years the names of two men are inscribed upon the practical development of this revolutionizing device, that of Anschutz of Germany, and Sperry of the United States. A detail description of the work of these men would be out of place, as consideration must be given solely to the application of the apparatus. But Elmer A. Sperry has pushed his developments far ahead of Anschutz in the matter of simplicity of use in that he obviates any reference to mathematical tables, making all the requisite corrections either automatically or by easy adjustments on the instrument. Mr. Sperry is to be highly com-



WATER TIGHT PUSH BUTTON-TEST OUT

mended for his unflinching faith in the basic principle enunciated by Foucault, and his untiring energy in the ingenious solution of the many problems which have so immensely widened the field of application. In a paper read by Mr. Sperry before the 24th general meeting of the Society of Naval Architects and Marine Engineers and extracted in Vol. XXI, No. 12, of *International Marine Engineering,* he clearly defines the action of the gyroscope in simple terms. He says:

"The field of force utilized and upon which the new navigational instrument depends for its directive power is the actual rotation of the earth. This angular motion, although it occurs about an axis some 4000 miles distant, through a well-known gyroscopic phenomon, compels the gyro wheel to set its spinning axis parallel with the axis of the earth. The earth's rotational force is so impressed upon the gyro as to cause this phenomenon to take place with the greatest exactness, so that it may be employed as a navigational compass of high precision. The phenomon being a terrestrial one, the pointing is upon the true geographic meridian, which is identical with that utilized in navigation; therefore, when the compass is properly organized, no deviations or variations exist to complicate its use. The reason for the high precision of the gyro-compass lies in the

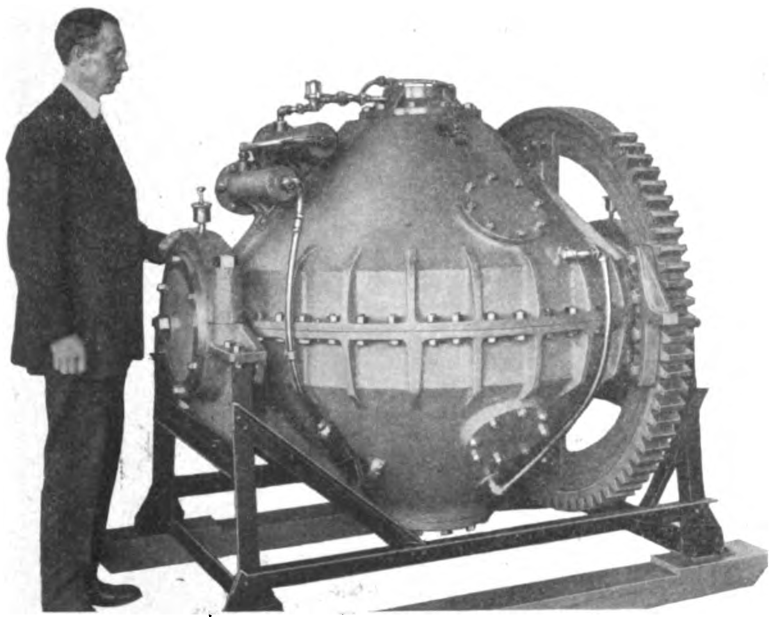


Sperry Commercial gyro-compass equipment. Sperry Gyroscope Co., Manhattan Plaza, Brooklyn, N. Y.

fact that, in addition to its true meridional pointing, its tenacity of purpose or directive power is many times that of the magnetic compass. The directive power of the new commercial compass is about 150 times that of the same standard navy magnetic compass in the positions occupied in both naval ships and those of the merchant marine."

The gyro-compass has not had general adoption in the merchant marine, due mainly to the fact that a commercial instrument has only recently been placed upon the market. As will be noted by the following quotation from Mr. Sperry's paper, the gyro-compass can easily be equipped by means of electrical connections to function as a perfect transmitter of compass readings. This characteristic enables the captain to steer his vessel from a number of locations in cases of emergency. This is not all. The compass may be made small in size and reasonably light in weight. He states:

"All repeating instruments are positively driven by especially designed step-by-step motors, which have no moving contacts in circuit. These instruments follow the movements of the master compass with a maximum error of about 1/12 degree and a lag of about 1/100 of a second. Less than 10 watts of energy are consumed for each instrument, yet the card is driven with as high a torque as 10,000 gram-centimeters, which abundantly insures the instruments against derangement from shock of gunfire. The new compass for merchant ships is smaller and lighter than the battle gyro-compass, and is being developed in a still smaller form for use on aeroplanes and small yachts.



Sperry gyro-stabilizer from 500-ton yacht. Sperry Gyroscope Co., Manhattan Plaza, Brooklyn, N. Y.

As built at present, it weighs only about 50 lb., exclusive of the binnacle in which it is mounted, the complete weight with the binnacle being only about 225 lb. The smaller size will weigh only about 40 lb. where the aeroplane mounting is used, there being no binnacle. The overall diameter of the compass with the binnacle is only about 16 in., and the weight about 100 lb. Due to the small size of the wheels (the wheels used on the destroyer type are only 5 in. in diameter), the time required to bring the compass up to speed from rest is only about 5 min.

"Three standard compass equipments are supplied. The simpler equipment consists only of the master compass, motor-generator, and a very simple switch panel, while the larger equipment contains in addition a pelorous stand, storage battery, two repeater compasses, and a larger switchboard, one panel of which is to care for the repeater compasses. These equipments are being installed on the secondary naval ships and the larger ships of the merchant marine."

In addition to the applications cited above, the practical operation of the gyro principle makes it an exceedingly good device for preventing the rolling of ships. Mr. Sperry has entered this field with the same success as that of the compass, and with his stabilizing apparatus both on ships of the sea and ships of the air, he has so improved the efficiency that great gains have resulted in carrying capacity, readiness of action, and safety of operation.

Motor Auxiliaries

In considering the application of the electric motor to shipboard purposes it should be borne in mind that at present this subject is in a transitional period. The applications previously discussed can be generally classified as agenda, or things done, the questions now to be investigated are of a speculative or experimental nature. Changes are often made for no reason whatsoever; not even for progress. This cannot be said of the contemplated employment of the electric motor in substitution of the steam engine. Subtly but reliably the electric motor first entered the field where steam motors dare not tread. This was the advent of the small motor—first for driving desk fans, then for galley (kitchen) utensils, and then for the larger ventilation blowers. This method of entry did not produce much opposition, but it also did not give a substantial promise for an argument in favor of the larger applications. The advance in the art of equipping large ocean liners demanded the use of electric elevators, electric cranes and other handling devices. Still the ordinary freight steamer maintained its fealty to the old methods in the face of this advance and the rapid developments of the application of electric motor equipment to naval vessels.

Historically in this country the first determined effort to replace steam power is an important function was the installation of the Pfatisher electric steering gear on the S. S. "Finland" of the Red Star Line. Briefly stated, this system consisted of a direct-current motor geared to the rudder and connected to a specially wound generator. The generator was built with two fields wound in opposite directions and balanced by two arms of resistance. In this manner perfect control of the steering-gear motor was obtained on the bridge. The student of physics will doubtless recognize here the similiarity to the well known method of Wheatstone for measuring an unknown resistance.

From the time of the "Finland" the adoption of electric steering-gear has been sporadic, although from time to time many English vessels were equipped with an auxiliary electric gear. The advantages of such an auxiliary reside in its ability to perform the same functions as the steam gear and thus permit the vessel to continue at full speed. The hand gear which is always carried requires at least a reduction to half speed for its operation. The more recent developments of the electric steering gear have been one large vessels.

The application was resusitated by the development of the automatic circuit-breaker known to the trade by the name "contactor." The motor or motors were directly geared to the tiller, and remote speed control obtained by energizing or de-energizing the contactors which automatically introduced or cut out resistance in the motor-circuits. This system necessarily produced heavy instantaneous loads on the generating plant, and for large steering gears made recourse to two motors instead of one in order to bring the currents within the range of the development of contractors.

As a further improvement, and to avoid the repeated shocks upon the generating plant, another design of control was employed. This design required the use of a special motor-generator used solely for control. Broadly stated it was similar to the well-known Ward-Leonard system. Neither of these designs has been adopted by the merchant service.

The crux of the steering gear problem rests in providing sufficient power to carry the rudder to the "hard over," position about 25 degrees to 30 degrees when the vessel is proceeding at full speed. A bare fraction of this maximum power is needed when the ship is on her course. At all times there must be good speed control so that the response to the wheel is immediately effective upon the ship. This latter requirement does not refer to cases of emergency alone but is of importance when the ship encounters a sea way.

(To be continued)

p 17-22 (Jul, 1915) waiting

"That is what the mines must mine, railroads must carry, switch and deliver to destination, more than was mined before on a railroad system that has been very little enlarged; but it must also take care of all of these enormous new supplies, shipbuilding and other supplies.

"Up to the present time the coal shortage has certainly been a railroad problem. We have lost considerable help from lack of work. Many of you know the situation. It is going to be a labor problem as well as a railroad problem. As I say, we have lost help, and the draft is taking help. If you say we must mine all this coal, yes, you can do it, and you can even get the railroads to carry it if you don't do anything else in the country, but there are all these other things to do. It all goes back to man power, and you have got to spread that man power around, to use it in shipbuilding, furnish so many to the army, and you must devote its share to improving the railroad facilities, and getting into the mines and getting the coal out. The problem we have is to meet an increase of 100,000,000 tons, and we can't make it. If we make half of it, we will do well.

"Now, what is the answer? There are two. The first, of course, and the obvious one, is to save all we can. Fortunately this country has been a very extravagant and wasteful country. Coal has been so cheap for manufacturing interests —I won't say the utilities, because that is their raw material— only 2½ percent., or in some cases only 1 percent., of the cost in coal so they haven't given any attention to it.

"The second is the great question of economy of power, of getting the benefit of the power we do make by fuel, and by other means, such as water, oil and so on, and getting all we can out of it. Then there are the other avenues of waste, as the householder, and the waste of light, all of those, in six divisions, we are attacking. But to save anything like 100,000,000 tons, as you all know, or even 50,000,000 tons, is something to do, but if your life depended on it, you would say, 'Well, that is on paper,' and we had better look around to some other life preserver, rather than to depend on it.

"There also comes in it the other safety valve, which is curtailment. Now, curtailment of industry, which is the place where curtailment has to come, is almost as serious as not having shell steel. The only standard you can make is war and non-war. Now, it is easy to understand, if we are going to have a shortage, it is certainly coming out of the non-war.

"We have probably 10,000,000 men, probably $20,000,000,000 worth of capital that is almost as important as the shell steel to the success of the war, to say nothing of the economic life of our country, to say nothing of after the war, so that I tell people to not always be saying a ton of coal means so many ships and means so many shells. Get your eye on the other end; a ton of coal in many places means a hundred people kept at work, every ton of coal you can save anywhere will keep at least fifty people at work.

"We have no right to put the utility people on the Table A list, and be sure that they get 100 percent. coal, if 60 percent. of their power is non-war, unless they are a part of the Fuel Administration, and the other 40 percent. is handled as we would handle it. In other words, as I said to the steel people, there is no way to try to give you 80 percent. or 60 percent. of your coal. The first thing to do is to make the steel business a war industry, a 100 percent. and then be sure it has 100 percent. coal. Now we want to make the utility business a 100 percent. war business in the double sense. Now that means that you have got to act for us on the remaining 10, 20, 30 or 40 percent., which does not belong to any of the war needs.

"We have got to police the distribution of all the coal that can be saved from war industries. I have told the people down in Washington when we get to the district where there is only enough coal for war industries, and not a ton for anything else, we have got to be brave enough to face it, and say we are going to furnish the other industries some. If we have districts in which there is not enough coal for the war industries or any to spare, we have got to take a certain portion of that away from war and spread it around just enough to prevent disaster. Now, somebody has got to divide that, got to put it where it will do the most economic good, and you have got that same delicate problem of dividing your power, because it is not going to be fair for us to say to an umbrella man, you are only allowed your share of 70 percent., whatever it is, and the other umbrella man alongside of him gets his power from the public utilities, which get 100 percent.

"In other words, we have got to get close enough to you and you have got to get close enough to our problems so that we are just as safe in your hands, not only in the economical making of the power, but in the distribution of it first to war industries, and second what is left along similar lines to those on which we are distributing coal, so that it will preserve this country from economical disaster."

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The transformation of the remaining energy into the electric light, through dynamo, transformer and cable to lamp, means a loss of two percent. leaving seven percent. of the total for the light. The incandescent lamp wastes ninety-five percent. of the energy put into it through heat. That is, five percent. of less than eight percent. or less than one two-hundredths of the original energy in the coal actually produces the light. An almost perfect performance of inefficiency, not greatly helped by the newest lights, and this the most general method of light production.

How poorly man's efforts compare with nature's in the same direction—the light of the firefly, which, science says, has an efficiency of over ninety-nine percent. That is, the effort of the female, the males being unenlightened, in making light is almost wholly successful. The mere fact, however, that this and similar data are available shows the problem of efficiency to be receiving serious attention.

It is not actual efficiency, but the rate of improvement in such efficiency which must be considered in our development. Even if less than one percent. of the energy produces the light it is no synonym of failure; rather, of worthy accomplishment. Our progression has required too much effort.

The point is: Our present all-around efficiency can be greatly increased without any effort over and above what we are accustomed to put forth, if such effort be given the proper direction.

Monad.

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IMPROVEMENTS IN ELECTRICAL POWER WORKS IN FRANCE

One of the good results of the war will be to have aroused throughout France intense industrial activity, and consequently a considerable increase in electrical power works, formerly scarce in that country. In fact in 1884 they amounted to 7 only. In 1914 they numbered 1,173 some of which were over 10,000 h.p. By utilizing the great hydraulic forces of the region of the Alps, power was supplied to the works in 10 departments making an area of 57,000 square kilometres. The rivers Isere, Arve, and Durance form resources which are turned to good account by twelve hydro-metallurgic societies representing a total force of 180,500 h.p. During 1914 various plans for utilizing other waterfalls were being considered. Electro-mettallurgy has been rapidly improving during the war, as well as chemical manufacturers, so most of the plans made for development in these industries have either already been carried out, or are now in course of execution.

The manufacture of large calibre shells and armor-plate is assured by the help of water-power. Thanks to the facilities that the transporting of electrical power offers, the works which undertake to produce it can combine the advantages of the water descending from the glaciers, very plentiful in summer-time, with the force to be obtained from the waters of the rivers, which are swollen by the snowfalls of autumn and winter. Such is the system as a whole, adopted by the "Societe de l'Energie Electrique due Centre," which supplies electrical power to the towns and factories of the Loire, the Haute Savoie, and the Allier, and exceeds 20,000 h.p.

Before 1914, factories were scarce in the south west. One of the remarkable results of the war will be the industrial activity produced in the regions of Languedoc, Gascony, and Guyenne, which indirectly causes the development of electrical power works and enterprises. The Societe Pyreneenne d'Energie Electrique has seen its custom amongst manufacturers vastly on the increase since hostilities began. It covers in length over 1,100 kilometres. Its reserves are constituted by more than 50,000 h.p. obtained by the falls of water from the lakes and rivers of the Pyrenees mountains.

These new factors, fitted with the most modern appliances, and whose capital, to a large extent, will be covered by war profits, will one day and immediately after peace is signed, be called upon to play a considerable role in the economic struggle of the future. They will enable France to become a large producer of matter and materials for which Germany had formerly almost exclusively held the monopoly in manufacture; such as chlorine, bromine, magnesium, and products required in the dyeing industries. They also allow of very great economy in coal, and will become a fresh source of inexhaustible wealth and prosperity for the country.

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U. S. CHAMBER OF COMMERCE RECOMMENDS ASSISTANCE TO UTILITIES

The Chamber of Commerce of the United States adopted the following resolution at its Sixth Annual Meeting, held in Chicago, in April, 1918, and is sending a copy of it to every organization of importance in the country, urging consideration of the bearing of the resolution upon the situation of the public utilities in its community, the preservation of their credit and their ability to continue to furnish necessary services, and requesting the organizations to place their recommendations before the state and local regulatory bodies:

"Whereas the maintenance of the country's public utilities in the highest possible state of efficiency is essential not only to the war program of the United States but also to the nation's business, industrial and public interests; and

"Whereas such efficiency depends upon the preservation of the credit of the companies providing public utility service; and

"Whereas the increase of costs and the unusually onerous conditions of operation brought about by the war seriously threaten the ability of the public utilities to continue the furnishing of the necessary services they perform; and

"Whereas the protection of the credit of public utilities is very largely in the hands of regulatory commissions and other public authorities, rather than in the utilities themselves: Now, therefore, be it

"Resolved, that the Chamber of Commerce of the United States recommends to states and local authorities that they recognize the unusual and onerous conditions with which public utilities are contending, and that in the interest of the nation, of business, and of the public they give prompt and sympathetic hearing to the petitions of such utilities for assistance and relief."

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BOSTON EDISON WAR GARDEN

The Boston Edison Co. has decided to discontinue its practice of the last two seasons, of operating its own vegetable garden, and has turned the available land over to its employees who are interested in raising vegetables for their own use. Nearly three acres of land in the more recently acquired area of the property have been ploughed and harrowed at the company's expense, and divided into plots of approximately 2,500 square feet each, there being thus made available, 41 lots.

More than fifty applications for plots have been received. The plots were assigned by lot during the latter part of April. This early spring enthusiasm has been maintained, and the plots to-day, as a whole, are nearly all planted and are in good condition. The gardens are in charge of a committee consisting of Messrs. A. L. Knox, O. W. Labdon, and J. H. Horne, which committee served so efficiently last year. The plots have been assigned under certain restrictions.

SAFEGUARDING THE HOME AND PERSON FROM ELECTRICAL ACCIDENTS

If someone were to make a compilation of fatal electrical shocks caused during recent years by carelessness or curiosity it would show that the toll, though not comparable with that exacted by other forms of carelessness or curiosity, is too serious to be passed over lightly. The causes of these accidents have been investigated in a painstaking way by the Bureau of Standards of the Department of Commerce, and are set forth in an unusually interesting way in Circular No. 75 which was issued early in the year. Here is the story, well worth the reading by all those who are likely to lapse into carelessness in the presence of or within the zone of influence of live electric circuits.

Electricity is one of the most conveniently applied forms of energy for household processes and activities. It is used not only to illuminate the home, but to supply power to various small motor-driven apparatus and to supply heat to cooking appliances and other small heating devices. In addition to the great convenience and adaptability of electricity for such purposes, it has the further important advantage, when properly used, of increased safety over many of its predecessors and competitors for rendering like service, such as candles, oil lamps, acetylene, and gasoline, for lighting; gasoline for power; and coal, oil, or gasoline stoves for cooking and heating. It does away with the use of matches and the use within buildings of substances such as coal oil and gasoline, which of themselves impose a greater or less fire hazard whenever stored within the building.

Notwithstanding all this, there are serious possible hazards to both life and property from electric wiring and devices if wrongly installed or mishandled. These will be here considered, so that the careful householder may realize the maximum degree of safty in his electrical installation which the development of modern methods of wiring and modern designs of appliances make available to him. The current which passes through wires can not be seen, but the considerable amount of power sent over them can be appreciated by its effects in supplying lamps, motors, and heating appliances. It can thus readily be understood how an electric current may cause fatalities or fires if diverted through the human body or through combustible materials, and the record of electrical accidents shows that there is, in many cases, need of greater care and precaution on the part of the users of electricity in the home, as well as of the general public, utility companies, and electrical workmen.

Because the convenience of electricity is extending its use so rapidly, and because our highways and buildings are being equipped with networks of wires, some definite ideas as to the nature of electrical dangers and how to avoid them should be familiar to every householder and to every child old enough to play or work unattended. Each person will thus have it largely in his own power not only to avoid shocks and burns to himself, but frequently to warn others against dangerous places and practices.

What are the Dangers from Electricity

Accidents of electrical origin may be classified in three groups —shocks to persons, burning of persons, and burning of property. A fair understanding of the causes of electrical accidents requires some appreciation of the meaning of the terms electric current, voltage, and circuit. The simple analogies between an electric circuit and a line of garden hose may be of assistance in this connection.

(*a*) *Analogy Between Flow of Electricity and Water*—The line of hose determines the path of water flow, just as the metallic wire determines the path of the electric current. The force which causes the water to flow is the height of the water surface in the reservoir or standpipe above the hose nozzle, while that which causes the electric current to flow is the voltage (or electrical pressure) on the wires entering the building. The opening of the nozzle of the hose corresponds to the closing of a switch on one side of the electrical circuit. Just as the opening of the hose nozzle allows water to flow from the high-pressure water supply to the open air where no pressure exists, so the closing of the electrical switch allows current to flow from the wire under higher electrical pressure to the other or to the ground. A leak in the hose covering allows water to escape and corresponds to a breakdown of the insulating covering which confines the electrical current to its designed circuit. This escaped current may cause personal injuries or fires as outlined in what follows. The analogy is by no means complete, but it serves in place of a long technical exposition.

(*b*) *Shock*—Electrical shock is the name given to the physiological effects on the human body produced by the passage of electric current through any portion of it. Small shocks may be manifested by very slight tingling sensations in the part of the body through which the current passes, or frequently in minor muscular contractions which become more severe and even painful as the amount of the current increases. Severe shocks may cause muscular contractions which will throw the person down more or less violently or throw him against neighboring objects, thus causing bruises or fractures. And in extreme cases the shock may actually injure the muscles affected or even check or stop heart action. Another rather common effect of severe shocks is to stop the process of breathing. If breathing is not started again within a few minutes, it may result fatally, and proper methods to restore breathing need to be very quickly applied. (See Fig. 1). This can often be done when the victim of a shock is apparently lifeless by applying the first-aid method.

Slight shocks are sometimes administered by physicians because of their stimulative effects. Heavy shocks are more or less harmful according to the severity, even if unconsciousness or other visible effects do not result. The severity of the shock depends upon several factors, increasing with the voltage which is applied and with the area of the contacts made by the electrical circuit with the body, since both factors permit an increase of current flow. On the other hand, the severity of the shock is reduced as the resistance of the portion of the body coming into electrical circuit is increased, since this would tend to prevent the flow of a large amount of current. The amount of this resistance depends partly on the portion of the body coming into the electrical circuit but largely on the character of the contact surfaces, whether large or small and whether wet or dry. A contact with the dry skin of the hand, for instance, especially where calloused, will give very high contact resistance, tending to reduce the shock, whereas a hand or other part of the body moist with perspiration or from other cause will give comparatively low contact resistance and correspondingly greater shock when other conditions are the same. A lineman with dry calloused hands might safely handle a wire which would give a serious or fatal shock to a child or woman or even to himself if it touched a damp wrist Where large blood vessels are close to the surface of the body, as at the wrist, the resistance will usually be less than elsewhere. The resistance within the body, and therefore the amount of current flowing under a given voltage or pressure, depends much upon the course of the current through the body, whether the blood vessels lie along or across the path of the current. If along the path of the current the resistance is low and the seriousness of the shock relatively great.

Another factor of great importance in determining the severity of the shock is the course of the current as related to vital organs of the body, a current passing from finger to finger of one hand, for instance, having usually only a local effect; whereas when passing from one hand to the other the course of the current may lie through the vital organs, the heart, or the central nervous system and be much more likely to cause serious results. A similar serious result might follow were the path of the current from the neck to the foot or even from a hand to a foot.

(*c*) *Contact Burns.*—When a current passes through any portion of the human body, besides the shock effects mentioned above there may sometimes be, if the intensity or duration of current through any part of the body fluids or tissue is very great, a serious structural change of the fluids or tissues, possibly enough to cause permanent functional disturbances or even the destruction of vital tissues. Only rarely, however, even in the most severe and even fatal shocks, will there be serious internal changes of these kinds.

Fig. 1.—The prone-pressure method of resuscitating a person who has received an electric shock.

Much more frequent injuries from contact with live parts are electrical burns which result in the following manner: Where the area of surface contact of the body with an electric circuit is very small, the current, which within the body may be distributed over a wide path and along fluid paths of low resistance, may be so concentrated in the small surface area where fluids are absent or quickly dried up as to cause a local burn. Accompanying severe shocks there is frequently more or less destruction of external tissue at the point of contact by burning. Often, however, where the shock effects are very slight, or though severe have only temporary effect, the burning at the points of contact may be serious and its effects last a considerable time, possibly with some disfigurement. With large areas of contact, as where persons are in bathtubs and touch live electrical fittings with wet hands, contact burns may be absent, because the contact resistance is low, but the amount of current passing through the body will be greater, and the shock and other internal effects will be greater also.

(*d*) *Precautions to Prevent Shocks from Electrical Devices.*—Both electrical shocks and the kind of electrical burns and internal injuries mentioned above are caused by the passage of an electrical current through the body and are entirely impossible if a circuit is not *completed* through the body. The mere contact of some *one* part of the body with some portion of an electrical circuit will *always be harmless* unless through contact of some *other* portion of the body with some *other* part of the electrical circuit or with some other conducting surface—the ground, plumbing, or the like—a completed circuit is made through the body and a current thus permitted to flow from one surface of the body to another. The precautions to be observed in electrical installations, as outlined hereafter, are intended to minimize the probability that the person will accidentally make an electrical circuit through his body and to minimize the danger if one or even more contacts *do* occur.

Before touching any electrical device such as a portable cord or device or a switch (these being most often handled), persons of careful habit will see that they are not *also* touching any other part of the electric circuit or its devices and will so far as possible *use only one hand* on the device. They will also at such times avoid standing on or leaning against plumbing fixtures, tubs, radiators, basins, or even standing on cement or brick basement floors not covered with dry wood or rubber platforms. Outside of buildings careful persons will avoid touching any wire or other conducting object which may by any possibility be itself touching overhead electric wires at some other point. By such precaution persons will avoid allowing the body to become a portion of an electric circuit.

The protective measures applied to the indoor and outdoor wiring as a means of preventing the likelihood of shocks, burns or internal injuries, and of reducing their severity where for any reason shocks still occur in spite of reasonable safeguards in the manner of installation, will be taken up in some detail later in this article. They consist of, first, the complete isolation of high-voltage wires; second, the use for wiring within buildings, and thus more or less accessible, of only comparatively low voltages, together with the prevention of higher voltages on this interior wiring by various means, usually by connecting one point of the low-voltage circuits to ground; third, the provision of certain specified insulating coverings over all wires and other current-carrying parts of electrical installations; fourth, the grounding where practicable of external metal parts of electrical devices which may be handled. The insulating coverings serve to prevent contact of persons with live parts, even at low voltages, and the ground serves to prevent existence of *any* voltage between the wire or part grounded and the ground or grounded objects which a person may touch at the same time.

(*e*) *Flesh Burns.*—A kind of electrical burn other than the contact burns mentioned above may result without the body coming into contact with more than *one* part of an electric circuit or even *without a single* contact through proximity of the body to electrical arcs. These arcs may be caused in a number of different ways; for instance, where one of the older types of an attachment plug is partly removed from its receptacle the hand may be burned by the arcing or flashing. Such disconnection should always be done quickly and with the hand held away as far as possible from the point where the circuit is broken. Then, too, where wires are in close proximity and the intervening insulation is in any way exposed to mechanical injury or to the action of moisture, oil, or other deteriorating agency, the breakdown of the insulation may occur, causing arcing, as well as danger of shock. As will be later more fully developed the protection of house-wiring installations against injury to the wire insulation is highly important and is in practice accomplished to a satisfactory degree by observance on the part of electrical installers of suitable installation requirements, particularly those of the National Electrical (Fire) Code,[1] if reasonable care is observed by the users of the electrical appliances.

(*f*) *Fires.*—The fire dangers of electricity arise largely in the

[1]Published by National Board of Fire Underwriters, 76 William Street, New York City.

same way as do the last class of electrical burns considered above, with the difference that the arcing instead of burning some person who may happen to be touching the arcing part or be in its vicinity may set fire to surrounding fabrics or less often to the surrounding floors and other woodwork; or, if the arcing is long continued, hot metal or burning insulation may be thrown upon neighboring fabrics or building material with the same result. The precautions necessary in the installation of wiring and devices to prevent fires from this cause will be considered in some detail later.

Another and much less frequent cause of electrical fires is the overheating of electrical conductors or electrical devices which, while designed for carrying a limited current, become overloaded from some cause and carry more current than is safe. The de-

Fig. 2.—Illustrating danger from shock when in contact with an electrical fixture having an exposed metal frame which is not grounded.

Note insulating ring at *C* in back of fixture. The path of the possible current from *A* to *B* is roughly indicated by the broken lines across the body. This condition sometimes happens when a fixture wire with broken insulation comes in contact with the exposed metal part of an ungrounded fixture. (Installation rules eliminating this possible hazard have been formulated by the Bureau of Standards).

sign of such equipment necessarily requires that the normal operating temperatures either of wiring or devices be *very much lower* than the high temperatures at which danger of igniting surrounding material will occur, since any temperature even approaching this will soon make the insulation useless as such and destroy the usefulness of valuable apparatus or wiring. To prevent the passage of too large currents the electric circuits are provided in practice with fusible cut-outs which, by the melting of metal strips when too great a current flows, will interrupt or *cut out* the circuit so protected. The use of such fusible cutouts is required by the National Electrical Safety Code, Circu-

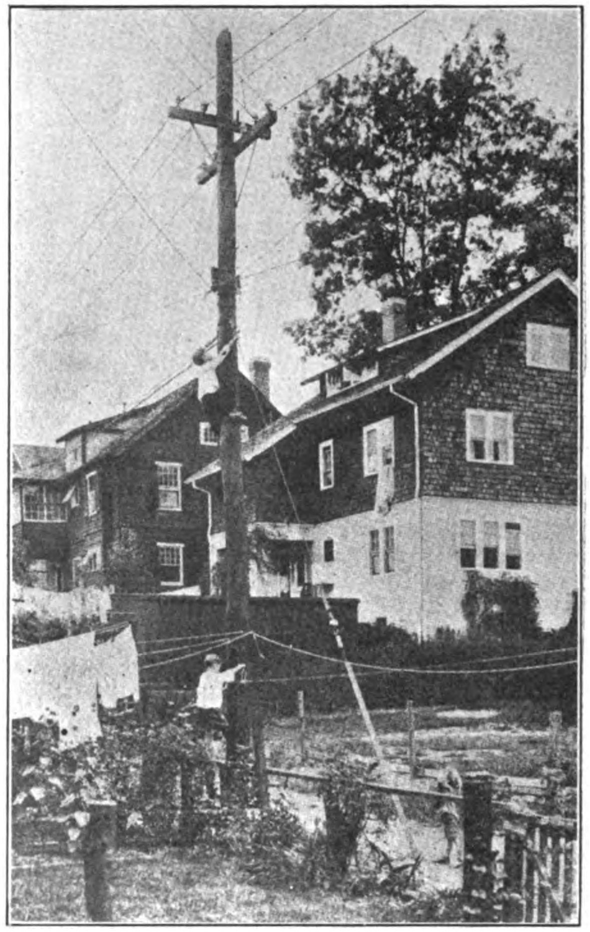

Fig. 3.—Illustration of possible danger to children climbing electric light poles.

Note that the steps ordinarily inaccessible from the ground are of ready access from the fence railing. Parents and schools should instruct against this practice.

lar No. 54 of the Bureau of Standards, and by the National Electrical (Fire) Code, and they are required to be proportioned suitably to the size of the circuit wire and equipment which they are designed to protect as will be later more fully described. The fact that there is *any* existing hazard from too heavy current in wires and devices is a result of the replacement of the proper fuses by improper materials or too large sizes either by an uninformed owner or by a careless contractor or lighting company. The object, of course, has been to avoid the *trouble* of frequent fuse replacements, whereas the blowing of a fuse *should* be followed by an investigation and, if possible, removal of the overloading which gave rise to the operating of the fuse. The overloading of wires and blowing of fuses might be caused, for example, by the attachment of too many or too large devices or by too sudden starting of motors or by excessive friction in the motors or machines they drive.

It may be stated further that the fuse itself may become a cause of electrical fires as well as electrical burns if its operation under any condition permits the scattering of hot fuse metal. For this reason fuses of a type not having the fusible metal strip incased have been for a considerable time prohibited in this country unless in tight cabinets. It is desirable and in many instances required that such fuses, even though of a type having the fusible strip incased, be themselves inclosed in suitable metal cabinets as additional precaution against fire. Certain other possible causes of electric fires will be referred to in the later discussion on interior wiring installation methods.

Private Electric Lighting Plants

(*a*) *Household Generators and Batteries.*—Electrical energy for use in the household or on the farm is usually obtained from circuits are available. There are, however, many farms which such lines do not reach. Electrical energy for lighting has so many advantages over other forms of energy that farmers and others to whom energy from the distribution circuits of lighting companies is not available frequently install isolated power plants. Wherever possible it is more desirable to locate them in a separate smaller building or inclosure rather than in the house, barn, or other principal building, since they involve the use of a gasoline or oil engine together with an electric generator.

Where oil or kerosene engines are used for these private plants the hazard is much less than with gasoline engines of similar capacity. The mixture of gasoline vapor with air is very explosive and may be easily ignited by lanterns, matches, or flashes caused by opening electric switches used with a power plant. If a private plant is placed in the home or other main building, the character and amount of fuel deserves very careful consideration.

Power plants of this type installed by persons on their own premises have increased in number very rapidly in recent years. The fact that such plants are scattered and are seldom within any regular inspection jurisdiction may have a tendency to encourage careless installation practice on the part of those who do the installation work. It is consequently necessary that careful attention should be given to secure proper equipment and proper installation.

When the proper precautions are followed, an electric plant is much safer than an acetylene or gasoline lighting plant. The use of electricity also permits the application of electric power to operate washing machines, churns, water pumps, etc. With a water system in the house means are available for quickly extinguishing a fire before it gains much headway, and power available for pumping is thus an added element of safety. It is customary to provide small electric lighting plants with storage batteries so that it will be necessary to run the plant only at intervals in order to have current available at all times.

Where storage batteries are used in this connection a few precautions should be observed. Metal objects should not be placed on the shelves or over a storage battery where likely to fall across the connections and cause a spark or a large local current. Batteries should be placed in a light place where they are easy of access and where they will be well ventilated. It would be preferable to have cells covered were it not for the fact shown by experience that when inclosed they do not receive the proper attention.

(*b*) *Safe Wiring and Appliances for Small Power Plants.*—It is common to install small lighting plants for operating at about 30 volts. This is approximately one-fourth of the voltage in common use by electric light companies and is chosen because a storage battery having only 16 cells is sufficient. To operate at the customary higher voltage would require 3.5 to 4 times as many cells of storage battery, the individual cell of which, however, would be of smaller capacity. By using a small number of cells the plates in the battery can be made thicker, permitting a longer life, while the initial cost and the cost of renewals will be less and the batteries will require less care.

A system using this low voltage requires wiring especially suited to it. Since the wiring in the ordinary city house is installed for a system using 110 or 120 volts, the farmer must make sure that the electrical contractor who does the work is informed as to the voltage and kilowatt capacity of the plant and proper methods of installation. He must not permit the fact that it is possible to use cheaper materials to lead to an inadequate wiring system. He should require that the job when completed will pass inspection by a regular electrical inspector. When the work is finished it will be worth while to have an inspector go over it, even though it be necessary to have such an inspector make a special trip from a considerable distance for the purpose. He should also require that his lines be properly fused with respect to their carrying capacity.

The 30-volt system under consideration has the advantage over the more customary 110-volt system that it involves no danger from electrical shock in case of accidental contact with the wires. The low-voltage system has the disadvantage, however, that in order to supply the same amount of power to lamps, motors, or other current-consuming devices a larger current is required than for a 110-volt system. There is a fire hazard connected with both which may be reduced to a minimum by proper installation by competent persons together with the inspection previously mentioned.

The 30-volt system can be made safe if certain precautions are followed. Since larger currents are employed when the voltage is smaller, the conductors *must* be larger to carry this larger current. A system for 110 volts uses smaller current and smaller wires and such wires would not be satisfactory for a 30-volt system. Larger wires and accessories mean a more expensive wiring installation, but this is offset by the lesser cost of the power plant and the lesser cost for battery maintenance.

It must be remembered also that while the low-voltage system will be satisfactory for operating lamps and motors which are properly installed and connected, it will not be feasible to connect heating devices, such as electric toasters, coffee percolators, and flatirons, to the sockets which have been installed for lamp connections. This will be clear by considering an example. The ordinary size of flatiron requires 5 amperes, when used on a system of 110 or 120 volts. A flatiron for doing the same work on a 30-volt system will require about 18 amperes. This current is too much to use on an ordinary lamp socket and is very likely to overheat it and create a serious fire hazard. If it is desired to use such heating devices in the house, it will be necessary to install special separate circuits using wire of a size not smaller than No. 10. A 20-ampere receptacle should be placed in the wall and a 20-ampere attachment plug should be used at the end of the flexible cord attached to the heating device. Possible future requirements should be anticipated and not less than two of these special circuits should be installed when the house is wired.

Lighting fixtures should be obtained which are wired with a size of wire not smaller than No. 16. Except in fixtures no wire smaller than No. 12 should be used with a 30-volt system. If the equipment, including switches, sockets, and ordinary lighting fixtures, is of the kind which would be installed for a 110-volt system, there will be a serious danger in afterwards making connections to such lighting fixtures for such heating devices as flatirons.

In view of the conditions just outlined, it is well for anyone installing such a private plant to give serious consideration to the advisability of installing a plant for 110 volts. As has been noted above, this involves a greater cost for storage battery and it will also involve a greater cost for storage-battery maintenance. At the same time it will permit the installation of less expensive wiring and equipment in the building and it will also have the advantage that if service later becomes available from the extension of the lines of an electric lighting company into the community, such service may be utilized without any change in the lamps or in heating devices such as flatirons. If such a change in source of power is made with a 30-volt system, it will be necessary to secure new lamps, etc., suited to the higher voltage.

Since the lines of most electric lighting companies are supplied with alternating current, it will be necessary to secure new motors regardless of the voltage, for a storage-battery plant supplies direct current.

The fact that farmhouses are usually solitary in location so that they do not have the benefit of public fire protection makes the minimizing of the fire hazard a prime consideration. The lack also in such locations of regular inspection service throws a greater responsibility upon the householder for making a selection of equipment which will be less likely to involve any fire hazard.

Electrical Hazards Outdoors and their Avoidance

While the hazards of small power plants in or near the home are serious and often impose hazards on the building wiring, and the alternative method of securing electrical energy by connection to distribution circuits is therefore generally to be recommended, there are still certain hazards to the members of the household that may arise through defective construction or maintenance of these outside distribution circuits. Electrical wiring outside of buildings is, of course, mostly so well isolated above or below the street as to call for very little observance by the ordinary householder. It is installed and maintained by the public utility serving the community and presumably with adequate precautions. Yet there are certain general features of outside wiring construction which should be appreciated by the public, so that individuals can supplement the installation precautions by their own reasonable vigilance and prudence.

(*a*) *Isolation of High-Voltage Circuits.*—For the high voltages ordinarily used in distribution of electrical energy, certain precautions are necessary for the safety of the public and of service, such as careful isolation of the circuits on poles at suitable elevation above streets and with suitable clearances from buildings near which such wires run. These necessary clearances are such as will permit vehicle traffic to be safely carried on and will make the ordinary repairing, painting, and cleaning of buildings safe. The necessary clearance distances are covered thoroughly in the rules of the National Electrical Safety Code.[3] Every householder can assist in increasing the safety of the community by reporting to the electric service company or other proper authority any wires which have fallen in the street or broken or sagged down so as to be within reach of passers-by or of vehicles, or any excessive leaning over of poles and their wires toward buildings. The limb of a tree, if across wires and hanging within reach of the public, offers, although to a less extent, the same kind of hazard that the high-voltage wire itself would offer were it excessively sagged or hanging broken so as to be within reach. These conditions are most likely to occur during or after sleet storms, heavy winds, or electrical storms.

(*b*) *Danger of Contact with Overhead Wires.*—These reductions in the safe clearances of overhead wires, as a matter of fact, constitute the only danger to the public from outside wires and are responsible for a considerable number of fatalities annually, largely of children who have not been properly instructed to avoid such wires, or of older persons failing to observe reasonable prudence. In this connection, it should be understood by all members of the household that the *insulating covering on high-voltage wires can not be depended upon* for safety of persons touching them. It is not feasible to maintain reliable insulating coverings on swaying overhead wires, such insulating coverings as they do have serving principally to minimize the probability of short circuits between wires and their consequent breakage when crossed by fallen twigs or by other wires. The fact that persons have touched low-voltage wires inside the house without injury does not mean that wires of similar appearance outside the house can be handled with impunity.

The flying of kites near overhead wires has also been responsible for some accidents, particularly where wire or tinsel has been used in the kite string either for strength or ornament. Parents should instruct their children not to throw objects such as sticks, strings, or pieces of wire over the high-voltage wires, since even if the child is not shocked, this may short-circuit the wires and make them fall upon other wires or in the street, thus causing danger to others. Children should also be particularly warned against the climbing of poles or trees near which electric wires pass, since this does away entirely with the protection afforded by their clearance from the earth surface and from buildings.

Still another not infrequent cause of injury to the public has been the careless raising of well-drilling outfits or well casing, or even of long metal rakes or pipes into the overhead wires which have sufficient clearance from the ground for all ordinary purposes.

(*c*) *Third Rails.*—Where third rails on the fenced rights of way of electric railways are not provided with overlapping guards, approach to them is dangerous, and children in particular should be instructed to keep away, notwithstanding their harmless appearance and similarity to ordinary rails.

(*d*) *Tree Trimming.*—A matter in connection with outside wiring, where the householder can effectively assist in securing his own safety and that of the community, is in seeing that near his own dwelling particularly and in general throughout the community trees are not allowed to grow up into the overhead wires. He should also see that where the wires are near the lower part of the trees, branches are not allowed to grow near them. In fact, sufficient clearance should be allowed for the swaying of the trees in the wind, and particular caution should be taken that if any parts of the trees are above the wires, all dead limbs above should be cleared away. Sometimes communities have a tree warden whose duty it is to trim the trees, and when any condition is observed where any portion of a tree is likely to come in contact with the wires, this should be reported to the warden or service company. Besides the probability that swaying branches may break the wires or sag them so that they will come within reach of passers-by, there is also the lesser hazard caused by contact of a wire with some portion of the tree by which leakage down the tree trunk may result in more or less danger to those who may touch it in passing.

(*e*) *Extra Precautions During and After Storms.*—It may be added that during and after severe storms, either sleet, wind, or electrical, it is well to avoid contact even with trees through which wires pass, since there may be a wire in contact with some branch of the tree. Persons should also at such times avoid touching poles, since the insulators supporting high-voltage wires on the poles may have been broken or punctured by the lightning and the wire may be uninsulated from the pole. Guy wires supporting the poles should also be avoided, since live wires may have sagged against them as a result of the breaking of insulators or of the overstretching or breaking of the wires under stress of wind or ice. As above stated, the householder and his children should also be on the lookout for fallen or hanging wires and, besides avoiding these, should report them immediately to the proper authority.

Electrical Hazards of Interior Wiring, and Their Avoidance

(*a*) *Restricting Voltage and Current.*—While the use of comparatively high voltage is usually necessary for distribution of electrical energy throughout a community, the use of such high voltages within buildings where the electrical devices are close to persons and often to combustible material would be very unsafe. Therefore, the current, if distributed at the higher voltage, must be transformed to a lower voltage before entering the premises, and the prevention of entrance of the high voltage must be assured. As before noted, an excess of current in the wires of the interior wiring system must also be avoided. The safeguard against the latter is provided by fuses, as shown under the heading "Fires" and again mentioned farther on.

(*b*) *Grounding Circuits.*—The safeguard against the high voltage, where necessary, is accomplished by the grounding of the low-voltage circuits connected to the interior wiring. By grounding is meant the effective connection of one wire of the circuit to the ground through some medium such as a water-piping system. This grounding, if properly done, will prevent any abnormal increase in voltage in the interior wiring, either above the earth or above the plumbing and other piping, basement floors, etc., within the building, which are intimately connected with the earth. If the low-voltage circuits entering buildings are exposed to any possibility of leakage from high-voltage circuits, either by contact in overhead line construction or by breakdown of transformer windings, this connection of the low-voltage circuit to the earth becomes essential, and to be reliable it must be made in accordance with certain definite requirements varying with the current capacity of the high-voltage circuits to which the low-voltage circuits are exposed. Requirements for the

[3]Circular No. 54 of the Bureau of Standards.

method of making such connections are given in section 9 of the National Electrical Safety Code.

The ground connections should generally be multiple ones, and in most cases it is preferable, because of the desirability of securing accessibility of the connection and of frequently inspecting it to assure its continued effectiveness, that the connection be made at the point of entrance of the wires to the building but outside the main switch and fuse. The householder should see that any wire or metal strip used as a ground connection from the service wires to the water pipe within his building is never disturbed by members of the household or by workmen about the premises. The security of the house wiring against high voltages for which it is not designed may be largely dependent on the integrity of this ground connection.

(*c*) *Insulating Coverings.*—Suitable precautions having been taken where necessary against the entrance of high voltages, the entire wiring within the building is next designed for the moderate voltages which have been found by long experience to be safe

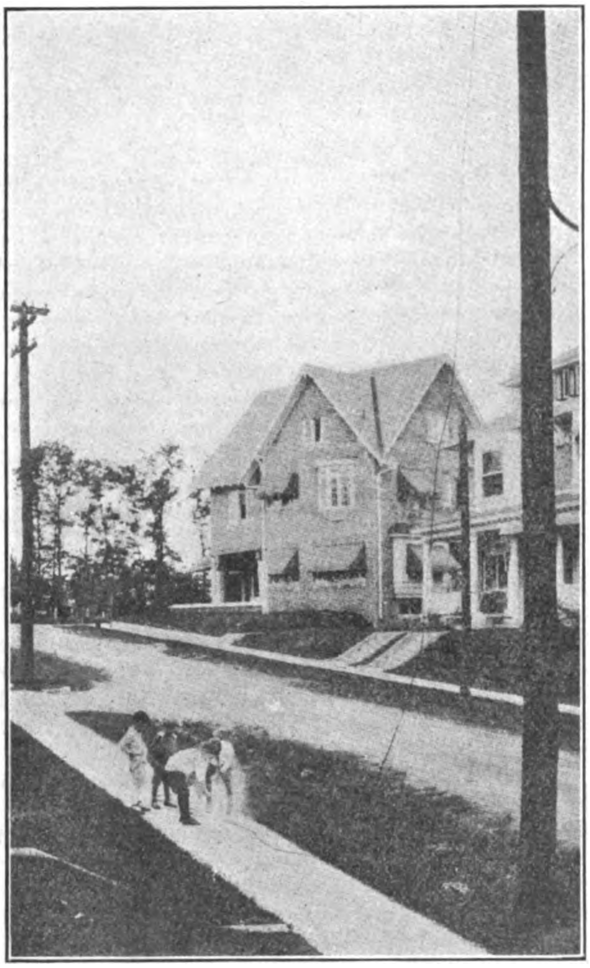

Fig. 4.—The fallen wire serves as an object of curiosity, especially where dangerous voltages cause flashing at the contacts with the earth.

The false sense of security given by the presence of an apparently insulating covering has also caused many fatalities. One injured child said he thought it was a stick of licorice.

for general use, usually either 110 or 220 volts. As noted in a foregoing part of this chapter, a considerably lower voltage, instead of affording greater safety, is liable to produce serious fire hazards. To prevent leakage from wires or fittings, insulating coverings are used on wires and insulating linings in fittings, and certain spacings are maintained between the wires of opposite polarity and between current-carrying parts of connected fittings throughout the building.

To protect the wire insulation from mechanical injury and moisture as well as to prevent contacts with it by persons, and thus to secure the longest life for the wiring system as well as the greatest security from shocks, the inclosure of all fixed wiring in conduit gives the greatest measure of protection. Where hollow studded partitions or hollow joisted wood floors exist, a good degree of protection against deterioration of wire installation and contact of persons with fixed wiring can be secured by the concealment of wires within such partitions and their support away from the inner surfaces of these wiring spaces on porcelain knobs and tubes. Of course, such wiring affords little security against fire if these wiring spaces are allowed to be filled during construction or later with loose plaster, wood chips, or other materials in contact with the concealed wires. In subsequent work on such partitions or floors the householder should take care to see that wires are not disturbed by the workmen. Open fixed wiring should generally be avoided even in attics and cellars, where its objectionable appearance does not prevent its use, unless the open wires are well out of reach of persons and unlikely to be disturbed or injured by the moving of implements, furniture, or other objects. Children should be instructed as to the danger resulting from touching or disturbing such wires. Where open wiring is used within reach of persons, the danger of disturbance may be minimized by surrounding it with substantial wood boxing well spaced from the wires. This should be closed at the top, except for tubes through which the wires pass, and should be so arranged at the bottom as not to retain either moisture or dust about the wires.

Portable wires to lamps, pressing irons, fans, and other electrical devices used about the house can not, of course, be either out of reach or guarded by exterior metal covers. For this reason the insulation of such wires is more subject to deterioration by mechanical injury and moisture than fixed wires. Portable wires in general impose a greater shock hazard than other parts of the electrical installation. It is largely on account of such wires that the grounding of circuits as above mentioned is so necessary and that the use of sufficiently low voltages for interior wiring is essential. Even the 220-volt circuits impose a considerably greater shock hazard than the 110-volt, where many portable devices are involved, since their protection can not be as complete as that of fixed wiring. A satisfactory degree of protection is, however, provided by the use of heavy fibrous covers over the insulating coverings of portable cords, and where cords are used only as pendants by placing them sufficiently high and making them sufficiently short so that they can not be much handled or moved about.

(*d*) *Shock Hazards of Portable Cords.*—The deterioration of such cords, varying with the moisture and the amount of handling to which they are subjected, should be very carefully watched by the householder, and when any abrasion of the protective covering is noted, the conditions should be promptly corrected. If the cord is very much bent or kinked in handling, there is also the possibility that some of the cord strands will be broken and will later pierce the insulating covering and the outside protective covering, thus exposing these almost invisible strands to the contact of persons and imposing a shock hazard on the users. For the above reasons cords should be made as short as convenient, and where practicable, so located and used as not to be within reach of radiators or set tubs, kitchen ranges or sinks, bathroom fittings, cement basement floors, or other objects well connected with the ground, whereby a person touching the cord may become a part of an electric circuit and receive a shock. Where the surfaces are very damp and especially where the air may be moist with steam, as in bathrooms, kitchens, and laundries, the conditions are especially bad for the deterioration of the cord as well as for the severity of shock in case the cord is abraded or otherwise injured. For this reason cords should have special waterproof coverings where used in laundries, bathrooms, and similar places, and in general the floor on which users stand in such places should be covered with dry wood, rubber, or other insulating material, and caution observed in handling the cord.

The use of such cords with portable devices by persons while in bathtubs, or who are likely to touch laundry tubs, kitchen ranges, or other grounded objects, is particularly dangerous, the danger being increased in cases of persons in bathtubs by the fact that a large surface of the body in the tub is in contact with the conducting water. Accidents under these circumstances frequently prove serious or fatal.

(*e*) *Shock Hazards of Portable Devices.*—The same general considerations that apply to the use of portable *cords* in various locations apply to a considerable degree to portable *devices* in these same locations. While using them, members of the household should keep away from grounded objects, and they should avoid using them at all where they can not keep away from grounded objects. For instance, an electrical vibrator should never be used by a person in a bathtub. Of course, where such devices as electric pressing irons are used, the fact that most of the metal parts, which might be accidentally touching the live wires within, are very *hot,* will often deter persons from making any considerable contact with the iron, so that the standing on a damp floor or the touching of a set tub while using an electric iron will not usually impose a serious life hazard even after the insulation within the iron has deteriorated or accidentally broken down. However, accidents from this cause *have* occurred and precautions, such as the use of a dry wooden platform and keeping away from laundry tubs, are advisable. With both cords and portable devices the need for observing precautions is very much greater with 220 than with 110-volt circuits.

(*f*) *Removal of Shock Hazard of Portable Cords and Devices.* Methods are being sought and devices may probably be developed that will largely remove the shock hazard from portable cords and devices through the use of an outer grounding wire in the cord, this being connected to the frame of the portable device and assuring the maintenance of its potential close to that of the earth. Such cords and devices have not yet, however, been marketed to any considerable extent.

(*g*) *Fire Hazards by Overloading Wires.*—Besides the shock hazard, there is possible a fire hazard from overheated wires due to passage of too great current through them. This, as before noted, is guarded against in practice by the use of fusible cutouts. As all the current of the installation passes through the incoming or service wires, they will be the largest, and the main fuses must be of such a size as to protect them against overheating. Within the building the circuits are so subdivided as to minimize the amount of energy which can be expended in any short-circuit between wires or in any fitting, caused by the breakdown of insulation from mechanical or other causes. These smaller circuits also have fuses of a size corresponding to the current-carrying capacity of the wires, and the devices are so constructed as also to be reasonably protected against excessive current by the fuses employed. In the interest of economy a standardization of these small circuits has taken place, and the maximum size of fuse permissible is 10 amperes with 110-volt circuits and 5 with 220. The size of wire may, of course, be larger for mechanical or other reasons, but should never be smaller than would be properly protected by these fuses.

(*h*) *Improper Fuses.*—When fuses blow they should be *properly* replaced. This means replacement by a fuse of proper *character* as well as proper size. Unsuitable elements may explode and possibly throw molten metal on surrounding inflammable materials or wood floor. If the fuse is too large so that devices fed through it are not protected by it, they may overheat and cause fires, or possibly their insulation may break down and cause a shock hazard or the burning of persons by arcs. The householder should *see that blown fuses are replaced only by fuses of suitable size and style.* The proper sizes for small circuits are given above. For the larger circuits, including the service wires, the rating of fuse should be proportioned to that of the wire. As the householder will often be unfamiliar with the sizes of wires in use, the *inspection of the fusing of the different circuits by the proper authority should be made before the installation is originally accepted* from the wiring contractor, and occasionally thereafter. If for any reason the blowing of fuses is frequent, *there is something wrong* with the installation, and this should be found and removed. The trouble should not be allowed to continue by the insertion of larger fuses.

(*i*) *Hazards in Handling Fuses.*—In replacing fuses where any metal part used for carrying current can be touched, as is the case for instance with cartridge fuses, the installation should provide a switch the opening of which will disconnect such current-carrying parts from the circuit. In many of the older house wiring installations, the disconnection of the circuit to make safe the changing of fuses can be accomplished only at the main switch to the building, and this is a satisfactory arrangement except that it necessitates the cutting of the entire building out of service where possibly one circuit only out of many needs attention. A more convenient arrangement is to *have each fusible cut-out arranged with a separate switch whose operation will disconnect it.* It goes without saying that the main switch should thus protect all the fuses in the building, including the main fuses. Devices are now marketed to some extent which in new installations well accomplish the purpose of safety by inclosing both switch and fuse in a cabinet so arranged that the switch can be operated without opening the cabinet and that the fuses are inaccessible until the switch has been opened.

(*j*) *Hazards of Switches and Their Location.*—The protection of live parts of switches is important in securing the safety of the household since these, next to portable devices, are the most handled portions of the electrical equipment. Their protection is satisfactorily accomplished in most modern installations by the inclosure of switches under the flush plates of metal wall boxes, with only insulating buttons projecting, or by the use of snap switches usually with fiber-lined metal covers. Where snap switches are used in damp locations and particularly in bathrooms, the covers should be of porcelain or other material not so likely as is a fiber lining, to become conducting under the damp conditions found in such locations. The use of open knife switches is generally confined to cabinets intended to prevent their short-circuiting by metal utensils about the house. Unless well away from grounded plumbing, radiators, or basement floors, the use of switches having live parts covered is to be recommended, even in cabinets; or the same end may be accomplished by the use of one of the switch and cabinet combinations in which the switch is operable from without.

Switches should be placed in convenient locations. This is especially true of the main switch which is installed for the purpose of cutting off the building wiring from the source of electrical supply. In case of fire, severe lightning storms, or other emergency, or where a house is to be left unoccupied for long periods, the main switch should be opened, thereby cutting off the building from the source of electrical supply. In opening this main switch, care should be taken not to touch bare metal parts. The probability of touching live parts is absent in some of the newer types, which are arranged to be operated from the outside of an iron inclosing box. It should be the duty of the occupants of the house to familiarize themselves with the location of the main switch and the method of operating it.

(*k*) *Hazards of Metal Fixtures.*—A further precaution which may be taken in the interior wiring installation is the placing of electrical fixtures out of reach of persons who may be touching grounded objects such as bathtubs, radiators, etc., or the *grounding of such fixtures.* The insulation of such fixture frames does not offer reliable protection, since one of the wires within may unexpectedly be in contact with such an ungrounded frame and make it alive. Where conduit is used as a mechanical protection for wires, it should, of course, be carefully grounded. Where fixtures are connected to a conduit system, their grounding through, the conduit system is easily accomplished. where fixtures are on a concealed knob and tube system or an open knob system, the grounding becomes somewhat more difficult, but in all new installations this safeguarding can be readily accomplished without an expense greater than is warranated by the protection secured for the members of the household against chance leakage from the circuit wires to the fixture frames and the shock hazard imposed in this way. Where the difficulty of grounding is too great, however, the fixture can either be isolated so as to be beyond the ordinary reach of persons, or in some cases fixtures entirely of porcelain or other insulating material may be used instead of metal.

Where drop cords with key sockets but without wall switches are used in such locations, particularly in bathrooms, where many grounded plumbing fixtures are within reach and the body surfaces are often wet, sockets of porcelain will usually be necessary until the introduction of grounded outer wires in flexible cords makes the effective grounding of metal-shell sockets on such cords generally possible and their use safe in such locations. Where fixtures or sockets are necessarily in these locations, even if within reach, switches should be provided at convenient points so that the turning on and off of the lights will be done at the switch rather than at the fixture.

(v) *Hazards of Incorrect Wiring Changes.*—It is presumed that the original house-wiring installation has been installed by responsible and competent persons and has been inspected to assure against defects which might cause life or fire hazard. This is just as necessary, usually more so, with house wiring served from a power plant on the premises as when served from distribution lines. The householder should particularly discourage changes or additions to his wiring except where made by thoroughly competent persons, and the practice followed by some householders unacquainted with proper electrical construction methods of making such changes themselves should be strongly condemned. Additions to the circuits may overload them seriously and require larger fuses than are safe and changes may be made in such a way as to lower the insulation of the circuit and so encourage arcing or complete breakdown of the insulation, thus imposing a shock hazard which did not exist before.

As has been previously noted in section 3, the dangers from overloading are much more serious on the 30-volt farm-lighting systems than on the ordinary 110 or 220-volt lighting systems, and much greater care is therefore necessary, particularly where any circuits are to be extended. Wire which might be purchased of a dealer who was not informed of the class of service for which it is to be used is likely to be proper for 110 volts but may be entirely too small for the 30-volt circuits.

Hazards of Household Electrical Appliances

(*a*) *Character.*—Many household electrical appliances are purchased *after* the wiring and fixtures have been inspected, and in the selection of such fittings care should be taken to *see that they are suitable for the purpose intended,* and where devices have been submitted to examination and test by a competent authority and found to comply with the requirements of the National Electrical Safety Code and the National Electrical (Fire) Code, such devices should be given the preference. Cords and devices which constitute a very serious life or fire hazard are sometimes sold by uninformed and often by unscrupulous dealers. Cords with very thin insulating covering or insufficient protective covering are too frequently seen, as well as portable lamps loosely put together and having rough edges over which the portable wires must pass. Electrical stoves have been seen with insulation to their frames so poor and with frames so little raised above the surface on which they stand as to make the accident hazard through touching the frame and the fire hazard to objects beneath them very serious.

Since household appliances are liable to be handled in use, their design and construction should be such that no terminals or other current-carrying parts are left exposed to contact by the user. In selecting wall receptacles a type should be chosen which does not have exposed live parts or permit of the fingers being placed in contact with live parts at any time. It is advisable always to *purchase devices from responsible* electrical dealers. If ordering devices from a dealer in another community or one who is not familiar with the kind of current and voltage used in your house wiring, see that correct information on these points accompanies your order. When in doubt it is wise to request advice and an inspection by the proper authority before using new devices.

(*b*) *Use.*—Besides being sure that the electrical appliances selected and used are of safe type, the householder should see that the members of the household observe proper caution in their use.

A rather common hazard is the overloading of fixtures by the attachment of purchased appliances. Large numbers of electric appliances are coming into use because of their convenience and intrinsic safety as compared with heating and power appliances depending on other forms of energy. Lighting fixtures quite generally, however, are designed with small arms and small wires suitable for supplying current to lights, but not large enough safely to supply some of the larger appliances or several of the smaller ones. A single socket can rarely with safety be made to supply a flatiron and toaster simultaneously through the use of a double socket or current tap, plug, or other similar device such as is commonly sold to permit more than one attachment.

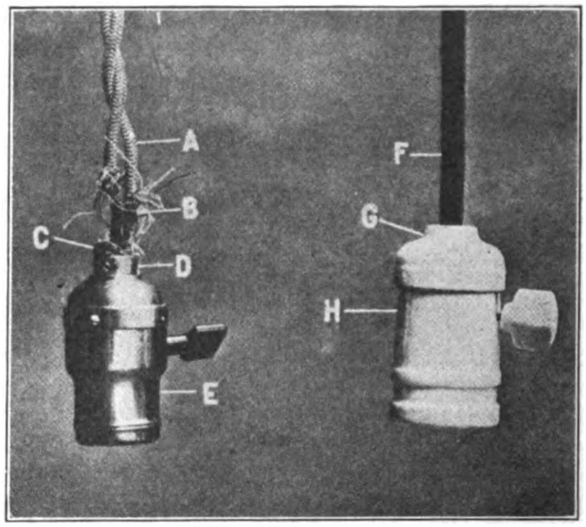

Fig. 5.—Examples of bad and good methods used in portable lighting.

Note the broken bushing at *C* in the brass socket *E*, exposing the nonreinforced lamp cord A abraded at *B*, by the cutting edges of the brass threads in the neck of the socket *D*, injuring the insulation and exposing the live wire in contact with the metal socket. A person using the socket may receive a shock. A nonabsorptive insulating socket, such as the porcelain one *H*, which is shown wired with reinforced lamp cord *F*, will insure adequate protection to the cord by the rounded neck *G* and to the user.

Even the main fixture wire where the fixture has more than one socket is rarely suitable for supplying more than one device, and it would be generally advisable to attach such appliances to entirely separate fixtures. It would be still more safe to provide special heating circuits which have wires of proper capacity. With the increasing use of appliances the practice of adding these circuits to existing installations and of running such circuits in addition to the lighting circuits in all new installations is becoming more frequent. An additional reason for using these special circuits is that where more than one appliance is used in one of the lighting circuits, fuses which have been installed to properly protect these lighting circuits are likely to blow out and to be replaced, sometimes at the suggestion of those more interested in the sale of appliances and current than in safety, by fuses too large to properly protect the smaller wires and fixtures of these lighting circuits.

It is apparent, of course, that devices safe for one community are transferred by uninstructed householders to another community where the character of current and voltage so differs as to cause a hazard in the use of the devices. This condition sometimes exists where devices suitable for a direct-current circuit are later attached to an alternating-current circuit in another community or vice versa.

Then, too, many devices are *safe for temporary use, but need to be turned off* when their temporary use is ended. This is particularly true of many heating devices. Pressing irons left on ironing boards and not turned off have been the greatest cause in recent years of electrical fires, by burning slowly through any combustible matrial beneath. Teakettles, chafing dishes, and other devices for boiling liquids become overheated and dangerous if connected to the circuit after the liquid has boiled away. Electric-lamp bulbs are very hot when free radiation is interrupted, and where these lamps can be carried about so as to come in contact with curtains, carpets, woodwork, clothing, or bedding the use of suitable inclosing wire guards is essential. Paper or cloth articles should never be placed against such lamps, and such materials should only be used for lamp shades if very liberal ventilating space is left between the shade and the lamp bulb.

(*c*) *Heating Pads and Quilts.*—Heating pads and heating quilts have been developed for both household and hospital use. The former are intended to be used as a substitute for hot-water bottles, the latter to eliminate the necessity or undersirability of a heated sleeping room. They are not to be regarded as presenting no hazardous features in their use and therefore, should, if used at all, be used with caution.

It is inadvisable for one to fall asleep with, or place a heating pad with current turned on, under heavy bed clothing, for a cumulative effect of heat may be produced (since the heat is confined under bed clothing), causing a high enough temperature to set fire to easily ignitible material; when used in the open this effect can not occur. Together with this, there is also the possibility of loose or broken connecting cords arcing and setting fire to the bed.

Regarding heating quilts, it may be said that the same cumulative effect of heat, if covered with other blankets or comfortors, may occur in certain spots if current is left on, the same as in the case of pads, whereas if placed on top of the bed this hazardous feature is absent. But in both cases there still exists the possibility of broken or loose connections, either inside of the quilts or in connecting cords, with their attendant hazards.

Inspection departments have reported fires and injuries from the use of these devices, and insurance companies discourage their use.

(*b*) *Electrical Toys* (*Toy Transformers, etc.*)—There are many electrical toys on the market, in the purchase and use of which certain precaution is necessary. These toys are most in evidence during the Christmas holidays. Their increasing use has brought about the development of devices for use on house-wiring circuits to reduce the voltage of the house wiring to a safe voltage for use with toys and to avoid the excessive cost of dry batteries and their frequent replacement. With alternating-current service, small transformers are obtainable for accomplishing both purposes. *With direct-current service it is impractical to secure a truly safe supply for electrical toys,* or to effect a material saving over the entirely safe dry batteries. Before purchasing electrical toys, therefore, it is well for persons to ascertain whether their electrical service is alternating current or direct.

If alternating-current service is supplied, selection should be made of a transformer which is entirely inclosed in an iron or other case. Some now on the market have openings in the case for ventilation, through which fire originating in the windings may be communicated to combustibile objects in the vicinity. The transformer should always be provided with a permanently attached, heavily insulated cord, and an attachment plug for connection to lamp sockets or receptacles. The transformer arrangement should be such that the higher voltage terminals are entirely inaccessible, and it is very important that the higher and lower voltage windings should be entirely separate with no connection. If the purchaser is in doubt as to the safety of the device, it should be remembered that it is always better to ask advice of the local inspection authority than to run the risk of accident to one's family home.

The purpose of the toy transformer with alternating-current service is to produce a voltage of 10 to 15 volts, suitable for toy operation, in place of the 110 to 220 volts used on the house wiring. If the transformer is properly constructed and connected, persons operating the toys will come in contact only with this low voltage while handling the secondary terminals of the transformer or the toys and their wire connections. Even though such a voltage is ordinarily entirely harmless as regards shock, the current produced may be large. For this reason the transformer selected should preferably have its low-voltage terminals guarded to prevent flashes and possible burns or fires. It is also important that the current from the low-voltage winding be limited by fuses which will prevent too great current in the toys used or in the transformer.

Certain precautions which follow should, of course, be observed in the use of transformers to avoid burns or fires. The low-voltage terminals should never be connected in any way to a lamp socket or receptacle on the house wiring, as flashes would occur, very high voltage might be caused, and even if no shock, burn, or fire resulted, the fuses in the house circuit might be blown and damage result to the transformer. The low-voltage wires should not be connected directly together, as this will tend to cause flashes that might result in damage. Unless the fuses recommended above are provided at the low-voltage terminals (which is not the case with many transformers now marketed), connecting these together will overheat the transformer so as to quickly destroy its effectiveness and the safety it provides against shock. For the same reason the tracks of electric toy railways should not be short-circutted by laying metal objects across them. The transformer should never be connected to a direct-current circuit, nor left connected to any circuit when not in actual use.

The purpose of toy resistances with direct-current service, like that of the transformer with alternating current, is to produce the toy operating voltage of 15 volts or so in place of the 110 or 220 volts used on the house wiring. The high-voltage and low-voltage windings, however, can not be kept separate, as is possible with toy transformers, and *danger of shock or fire is always present.* This will be a minimum if two resistances are used, one in each wire of the circuit. The dealer should be able ano willing to inform the purchaser on this point.

In using toys supplied through a direct-current resistance device it is well to avoid touching or standing on water or steam pipes, radiators, stoves, or other metallic objects It is, of course, somewhat problematical whether children may be depended upon to observe this degree of precaution.

(*e*) *Wiring for Temporary Display Lighting.*—Temporary display wiring, such as that for Christmas-tree lighting and other temporary decorative illumination in or about the house, should be confined to materials that are specially suited to such cases. Flexible cords with miniature or other sockets distributed along their length and festooned over trees or about rooms are particularly liable to suffer injury to their insulating coverings, and in some cases where the fittings are improperly designed the live parts of the lamps or sockets are exposed to contact. Only cords having very substantial protective coverings over the insulation proper and with both the insulating and the protective covering in good condition should be put into use, and careful inspection should be made from time to time during use to make sure that no injury has occurred that will be likely to cause either fire or life hazard. In this connection it may be noted that a large proportion of the Christmas-tree lighting outfits now on the market, and arranged with plug connectors to fit the sockets in the house wiring, have only a very thin insulating covering and are as a matter of fact suitable for use only with low-voltage batteries, instead of the higher voltage house circuits. Outfits having thicker insulation and more suitable for connection to house wiring are on the market, usually at somewhat higher prices.

Display wiring should, of course, be connected to the house circuits in a proper manner. For the larger displays this frequently requires the provision of special means of connection, which should be arranged for under the supervision of competent wiremen. As soon as the display is permanently discontinued, it should be removed so that it can not later be accidentally connected after it may have become dangerously deteriorated.

The presence of decorations in immediate vicinity of lamps and fuses is to be avoided. Cotton batting or other highly inflammable material is dangerous because of the temperature rise when touching incandescent-lamp bulbs. Tinsel and other metallic decorations frequently give rise to hazards by working their way into the live parts of the sockets or fuses. Because of these hazards, it is highly desirable that such decorations be placed at a sufficient distance away from electrical wiring, fixtures, and grounded surfaces. If the electrical decorations are at all extensive, it may be advisable to have the installation inspected by the proper authority.

(*f*) *Amateur Wireless Installations.*—Installations of wireless systems should be made only by thoroughly competent electricians familiar with all the rules applying to such installations, as given in the National Electrical (Fire) Code. Of course, as therein required, every such *wireless system should be kept disconnected from the aerial wires when not in use and effectively grounded* at such times. This can be done by use of a double-throw, single-pole switch outside the building. The aerial should also be kept connected to the ground and not attached to the wireless apparatus inside the house during severe electrical storms. If such installations are to be connected to building wiring, the possible overloading of the house wiring or the introduction of some other hazard on the ordinary wiring system should be carefully avoided.

Where persons not thoroughly competent to install house wiring undertake the installation of wireless systems, the entire wireless system should always be inspected by the proper inspection authority before a connection to the house wiring system is permitted. Antennae should be kept entirely away from all overhead electric-light or telephone wires, whether carried on poles, attached to buildings, or carried over buildings, and should always be run at right angles to these light or telephone wires, in order that interference between the two systems be avoided. Contacts with such overhead wires in storms would endanger members of the household as well as persons passing underneath the outside wiring.

Even if the person installing the wiring for the wireless system is thoroughly competent to do house wiring, inspection of the installation for the wireless system by the proper inspection authority should generally be arranged for, so that the safety of other persons and other properties may not be endangered through some chance oversight. It is, of course, to be taken for granted that the installations will always be made in accordance with any local ordinances in effect regarding such construction, and that where permits are called for these will have been obtained before the construction is begun.

Transmitting stations are required to be licensed by the Federal Government, and information concerning the obtaining of licenses can be secured from the Bureau of Navigation, Department of Commerce, Washington, D. C., or from the radio inspector in charge of the district in which the wireless system is located.

Safety Precautions*

Although electricity is undoubtedly the safest available agency for producing light, heat, and power, nevertheless many accidents still occur in its use because of improper installation or careless handling of electric wiring and appliances. Careful observance by the public of the precautions outlined below would undoubtedly save hundreds of lives annually, besides avoiding many serious injuries and preventing the loss of hundreds of thousands of dollars worth of property. In order to make these suggestions as widely useful as possible, their distribution by service companies, schools, and societies is recommended.

(*a*) *Outside the Home.* 1. Never touch a wire or any electrical device which has fallen on a street, alley, or lawn, or which hangs within your reach, if there is any possibility that it may still be touching any overhead electric wire.

And such wire or device may be dangerous, or may become so at any moment by leakage from other wires either nearby or at a distance. Even a damp or green branch hanging from an overhead wire may be alive. Throughout the country as a whole many people are killed annually by touching fallen wires, the conditions being especially bad during or just after wind, ice, or electrical storms, since wires are more apt to be broken and in contact at such times. Some of these persons come in contact with the wires without seeing them; others, overconfident of their ability, attempt to remove the wires without proper appliances.

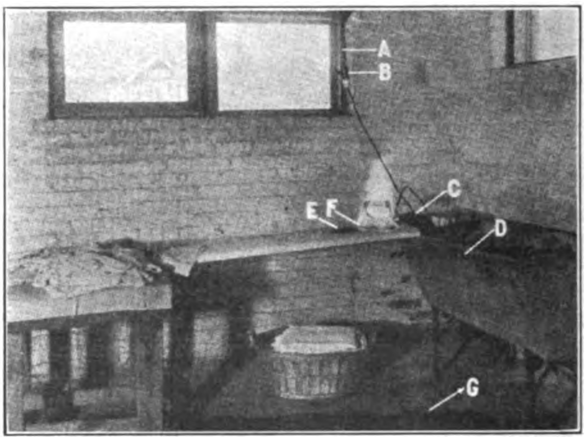

Fig. 6.—An improperly equipped and inadequately protected arrangement.

Note the metallic shell socket B with nonreinforced lamp cord A, the necessary proximity of the worker to the grounded laundry tubs D and the damp concrete floor G which exposes a condition exceedingly favorable to receiving shocks. Carelessness is indicated in leaving an iron on the board while connected to the service, as indicated by E and F, where the stand C should have been used, giving rise to fire hazard. This is probably one of the most frequent causes of electrical fires.

When such a wire is seen, watch it closely from a safe distance and warn others away from it. Have some one notify the electric-light company or the city electrician. *Insulated overhead wires should be treated the same as bare wires,* since the insulation quickly becomes defective in outdoor use.

This action will safeguard others and possibly some of your own family or friends.

2. Avoid touching the guy wires which are used to anchor poles to the ground, or the ground wire run down wood poles. Never try to jar arc lamps, nor touch the chains or ropes supporting them. During and after storms do not touch even poles, if wet.

These wires, chains, or poles may be receiving leakage current from the live wires overhead, although no evidence can be seen of such sparking or otherwise. These dangers are greatly increased during and after storms on account of possible fallen wires, broken insulators, and the wet surfaces of the poles.

3. Never climb a pole or tree on or near which electric wires pass. Never touch such wires from the windows nor while on roofs. Also never raise a metal pole, rake, or pipe, or a metal-bound ladder, so that it comes in contact with overhead wires. Do not use a metal-bound measuring rule or a measuring tape (which may contain wires woven into it) near electric circuits or apparatus.

*Recommended for the observance of the public while in the vicinity of electric lines or electric circuits.

Warn children against climbing poles or standing on pole steps.

While these warnings may seem unnecessary, many persons, among them many children, are killed annually while trespassing on poles or by climbing in trees and coming in contact with wires passing through the trees. A number of persons are also killed by touching live wires, passing above roofs or near eaves, either with the hand or with shovels, rakes, or other tools they are using. Still others are fatally injured by leaning out of windows and touching wires passing near the windows.

4. Never throw strings, sticks, or pieces of wire over the electric wires carried overhead. Also, never fly kites near overhead wires, nor throw sticks or stones at insulators.

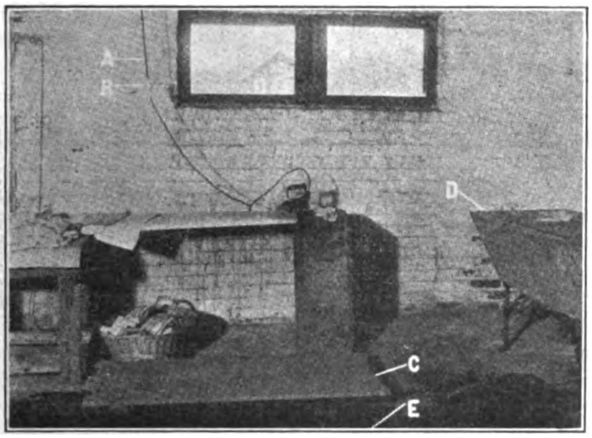

Fig. 7.—A properly equipped and adequate protected arrangement

The porcelain socket *B* with its reinforced cord A, the dry wooden platform *C*, and the distance of the worker from the grounded laundry tubs *D*, all contribute to safety. Note the protection afforded by the wooden platform from the wet concrete floor *E*.

Besides the danger to oneself, one may short-circuit the wires, causing them to fall, or one may cause enough current leakage to set fire to property near at hand or at a distance, and thus endanger the lives of many persons.

(*b*) *Inside the Home.*—5. Do not touch or disturb any electric wiring or appliances in buildings, except such as are intended to be handled.

Keep furniture and materials away from interior wires, or see that the wiring is in conduit or otherwise adeqnately protected against mechanical injury.

Abraded insulation is a too prolific cause of personal injuries and fires, and this often results from disturbance of originally well insulated wires. If in doubt about the condition of wiring and appliances, have them inspected by the city electrician or other electrical authority.

After using portable heating appliances, *turn off the current before leaving them.*

Pressing irons, in particular, frequently cause fires where left on ironing boards by slowly burning through combustible materials beneath.

Water-heating devices also sometimes become dangerously overheated and set fire to adjacent woodwork after the water has boiled away.

Where electric lamps can be moved about so as to come in contact with combustible materials, always see that they have substantial wire guards.

Even if not moved about, the placing of such substances as paper or cloth over lamp bulbs is likely to result in fires. An electric lamp gives out enough heat to set fire to combustible materials against it.

6. Never touch those interior live metal parts of sockets, plugs, or receptacles which are used to carry current. In handling electrical devices, use the insulating handles which are provided for that purpose.

Persons are sometimes killed or injured in their own homes by carelessly or recklessly touching bare current-carrying parts, especially where the devices are of bad design or poorly maintained. Touching such parts is particularly dangerous, if the hands are wet by perspiration or otherwise, and so make good contact, as is likely to be the case in bathrooms and laundries. The hands of children are usually moist enough also to increase this danger.

It is important that only reliable makes of electrical fittings, in which the interior live parts are normally guarded against contact, should be used.

While in bathrooms, toilet rooms, kitchens, laundries, basements, or other rooms with damp floors, stoves, heaters, steam or hot-water radiators, or pipes, which may be touched, avoid touching *any metal* part of lamp sockets, fixtures, or other electrical devices, since it may accidentally be alive.

The thorough grounding of these metal parts will obviate all danger from this source, but in the present state of development of electrical installation methods, grounding of such parts is frequently impracticable.

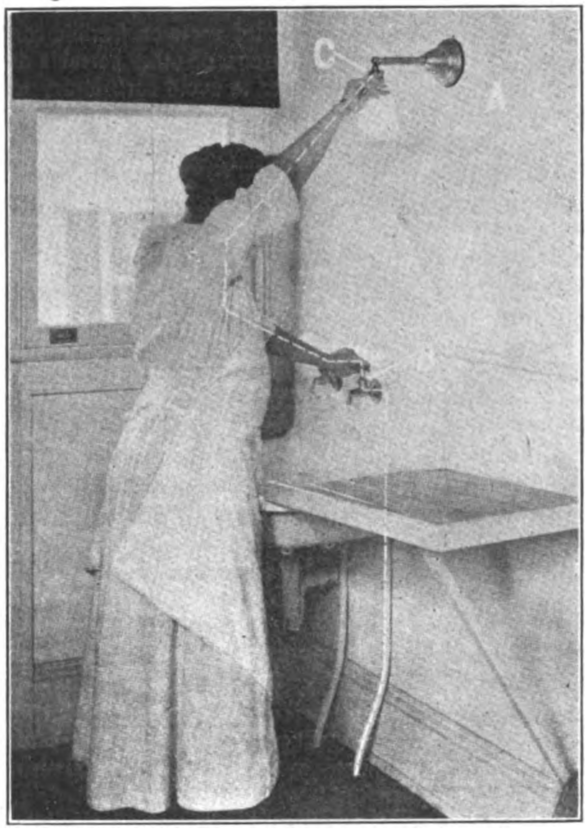

Fig. 8.—Illustration of the possible danger from shock by the passage of electricity from the metallic undergrounded fixture C. (see insulating ring at base of fixture A,) through the body to the grounded water faucet at B.

Path of electric current is indicated by broken line through body.

While in a bathtub never touch any part of an electric cord or fixture, even if it is a nonconductor. When using the telephone, avoid touching stoves, radiators, or any other of the metal objects above mentioned, particularly during electrical storms.

In handling electrical appliances in bathrooms, toilet rooms, or under the other special circumstances listed above, a dangerous current through the human body is much more liable to be set up than in drier places having less exposed plumbing. It is, therefore, necessary to keep in mind the possibility that exterior metal parts of electrical appliances may be receiving leakage current from the live parts within.

If the location is frequently damp, as in bathrooms and laundries, the insulation in electrical devices is also much more likely to become defective and to permit such leakage. Especially dangerous is the handling of lamp sockets, portable vibrators, or similar electrical appliances while in bathtubs, since the surfaces of the body are very wet and the insulation is particularly liable to be deteriorated.

Unless lamps or other devices in such locations need to be moved about as they are used, it is usually advisable to have them located out of reach, if practicable, and at any rate to have them controlled by wall switches, so that the devices themselves require no handling whatsoever. Such wall switches should, of course, be located, in general, near the room entrance or otherwise well away from all plumbing or other grounded fixtures.

7. Never try to take electric shocks from the wiring in buildings or in streets, nor induce others to take such shocks.

A shock which appears harmless to one person may be fatal to another, who may have a weak heart, for example. A second shock may be fatal even to the first person, if received for a longer time or under different circumstances. For example, a harmless shock may be received by a person whose hands and feet are dry, and a fatal shock might be received by the same person from the same wire if his hands or feet are wet.

8. Avoid touching bare or abraded spots on flexible cords attached to electric lamps, pressing irons, or other portable devices. Handle all cords carefully in order to avoid such injury to their insulation. Do not hang them on nails or over fixed wires. Always have them repaired or replaced by a competent electrician when any injury to insulation is observed.

Where toasters, fans, pressing irons, or other devices are moved about so that the cords receive more or less hard usage, use only cords with heavily reinforced coverings to protect the insulation. In damp places use only having a heavy waterproof outer covering.

In buying any cord or portable device, inquire whether it has been inspected and approved by the proper authority.

Many persons are injured in their homes and places of employment by contact with the wires of cords. Sometimes the insulation has been worn or broken off, and sometimes the fine wires of the cord have been broken by frequent bending and have afterwards pierced through the insulating covering to the cord and are, although almost invisible, a source of danger.

Unscrupulous and ignorant dealers sometimes sell cords or appliances which are defective, or assemble them in such a way that they are dangerous. It is best always to have devices inspected by the proper authority before use.

Cords constitute one of the most difficult sources of hazard to remove, since their use is necessary for the many portable devices needed by the public. They should, however, be as short as can conveniently be used in any case, thus minimizing the danger entailed by their use.

9. Never touch a person who has been shocked while he is still in contact with the electric circuit, unless you know how to remove him from the wire, or the wire from him, without danger to yourself. Have some one immediately call the nearest doctor and the lighting company.

Use a long dry board, or a dry wooden-handled rake, or broom to draw the person away from the wire or the wire away from him. *Never use metal or any moist object.*

By touching the person one may receive the shock himself. Cases have occurred where several persons by attempting to rescue other persons from contact with a live wire, without understanding how to do so safely, have been themselves fatally injured.

10. When a person, unconscious from electrical shock, is entirely clear of the live wire which caused the injury, do not delay an instant in attempting to revive him. Turn him on his stomach, face sidewise, pull his tongue out of his throat, if he has partly swallowed it, as sometimes happens, and immediately induce artificial breathing of the victim by pressing down firmly but not roughly on his lower back ribs at the *rate of about 15 times per minute*, continuing until the doctor or other competent person arrives. If the doctor is delayed or suggests no better action, do not give up the effort but *continue this artificial respiration for hours.*

Remember that *the lungs should not be compressed too many times a minute.* Apply the pressure every four or five seconds by a watch, or each time the worker's own breath is exhaled at moderate rate.

It is very important that all persons should learn approved methods of resuscitation by actual practice so that their efforts to revive unconscious persons may be carried out intelligently and without panic. The same methods may be used to revive persons unconscious from partial drowning or from asphyxiation by gas. The method outlined above is generally known as the prone pressure method.

General

11. Always be on the lookout for fallen wires, broken insulators, broken or leaning poles, broken arc lamps, open manhole openings in streets, or other defective conditions of electric lines outside buildings. Notify the electric-lighting company or the city authorities of such conditions, as well as of any sparkling or burning about wires. Notify them whenever wires are seen in contact with trees or passing very close to windows, fire escapes, or eaves. Also report any shocks that may be accidentally received, whether from outside wiring or from that in the home, however slight the shocks may seem. Always warn anyone who is believed to be in danger near electric wires or devices, either outdoors or indoors.

An early report to the lighting company or the city authorities regarding dangerous conditions or slight shocks may prevent serious fires or save one's own life or that of some other person.

See that trees in the community are regularly and carefully trimmed so that live wires do not come in contact with them.

The rubbing of the tree on wires is liable to injure and break them, allowing live wires to fall within reach of the public. Dead branches above electric wires should also be removed, as they may fall upon the wires and short circuit them, so that they fall in the street.

The observance of dangerous tree conditions and a report to the tree warden, the lighting company, or the city authorities, may prevent fires or loss of life from this cause.

12. Never employ anyone to do any wiring unless he is properly qualified and authorized to do such work. Do not attempt to make any changes in wiring, adjust electrical appliances, or do similar electrical work, or even to replace fuses unless thoroughly familiar with electrical materials and methods and so qualified to do such work properly and with safety to self and others.

An electrician who is not familiar with accepted standard practice or does not adhere to it in his installation and repair work is a menace to the safety of one's house and family.

✦ ✦ ✦

The motormen, conductors and other employees of the Reading, Norristown and Lebanon Division of the Reading Transit & Light Company, and the employees of the Metropolitan Edison Company in Reading and Lebanon, are going in for war gardening now on a larger scale than ever before. Last year the companies placed large tracts of land at their disposal, tilled the soil for them, and furnished the seeds. Hundreds of bushels of potatoes and other crops were parceled out at the end of the season. The men of the Norristown division formed a farm association during the winter and with the dues they have been paying they have hired a farmer to do the heavy work on the farm which the company has placed at their disposal at Plymouth Park. The street car men's war gardens in the three cities easily set the pace, so far as results are concerned, for all other amateur gardeners.

ELEMENTS *of* ILLUMINATING ENGINEERING

As stated in our June issue, the proper lighting of buildings, both interior and exterior, and public highways has developed into a science during the last fifteen years. During the development period the essential fundamentals have not received the attention demanded by the importance of the subject. The premier part of the subject has been neglected. The importance of having a clear conception of the fundamentals is recognized by Ward Harrison, Illuminating Engineer of the National Lamp Works of the General Electric Company, and with this in mind he has compiled a primer of fundamental concepts. In our June issue, by courtesy of the General Electric Review, we republished for the benefit of our readers who haven't access to that journal, the first installment treating of intensity measurements, quantity of light, and methods of plotting curves. By courtesy of that same journal we now reproduce Part II of this series, which takes the form of a primer on illumination design.

Diffusion of Light

In addition to a knowledge of reflecting surfaces and reflectors, a knowledge of such factors as glare, shadow, and illumination of vertical surfaces—in a word, the diffusion of light—is necessary before an intelligent selection of a lighting system can be made. These factors all require most careful consideration if the best results are to be obtained.

Glare

By "glare" is meant any brightness within the field of vision of such a character as to cause discomfort, annoyance, interference with vision, or eye fatigue. Always a hindrance to vision, it often, like smoke from a chimney, represents a positive waste of energy as well. It is one of the faults most commonly found in all lighting installations.

A glance at the sun proves that an extremely bright light source within the field of vision is capable of producing acute discomfort. Light sources of far less brilliancy than the sun, such for example as the filament of a mazda lamp or the incandescent mantle of a gas lamp, are also quite capable of producing discomfort by direct glare, but the annoying effect is not usually so marked. From our present knowledge, it appears that there are at least two distinct brightnesses which are of particular interest in connection with illumination problems. The more definite of these two is the brightness at which a given source looks just uncomfortably bright when viewed casually against a background. The second, and much lower value, is the brightness at which a source proves tiring and causes fatigue when continuously within the field of vision for a considerable period of time. The latter value is much more difficult to determine and it apparently varies through wider limits for different individuals. What these values represent may perhaps be more clearly understood by considering the analogous case of looking out of a window which by day is a source of light for a room. Unless the room is very dark or the landscape very brilliant, the effect of looking out of the window for a moment will not be at all unpleasant, but to sit all day facing the window would prove extremely tiring, even if one were sitting at a desk or table and not paying particular attention to the window. This is exactly comparable to the case of a light source which is not bright enough to cause an immediate sensation of glare but too bright to be viewed continuously. The problem of determining definite values for these two conditions of glare is rendered extremely difficult because of the fact that the extent to which glare is objectionable is partially dependent upon the contrast in brightness between the light source and the background. This is illustrated by the fact that although automobile headlights as seen at night against a dark background are likely to be so glaring as to be temporarily blinding, the same lights would in the daytime hardly be noticed. The permissible brightness of a light source is greater when the general illumination is of high intensity than when it is of low intensity. That is, for a room which has dark walls and furnishings, a unit of lower brightness should be used than would be permissible in a well illuminated room in which the decorations are light in color. The permissible ratio between source brightness and background brightness is not, however, constant; the ratio must be smaller at high values of intensity than at low ones.

The glare from street lights is often scarcely noticed as one walks along the street, but if one sits on a porch facing a unit, the glare is likely to cause acute discomfort. Such data as are now available indicate that ordinarily the brightness of a lighting unit which is in the central portion of the visual field should not exceed from 2 to 3 candles per square inch of apparent area, if that unit is not to give rise immediately to a sensation of glare, and the brightness should be reduced to one-half candle per square inch of apparent area if it is not to fatigue the eyes when viewed continuously. In this connection it is interesting to note that the brightness of the sky rarely exceeds 3 candles per square inch. A 200-watt mazda C lamp in a 10-inch opal ball of medium-density glass will emit light at an intensity of about 180 candles (the opal ball so diffuses the light that the candle-power in all directions from the unit is approximately the same). The apparent area of a ball 10 inches in diameter is about 80 square inches, for as we look at such a ball from a distance we see a circular area of 80 square inches, which is acting as a source of 180 candles. In other words, the opal ball is a source emitting 2¼ candles per square inch of apparent area. Such a unit would be too bright for an office, but would be satisfactory for hallways, store rooms, and similar places which are used intermittently, and for a large proportion of stores and industrial plants where those using the illumination frequently move about and are not called on to face the lighting units for long periods. If a 60-watt lamp were substituted for the 200-watt in the 10-inch ball referred to, the brightness would be reduced to slightly over one-half candle per square inch, and this would usually be the largest lamp that could be used in a medium-density opal ball of this size if all danger of glare were to be avoided with the unit placed in an office or similar location.

It is sometimes possible to improve poor lighting conditions where the direct light from sources in the field of vision causes glare by changing the position of the sources. Little interference with vision is evident where light sources are 25 to 30 degrees away from the normal line of sight; but even when so located they are quite capable of producing eye fatigue if continuously within the range of vision.

A form of glare which is often less obvious than that which comes direct from the source to the eye, but which is frequently more harmful because of its insidious nature, is that which comes to the eye as glint or a reflection of the source in some polished surface. This form of glare, known as specular reflection or veiling glare, is frequently encountered where the work is with glossy paper, polished metal or furniture, or other shiny surfaces and is particularly harmful because of the fact that the eye is often held to such surfaces for long periods of time, and while the glare may not be sufficiently annoying to be recognized as of a serious nature, it may nevertheless in time produce eye fatigue or even permanent injury. Since the brightness of the reflected image is dependent upon the brightness of the light source, it follows that the harmful effects of specular reflection can be minimized by reducing the brightness of the light source. Frequently, specular reflections can be prevented from striking the eye by locating the light source in such a position with respect to the work that specularly reflected light will be thrown away from, rather than toward, the operator. The use of lighting units of large area and a diffusing medium to prevent any direct rays from the lamp striking the surfaces illuminated will aid in avoiding bad specular reflection; but on the other hand, if the source is very large, as, for example, a ceiling lighted by indirect units, a certain amount of specular reflection cannot be avoided. For a machine shop a more highly diffusing light source will be required than for a wood-working shop because the reflected images from metal are much more distinct than those from wood.

We see, then, that glare is a function of intrinsic brilliancy, candle-power toward the eye, distance, contrast, and proximity to line of vision.

Shadow

Shadows may be troublesome if they are sharp or so dark that it becomes difficult to distinguish between shadows and objects, or if the illumination in the shadows is insufficient for good vision. With general lighting, shadows from the work or fixed objects can be reduced by placing the units high and close together. A maximum degree of shadow results in the case of direct-lighting systems using unfrosted lamps in open reflectors of small area; a minimum in that of totally indirect lighting systems. Enclosing and semi-enclosing units produce shadows which are softer than those produced by open reflectors but much heavier than those produced by totally indirect systems. With semi-direct units, almost any degree of shadow can be obtained by varying the density of the glass.

In observing objects in their three dimensions, shadows are an aid to vision in that the surfaces can be more easily distinguished from one another than if they are all lighted to the same intensity. Reproductions from photographs very often show the power of light to change appearance. However, while shadows are of great value in the discernment of irregularities of surfaces, they are of little or no value in the observation of plain surfaces. For example, while shadows are highly desirable in industrial work, in office work they are unnecessary, and, in fact, often a decided nuisance. With few exceptions, soft, luminous shadows only are desirable in interior lighting. Those having sharp edges or a series of sharp edges are objectionable.

Illumination of Verticle Surfaces

For many locations, such as offices and drafting rooms, light is required principally on horizontal planes, such as desk tops or table tops, and it has been the custom to calculate illumination on the basis of that delivered to horizontal surfaces with the assumption that the obligue surface of objects would be sufficiently lighted. This practice may result in inadequate illumination. In a machine shop, for example, the lighting of the vertical surfaces of the work or of machine parts is fully as important as the lighting of the horizontal surfaces. As a matter of fact, most shops are lighted during the day only by light from windows, which give a greater light on the vertical surfaces than on the horizontal. In all such cases where direct lighting is used, only those lighting units should be installed which show a reasonably good candle-power in the 50-70 degree zone as well as below these angles. A shop lighted by closely spaced automobile headlights directing the light downward from the ceiling would furnish ample light on a horizontal plant but such lighting would be far from satisfactory. The dome porcelain-enameled steel reflector gives the type of distribution desired for this purpose.

Desirable Wall Brightness

The effectiveness of a lighting system depends not only on the effectiveness of the lighting unit, but on the reflecting properties of the walls, ceiling, and surroundings, and upon the size and proportions of the room. It is, in fact, entirely possible to find an installation of reflectors of poor design and inferior from the standpoint of glare, which is nevertheless, from the single standpoint of the percentage of light reaching the illumination plane, better than an installation where reflectors of good design are used, if the former are installed under favorable conditions such as light walls, ceiling, etc., and the latter under unfavorable conditions. On the other hand, it must be borne in mind that a large expanse of wall surface finished so light as to reflect a large volume of light into the eye is objectionable for offices, residences, and all rooms where the occupants are likely to sit more or less directly facing the walls for considerable periods of time. Such data as are available indicate that where the brightness of the walls is equal to, or greater than, the brightness of white paper lying on a table or desk, annoying glare will result. In fact, a wall brightness one-half that of the paper has been found unsatisfactory—a brightness of 20 percent. is, apparently, comfortable. With the usual types of lighting units, walls are not illuminated to intensities as high as those obtaining on desk or table tops, and walls which reflect less than 50 percent. of the light which strikes them should not produce discomfort, providing, of course, that they are of a mat or semi-mat finish. Walls finished in buff, light green, or gray reflect about the proper proportion of light and their use is meeting with general favor. Walls finished in a high gloss are not satisfactory from a glare standpoint.

Definite values for the efficiency of different types of units as they are used in practice are presented a little later in this bulletin.

Choice of Lighting System

As already mentioned, there are three general systems of illumination which have come to be classified in accordance with the manner in which the light is distributed:

1. Direct-lighting systems;
2. Indirect-lighting systems;
3. Semi-indirect lighting systems.

Direct-lighting systems employ units which send the light direct to the surfaces to be illuminated. Reflectors or enclosing glassware are used to improve the distribution of the light and to diffuse the direct rays from the lamp, and to increase the apparent size of the source. With open reflectors, both direct glare from the lamp and glaring reflectors are minimized by frosting the lamp and by the use of a reflector of large area. This will also have the effect of softening the shadows. Illumination of vertical surfaces can be accomplished by selecting a unit which has a distribution of light which is not too concentrating.

Indirect lighting utilizes the ceiling and walls for the redirection and diffusion of all of the light emitted by the units. Since the ceiling acts as the light source, with the maximum distribution directly downward, glare from the unit is avoided, and shadows are soft, but for a given illumination on horizontal surfaces there is usually less illumination on vertical surfaces than with other systems. For some locations, shadows are not sufficiently defined to be of much assistance in the discernment of small surface irregularities.

Semi-indirect lighting furnishes a means of combining the features of the direct and indirect systems. With a correctly designed bowl of dense-opal glass, brightness of the unit is low enough to avoid eye fatigue, and sufficient direct light is emitted to produce the proper degree of vertical illumination and the soft or graded shadows often desired. A light-density opal may be used in certain locations where the units are hung high and the nature of the work is such that the units are not in the usual range of vision.

The individual characteristics of the place to be lighted are important factors in the selection of a lighting system. The presence of large quantities of dust usually discourages even a consideration of indirect and semi-indirect systems for industrial lighting. The dark tone of the walls and ceiling in factories also often precludes the use of other than a system of direct lighting. Cost and efficiency are factors which may limit the choice, although the present tendency in industrial lighting, particularly in the more specialized manufacturing branches, is to make good lighting the first consideration. It may be mentioned in connection with lighting that the liberal use of paint or whitewash can hardly be too strongly recommended.

In residence, store, office, and public-building lighting, the system should, of course, be of good appearance and in harmonious relation with the decorative and architectural features of the surroundings. Semi-indirect and enclosing units lend themselves most readily to these classes of service if the color of the ceiling and walls permits their use. It should always be borne in mind, however, that such unit to be satisfactory as to glare must be selected with care in accordance with the suggestions previously given. Totally indirect units, on the other hand, are practically certain to be satisfactory from this standpoint.

Aside from the renewal of lamps, and breakage, depreciation of the light output of a unit due to the collection of dust is usually the largest item to be considered from the standpoint of maintenance. It is evident that lighting units which have concave reflecting surfaces opening upward will collect dirt much more quickly than if the surfaces opened downward. The contour should be simple and the exposed surfaces smooth in order to expedite frequent cleaning of the units.

From the many lighting units on the market, a selection of a certain unit should first be made on a basis of its characteristics with regard to absence of direct glare, glaring reflections, and sharp shadows, the nature of its light distribution as adapted to the possible spacing and hanging heights, and the illumination of vertical surfaces if the work demands it. The considerations of appearance, efficiency, maintenance, and cost will then determine which unit to select.

Choice of Intensity

The eye is capable of adapting itself to see under illumination intensities which range from a small fraction of a footcandle to several thousand footcandles in value. At very low intensities the eye does not receive sufficint light to enable it to distinguish color or detail, and at very high values, a blinding effect which also obliterates detail is experienced. Between these limits there is a wide range of intensities where good vision is possible. Considerations of economy usually limit the intensities employed in artificial lighting to the lower values of this range. So closely is the lower limit approached that it is necessary in designing a lighting installation to take into consideration such factors as the color of the objects requiring illumination (for objects are seen by the light which they reflect, and dark objects require higher intensities than light ones for equally good vision); the order of brightness of surroundings; the amount which it is considered expedient to apportion for the advertising value of a high intensity; and the intricacy of the work which is performed under the artificial lighting.

Table I

PRESENT STANDARD OF ILLUMINATION

		Foot-candles
Auditorium, Church		1.5— 3
Armory, Public Hall		2— 4
School	Class Room, Study Room, Library	3— 6
Store	Show Window	10—50
	First Floor Department, Shop on Bright Street or Corner	7—10
	Other Clothing, Dry Goods, Haberdashery, Millinery, Jewelry, etc	4— 7
	Other Drug, Grocery, Meat, Bakery, Book, Florist, Furniture, etc	3— 5
Office	Private, General	4— 8
	Drafting Room	8—12
Industrial*	For Rough Manufacturing Occupations, such as: Rough Assembling, Rough Forging, Rough Woodworking, Ice Making; Potteries, Lumber Mills, Tanneries, etc., etc	2—4
	For Medium Manufacturing Occupations, such as: Medium Woodworking, Rough Machining, Rough Bench Work, Automatic Machine Work, Meat Packing, Paper Making; Laundries, Bakeries, etc., etc	3— 5
	For Fine Manufacturing Occupations, such as: Fine Assembling, Leather Working, Fine Woodworking, Fine Lathe Work, Tobacco Manufacturing, Fine Sheet Metal Working, Manufacturing Light-colored Textiles, etc., etc	4— 8
	For Extra Fine Manufacturing Occupations, such as: Watch and Jewelry Manufacturing, Engraving, Type Setting, Shoe Manufacturing, Enameling, Manufacturing Dark-colored Textiles, etc., etc	7—10*
Building Exterior		3—15

(To be continued)

PRACTICAL ALTERNATING CURRENT ENGINEERING PROBLEMS

By W. R. Bowker

Starting Rotary Converters

Synchronous converted substations are necessary adjuncts to the generating station of a power distribution scheme or traction plant, whenever a transformation has to be made from the alternating-current supply on the distributing system to a direct supply on the working conductors. An important problem in the operation of a converter substitution, is the starting up of the rotary converter.

The principles utilized for starting rotaries may be divided into two distinct classes, namely those which require synchronizing devices, and those which do not. Thus, a rotary converter must be synchronised before it can be put on load, when it is started up from the direct current side; 2 when an auxiliary starting induction motor is used.

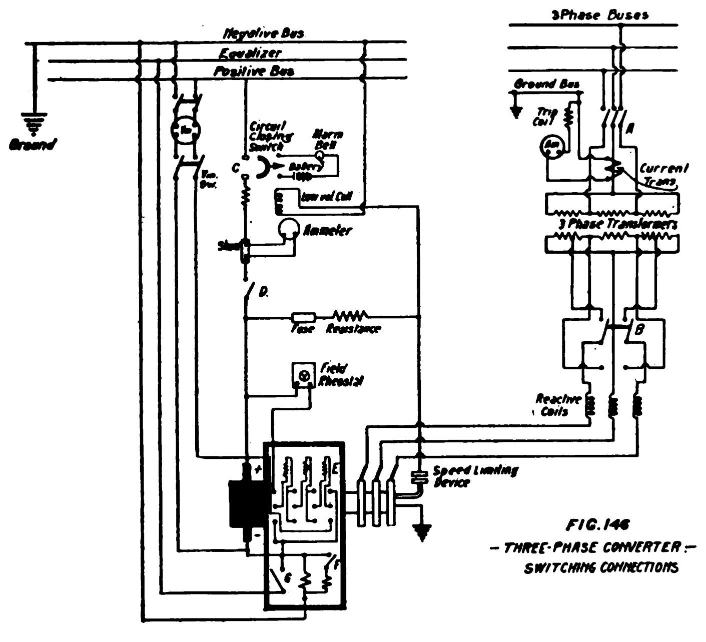

Fig. 146.

Diagram showing switching connections for three-phase converter.

One method of starting is to drive the machine as a shunt-wound direct-current motor and bring it into synchronism with the alternating-current circuit; another method is by starting the machine from the alternating-current side as an induction motor.

When starting from the direct-current side the machine is brought up to speed as an ordinary direct-current motor. This is done by first closing the field switch, giving the machine a full field excitation from the direct-current bus bar of the station. Next one terminal of the armature is connected to the positive side of the bus, and the other terminal through a starting box to the negative bus. The rotary will then slowly revolve, and as the resistance of the starting box is cut out, the machine gradually comes up to speed. When the rotary is running at full voltage it is ready to be "synchronized." The machine is running "inverted," generating or rather converting direct current into alternating current which flows into the secondary of the transformer, which in turn induces a high-voltage current in the primary.

A synchronoscope is now connected across the corresponding phases of the incoming machine and the line from the generating station. This indicates when the rotary and the generator are running in synchronism; that is, at the same speed, pole for pole. The speed of the rotary is varied by means of the field excitation until synchronism is attained, at which instant the oil switch connecting the rotary has to be instantly closed, thus throwing it into circuit with the line. If the switch is closed either too soon or too late, the two currents; that is, the rotary current and line current, will not be in step or unison and will not harmonize, with the result that the rotary's relay will trip the oil switch. In this event the machine has to be started over again, and the synchronizing operation repeated.

Starting from the direct-current side gives precision in speed control during the period of synchronizing, but it presupposes that a direct current supply is available. In the case of traction work the converter substations are entirely shut down during the early hours of the morning, so that unless a storage battery or a motor-generator set consisting of an induction motor and direct-current generator, be included in the equipment of the

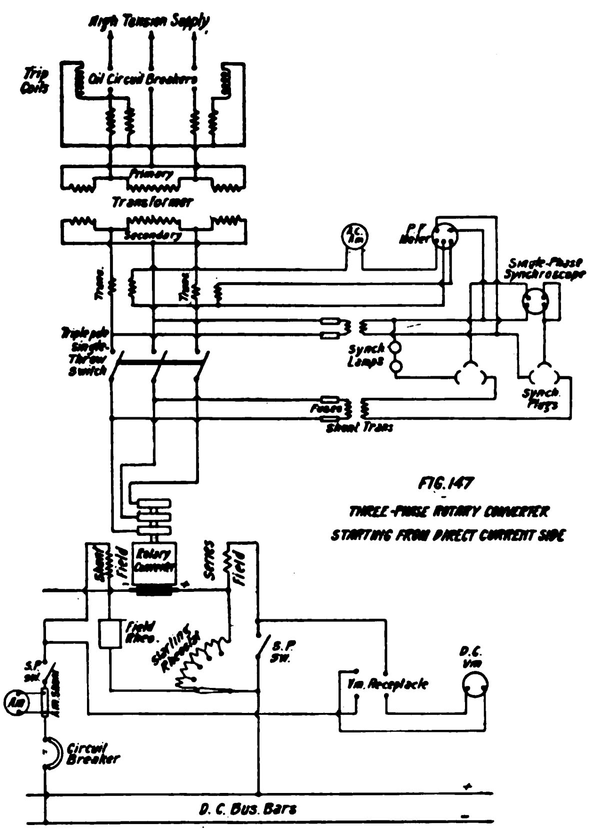

Fig. 147.

Diagram of connections showing three-phase rotary converter starting from direct current side.

substation, one of the other methods must be adopted for starting up the first rotary in the mornings.

It is also a disadvantage that the synchronizing device adds complexity to the switchboard equipment, which must also include field-changing switches, and relays for setting free the direct-current side from the distributing mains, when the alternating-current side is connected to the alternating-current supply.

In the second method of synchronizing, a small induction motor is mounted on the end of the shaft of the rotary, it being utilized for starting purposes. Its rotor is directly coupled to the rotary armature, and is usually mounted on an extension of the rotary armature shaft. This motor should be of a type having a relatively high secondary resistance and therefore, possessing the property of having a high starting torque per ampere with a corresponding reduction in the disturbance set up in the system when starting. It should also have fewer number of poles than the rotary (say one pair less than the latter) in order that the speed of the starting motor, including the "slip," will just nicely bring the rotary to synchronous speed at normal voltage.

After being brought up to speed by the induction motor the field switch of the rotary is closed, and all of the resistance cut in, so that there is hardly any drag on the machine. The resistance is then gradually cut out, thus adjusting the rotary speed by decreasing it, until the synchronoscope indicates that they are in synchronism. After the rotary is switched into circuit on the alternating-current side, the induction motor is thrown out of circuit and left to run free on the shaft.

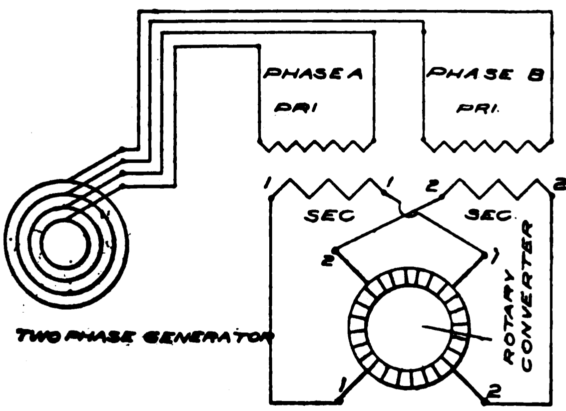

Fig. 148—Rotary converter and transformer, polyphase connections, two phase diametrical.

The advantage of this method is its simplicity, but it does not give such refinement in speed control as is obtained with the direct-current method of starting.

The method of starting from the alternating-current side is as follows: Three taps are taken from the secondary of the transformer—giving one-third voltage, two-thirds voltage, and full voltage—and are connected to starting switches. After seeing that all the machine switches are open, the high-tension oil-switch is closed. Then the first starting switch is closed and the rotary should revolve on one-third of its normal voltage. As the machine speed increases, a voltmeter connected across the direct-current side will oscillate back and forth, and finally come to rest in either a reverse or positive position. The double-throw field switch is closed in the normal position if the voltmeter indicates that the machine is generating current in the right direction. If, however, the voltmeter shows that the polarity of the rotary is reversed, the field switch is closed in the other position, which reverses the current through the filled coils. This will reverse the polarity of the machine, after which the field switch is pulled out and afterwards closed in the normal position. Then the other two "voltage tap" starting switches are successively closed, allowing time between the closing of each for the rotary gradually to increase its speed. When the last one is closed the rotary is running at full voltage and in synchronizing and ready for service.

The scheme of throwing the alternating-current side of the rotary directly on the alternating-current supply at reduced voltage does not require any special apparatus, since the rotary, is so to speak, automatically synchronized, it only being necessary to apply the full voltage after the proper speed has been reached.

There are thus three methods of starting rotary converters, and each method has its advocates and is considerably used. But none of these methods is, however, entirely satisfactory or

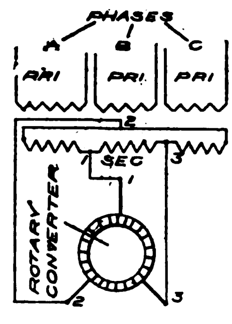

Fig. 149

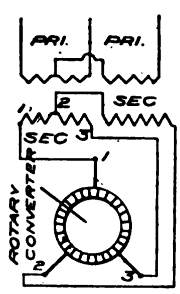

Fig. 150

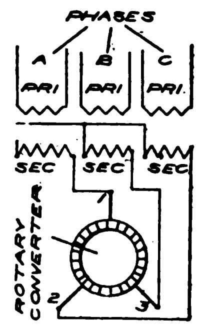

Fig. 151

Fig. 149—Rotary converter and transformer with three-phase delta connection. Fig. 150—Same with three-phase T connection. Fig. 151—Same with three-phase star connection.

perfect. With the synchronizing methods there is probably the least tendency to disturb the system and they are introduced and have been largely adopted in order to avoid electrical shocks to the system.

The direct method of starting from the alternating-current side of the rotary is somewhat simpler than the synchronizing methods, but it has the disadvantage of seriously disturbing the system (especially if started with the full voltage of the supply system) in consequence of the heavy magnetising and therefore, lagging currents drawn by the armature under these conditions. The usual practice being to employ one-third of the supply voltage for starting purposes, there is no difficulty in obtaining the reduced voltage if the windings of the transformer be provided with suitable tappings.

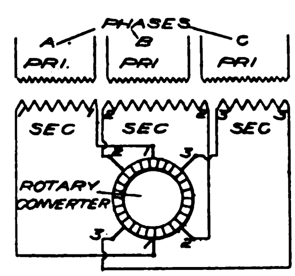

Fig. 152

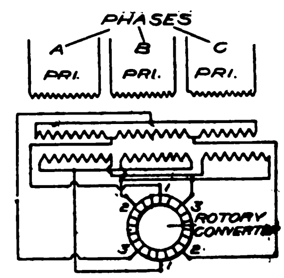

Fig. 153

Fig. 152—Rotary converter and transformer with six-phase diametrical connection. Fig. 153—Same with six-phase double delta connection.

This self-starting method reduces the usual simplicity of the shunt-field wiring, since it is necessary to have the coils so wired to a multiple-point switch that the individual coils may be disconnected, (as shown at E, Fig. 146) from each other in order to avoid the heavy induced voltage that would result, were this precaution not observed. A combination of the third and first methods is recommended for substations containing rotaries, having a capacity of 500 kilo watt or less, when there is no storage battery.

To begin operations the first rotary is started from the alternating-current side by the self-starting method and then as the other machines are required, they are started from the direct-current side; the direct current being supplied by the first rotary.

The characteristic features of each method, demand careful consideration as applicable to the operating conditions involved under different circumstances to be found in practice.

The advantages and disadvantages of the rotary converter as a machine for transforming from alternating to direct current or vice versa may be briefly summarised as follows:

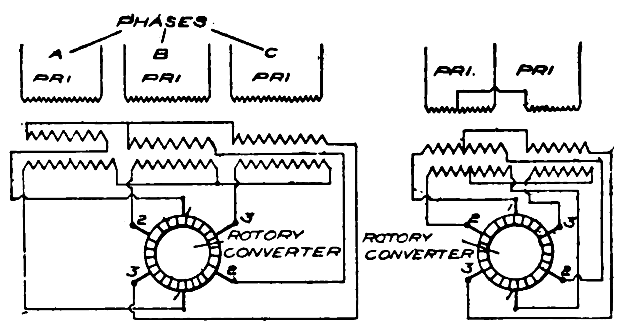

Fig. 154 *Fig.* 155

Fig. 154—*Rotary converter and transformers with six-phase double star connections. Fig.* 155—*Same with six-phase double T connections.*

Advantages. (1) The armature conductors may be of small cross-section for a given output, as the motor and generator currents therein overlap each other.

(2) As armature reaction is practically neutralized, it is possible to use a large number of conductors on the armature, and for the same reason it is unnecessary to alter the angular positions of the brushes during variations in the load.

(3) A large overload capacity and high efficiency.

(4) A high power factor and low-cost in relation to its output.

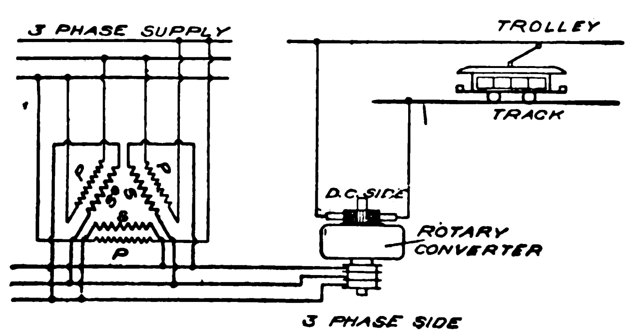

Fig. 156—*Three-phase transformer delta connected supplying three-phase current to rotary converter, direct current side connected for street railway service.*

(5) Owing to small and practically negligible armature reaction, there is little change in value of power factor with change of load.

(6) A uniform and adjustable power factor in the shunt-wound converter.

(7) A variable power factor with varying excitation in the compound wound converter.

(8) Economy in copper which increases with the number of phases.

When comparing the relative costs of rotary converters and other types of transforming apparatus, it must be taken into consideration that step-down transformers must of necessity be provided. This increases the cost and lowers the efficiency of the transforming combination. The principal disadvantages are:

(1) Satisfactory operation in practical service requires a low frequency which is not always suitable for other types of transforming apparatus.

(2) Requires skilled attendance.

(3) The necessity for using complicated regulating apparatus and switch-gear.

(4) Sensitiveness in parallel operation.

Notwithstanding these disadvantages, the rotary converter plays a most important part in the practical and commercial successful operation of large power plants, especially those which supply electrical energy in connection with street railway and trunk line railway schemes, in which the advantages greatly overbalance any disadvantages characteristic of this class of machinery.

It is important that the diagrams of connections as shown in Figs. 148 to 156 should not be overbalanced. They represent the schematic circuit combinations of the secondary side of the transformers connected to the slip rings and brushes of the alternating current side of the rotary converter.

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NO INCREASE IN NEW YORK EDISON CO. RATES

On June 3, J. W. Lieb, of the New York Edison Co. appeared before the New York Public Service Commission and said that an increase in rates would not be asked for at the present time. He made extended comment on the company's business and condition, saying:

Our revenue has suffered a considerable decrease due to the reduction in rates, while our output has been actually less than last year. Our expense account has shown a steady increase as compared with last year in the price of coal and labor, and, in fact, in supplies of every description concerned with articles of consumption and those needed in repairs and maintenance.

"Our records show that for the four months ended April 30, 1918, as compared with 1917, our operating income has been reduced from $3,624,723 in 1917 to $2,683,069 in 1918, a total of $941,654 in the four months. Net income, therefore, suffered a serious decrease. What the future may have in store for us it is difficult to predict. In fact, with the rapid changes which are taking place we can only express our doubts and anxieties.

"The loss in our operating revenue is not entirely accounted for by the reduction in the maximum rate from 7½ cents to 7 cents which went into effect July 1, 1917. It is disquieting, to say the least, that the reduction in the quantity of energy sold was from 223,061,388 kw.-hr. for the first four months of 1917 to 213,513,941 in 1918, a reduction in the output in excess of 4½ percent.

"The increase in operating expenses in 1918 and 1917 is a reflection of the increased cost of coal, of labor, supplies and taxes, and, with the exception of coal, the future price and efficiency of which is at this time problematical, these higher costs will continue, and possibly in an increasing ratio throughout the year. We believe that these conditions would justify the company in going back to the 8-cent rate. At the same time it is not absolutely certain that the decreases in output will continue for the rest of the year.

"The present situation is one of extreme doubt and uncertainty. We do not desire to come before the commission at this time and announce our decision to restore the 8-cent rate. We believe that probably the best solution would be a continuation of the present arrangement with the commission, maintaining the status quo for another six months, and reserving such rights as we have under the present arrangement."

The agreement affects practically all points in Manhattan and the Bronx and applies also to the United Electric Light & Power Company.

The company also announced that while it would continue to furnish lamps, it would be compelled to charge for them, and that the prices would be in line with the general increases made by the manufacturers.

EDITORIAL

AGAIN THE COAL SUBJECT

At the convention of the National Electric Light Association at Atlantic City last month the one matter that commanded most attention was plainly the coal supply for operating the central stations. So important did this subject appear to both the association and the Government that an official high in the councils of the Coal Administrator was present to explain at first hand the attitude of the Government in the matter of priority orders for this precious substance. How precious coal has become we all know, for we have not yet had time to forget the discomforts of last winter when the mercury was way below zero and the wintry winds were whistling down the chimney—and there was perhaps but one day's supply of coal on hand and none in the yards of the dealers. Similar discomforts may be ahead of us the coming winter, we are warned, for the war has wrought so many changes in the labor market that there is no assurance of anything like a full supply to take care of the factories, the railroads, the utilities, the shops, the offices, and the homes. A mild winter may mitigate the situation, but in any event there will be no coal to waste, and it will probably be something of an effort to get it at any time in full quantity until the end of the war is in sight. Conserve the coal and the wheat has become as urgent a need with us as it is to support the Red Cross and buy Savings Stamps and Liberty Bonds. If we don't forget what we have learned we shall emerge from this war creatures of the habits of self-denying and saving.

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ONE KIND OF PROFITEERING

In a recent utterance President Wilson was reported as saying that those who could not be got at by conscience would be taken care of by taxation. If this admirably expressed point of view could only be enforced practically and fully, some of the present and irritating inequalities would, for those of us who have no disposition to profiteer, be cheerfully ironed out. Unfortunately, some of the profiteering is hard to get at, even by taxation. On this subject American Industry In War Time says that the worst phase of profiteering in the United States is the profiteering of labor which has forced the price of its own commodity up in the neighborhood of one hundred percent. Under present conditions this variety of profiteering is not regulated or controlled but is rather stimulated and cozened by Governmental paternalism. Congress has the power to enact legislation that will make labor profiteering both uninviting and unhealthful, but Congress is not doing much in the way of stopping it. What is urged is not that these leeching profiteers be mulcted of a small percentage of their ill-gotten gains —which is of comparatively small moment to them— but that they be disillusioned by being deprived of their liberty. Let them keep their money, if need be, it is urged, but clap them in jail where they can't spend it, and where they can cultivate the faint glimmerings of something that resembles a conscience. The criminal courts are the places in which to make disposition of the war labor profiteer; he should not figure in tax legislation at all. What is a small tax to him? Nothing worth mentioning. But a jail and scanty coarse food is chastening. Even the prospect of it is discouraging.

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ELECTRICITY AND THE SHIP

For the greater portion of the last twelvemonth we have been publishing a serial story on the application of electricity to the building and navigating of ships. This story is now taking on the aspect of a finished product, the author having arrived at the point where the use of electrical energy to propel and guide the ship is commanding attention. It is in guiding the ship that the fine points of electrical application come into play; here the various signalling devices that connect the mind of the commander with that of the engineers and the navigators tell the story of how the craft is guided as to direction and speed from a bridge that is quite beyond the reach of both the eye and the voice. The electrically operated devices for translating the mind of the commander into direction and speed are both various and novel. Many of them reflect a great deal in the way of mechanical ingenuity, albeit they are inert until vivified by the product of the generator in the form of electrical pressure. These devices supplement the many motor-driven devices which formed part of the equipment that helped to transform the raw materials of an elder day into a stable craft. Together, the electrical construction apparatus and the electrical operation apparatus are doing a big bit in the bridging of the waters between here and what is now commonly spoken of as "over there." Not only are

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Patriotic citizens by the thousands are subscribing to the war savings stamps issued by the United States Government. An average of $20 per capita—$20 for each man, woman and child in America—is asked during 1918 from this source. The putting across of this splendid scheme is most helpful to the government at this critical period in our national life, and at the same time it is the most remarkable plan for encouragement of thrift among the young and old ever initiated. Are you doing your part? Are you saving your pennies, nickels and dimes?

they building the ships but they are helping in large measures to take them across once they are afloat. In this respect no other manifestation of energy, unless it be human effort, can measure up to the utility of electricity as a pro-Ally product. Other things being equal, there is no doubt but that ships will win the war. They form the bridge that keeps our troops in motion and in touch with their base of supplies, a tactical axiom in war time. For this reason too much emphasis cannot be placed on their importance, and, in view of the abnormal losses due to the depredations of the enemy, too much cannot be made of the part that electricity is playing in the way of ship supply and operation. These are the facts that make the series of articles we have been publishing of far more than ordinary value at this critical time. Written by an electrical engineer who has given the better part of the last twenty years of his life to the building and equipping of ships electrically, they are of immediate practical value to the progressive shipwright. And such they have proved to be, for the demand for back numbers of the issues containing the earlier installments of the series has practically exhausted the supply. If the demand warrants it, the entire series may come out in the form of a book as soon as the series is finished. In this issue we cover the last part of the interesting section that treats of interior communicating systems. In our next issue we shall take up the modern and rather novel subject of electrical ship propulsion. After that we shall have a bit to say about wireless apparatus. Owing to the exigencies of war, however, we shall be compelled to omit much that is both instructive and entertaining on wireless, as well as a lot more that could ordinarily be said on the subject of electricity on warships, for it is on such ships that electrical application takes its most manifold and fascinating forms.

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ELECTRICAL PRIORITY ABROAD

In England it has come to pass that anyone wishing to buy an electric motor or other electrical apparatus must make application to the Ministry of Munitions for a certificate of purchase. This application must be accompanied by a memorandum from the manager or the chief engineer of the public utility on whose lines the apparatus is to operate. This memorandum is to state the following facts:

1. That adequate generating plant capacity is or is not available.

2. That no additional cost or material is involved in connecting the premises to the mains (including substation equipment, if any), or

3. Where expense is involved the material and apparatus to be provided and the cost thereof, and whether lead-covered cable is necessary or not. Where lead-covered cable is deemed necessary, the voltage of the current transmitted should be stated.

In issuing these restrictions the Ministry has in mind to curtail the demand for electrical energy, unless it is to be applied directly to the making of something essential to the conduct of the war. This is restriction to the limit. We cannot conceive of similar restrictions being enforced on this side of the water, where there is so much in the way of hydro-electric power to supplement the steam power stations, and so much of both kinds of power employed in war industries. Only the case of a positive coal famine in those parts of the country beyond hydro-electric zones, and a positive shortage of steel and copper would warrant such severe measures, in which case there would probably be one ruling for the steam plants and another for the other plants. The nature of this ruling shows, though, the severity of the measures that our ally is enforcing in its own way. The price is high, but freedom is worth it.

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EARLY TELEPHONE HISTORY

The telephone rights of New York for $18,000!

In an article printed in The Telephone Review, Theodore N. Vail, President of the Bell System, describes the acquisition of the telephone rights of New York from Hilborne L. Roosevelt and Charles A. Cheever in 1878, for the sum of $18,000.

Roosevelt and Cheever were the first men to start the telephone business in New York, which they did under a license from the original American Bell Telephone Company in 1877. In less than a year they had exhausted their financial resources without having put the telephone business on its feet, and Mr. Vail was sent down from Boston by the present company and organized the Bell Telephone Company of New York, which took over the business. The new company started with a capital of $100,000, $60,000 preferred and $40,000 common.

With the money that was raised the first telephone exchange in New York was started in the central office of the Holmes Burglar Alarm Company, 518 Broadway. Soon it became necessary to raise more money, and a bond issue of $100,000 was authorized. Negotiations were had with various parties. Among these was Jay Gould. Only recently an autographed letter turned up at a sale of manuscripts, autographs, et cetera, in which Mr. Gould declined to purchase the bonds. The letter reads as follows:

Dear Sir:

I have yours of this date in reference to the sale of the Telephone Company bonds. At the present time I have my hands full and am not in a position to purchase them. I should think such a security ought to bring $75 to $80.

Yours,

JAY GOULD.

The bonds were sold to Hatch & Foote at 75%. During all this time there was a lively competition by the Gold and Stock Telegraph Company, which was a subsidiary of the Western Union. The Gold and Stock Company was put at a disadvantage by the superiority of the Blake Transmitter, which was brought out by the Bell System in the fall of 1878.

A combination of the two competing companies was effected in May, 1880, when the Metropolitan Telephone and Telegraph Company was formed, with a capital of $1,000,000, with Mr. Vail as president. In 1888 this company authorized an issue of $2,000,000 thirty year bonds, which matured in May, 1918, and were duly paid off by the New York Telephone Company. In 1896 the Metropolitan Telephone and Telegraph Company was merged into the New York Telephone Company.

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The "Liberty Ball," an armored tractor with a revolving turrent, is now offered as a possible quick method of driving the enemy to the point of suing for peace. A steel model of this device is on exhibition at the Ordnance Department at Washington. The full sized ball is 8 ft. high, has an outside revolving turret of 12 ft., a caterpillar traction tread of 3300 sq. in., and weighs 15,000 lb. It can cover at the rate of 6 miles an hour.

Power Plant, Line and Distribution Problems

A Record of Successful Practice and Actual Experiences of Practical Men

REWINDING AND RECONNECTING DIRECT CURRENT ARMATURE WINDINGS FOR A CHANGE IN VOLTAGE

By T. Schutter

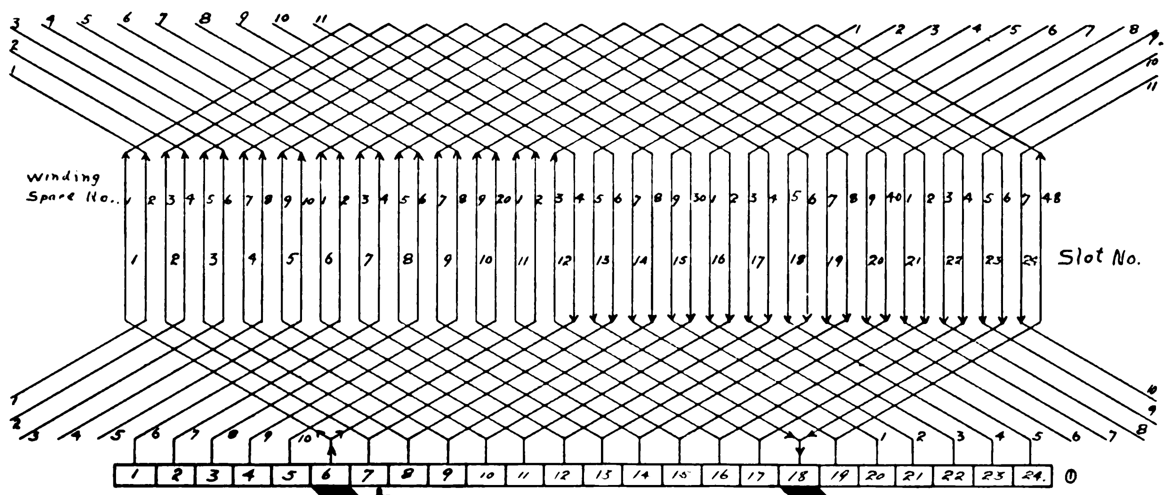
When a direct-current armature is to be rewound or reconnected for a change from one voltage to another, the number of turns in series between brushes will vary directly as one voltage to the other; and the cross-sectional area of the wire will vary inversely as the voltages.

To illustrate the above statement, take the case of a 2-pole armature consisting of 24 coils, 20 turns per coil wound one in hand using number 19B & S gauge wire, which has a cross sectional area of 1290 circular mils. This is a 240-volt winding and is to be changed so as to be operated on a 120-volt circuit. This can be accomplished in two ways. First, rewinding the armature; second, reconnecting the present winding.

By comparing the original voltage with the new operating voltage, it will be seen that the new voltage is just half of the original voltage, and if it took 20 turns per coil to produce 240 volts it would take half of 20 or 10 turns per coil to produce 120 volts.

As the machine is to do the same amount of work, it will carry twice the current at 120 volts that it did at 240 volts; and for this reason the wire must have twice the cross-sectional area, or 1290 x 2 = 2580 circular mil area. This is equal to a number 16 B & S gauge wire, still using the same number of coils. (24).

The other method is to reconnect the winding so that 2 coils are in parallel, and bridge 2 commutator bars. This will result in a winding of 12 coils, 2 in parallel, with 20 turns per coil. In Fig. 1 the original winding is shown, as it was wound and connected to the commutator.



Original 240 Volt Connection.

Fig. 1.

The armature core contained 24 slots and there were two coil sides per slot. The part of the slot which is occupied by a coil side is called a winding space; the odd numbered winding spaces are considered as being in the bottom of the slot, the even numbered winding spaces being in the top of the slot. The following is the winding and connecting table for the original winding:

Coil No.	Wound in spaces No.	In slots No.
1	1 and 24	1 and 12
2	3 and 26	2 and 13
3	5 and 28	3 and 14
4	7 and 30	4 and 15
5	9 and 32	5 and 16
6	11 and 34	6 and 17
7	13 and 36	7 and 18
8	15 and 38	8 and 19
9	17 and 40	9 and 20
10	19 and 42	10 and 21
11	21 and 44	11 and 22
12	23 and 46	12 and 23
13	25 and 48	13 and 24
14	27 and 2	14 and 1
15	29 and 4	15 and 2
16	31 and 6	16 and 3
17	33 and 8	17 and 4
18	35 and 10	18 and 5
19	37 and 12	19 and 6
20	39 and 14	20 and 7

21	41 and 16	21 and 8
22	43 and 18	22 and 9
23	45 and 20	23 and 10
24	47 and 22	24 and 11

The winding of Fig. 1, is connected as shown in the following table:

Beg of Coil No.	To Bar No.	End of Coil No.	To bar No.
1	6	1	7
2	7	2	8
3	8	3	9
4	9	4	10
5	10	5	11
6	11	6	12
7	12	7	13
8	13	8	14
9	14	9	15
10	15	10	16
11	16	11	17
12	17	12	18
13	18	13	19
14	19	14	20
15	20	15	21
16	21	16	22
17	22	17	23
18	23	18	24
19	24	19	1
20	1	20	2
21	2	21	3
22	3	22	4
23	4	23	5
24	5	24	6

By tracing the direction of flow of current through the windings from the positive brush to the negative brush, it will be seen that there are two paths or circuits, each consisting of 12 coils in series, the two paths or circuits being in parallel with each other. This winding operates on 240 volts.

In Fig. 2 the above winding has been reconnected so as to operate on a 120-volt circuit. As explained in the beginning of this article, it will require one-half as much winding on 120-volt as it did on 240 volts. This can be accomplished by connecting 2 coils in parallel, and using wider brushes; that is, the brushes should be at least as wide as 1½ commutator bars and not more than 2 commutator bars. If it is impossible to arrange for the use of the wider brushes, the commutator can be bidged, as shown by the jumpers A, B, C, etc. Fig. 2.

In the winding shown in Fig. 2, the connecting table is arranged as follows:

Beg. of Coil No.	To bar No.	End of Coil No.	To bar No.
1	5	1	7
2	6	2	8
3	7	3	9
4	8	4	10
5	9	5	11
6	10	6	12
7	11	7	13
8	12	8	14
9	13	9	15
10	14	10	16
11	15	11	17
12	16	12	18
13	17	13	19
14	18	14	20
15	19	15	21
16	20	16	22
17	21	17	23
18	22	18	24
19	23	19	1
20	24	20	2
21	1	21	3
22	2	22	4
23	3	23	5
24	4	24	6

By tracing the direction of flow of current through the winding it will be seen that the current flows in 4 circuits from the positive brush to the negative brush. In each path or circuit there are 6 coils in series, and the 4 paths or circuits are in parallel.

This reconnection is equivalent to rewinding the armature with twice the size of wire and one-half the number of turns as it was when wound for 240 volts. Both Figs. 1 and 2 show what is known as the lap or parallel winding.

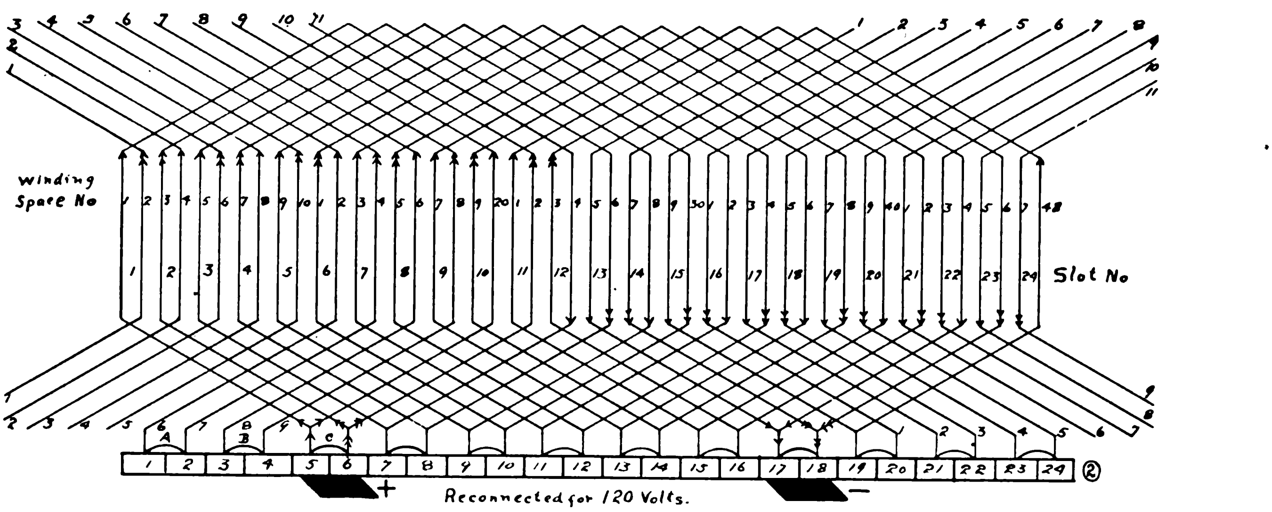


Fig. 2.

Fig. 3 represents a 4-pole wave or series unwinding, consisting of 31 coils. The armature core has 31 slots, and there are 2 coil sides per slot. It is wound so as to be operated on a 240-volt circuit. The coils in this Fig. are placed so that the beginning of each coil is placed in the bottom of the slot, and is represented by the odd numbered coil sides. The winding table is as follows:

Coil No.	Wound in spaces No.	In slots No.
1	1 and 16	1 and 8
2	3 and 18	2 and 9
3	5 and 20	3 and 10
4	7 and 22	4 and 11

The winding in Fig. 3 is connected as follows:

			Beg. of Coil No.	To bar No.	End of coil	To bar No.
5	9 and 24	5 and 12	1	28	1	12
6	11 and 26	6 and 13	2	29	2	13
7	13 and 28	7 and 14	3	30	3	14
8	15 and 30	8 and 15	4	31	4	15
9	17 and 32	9 and 16	5	1	5	16
10	19 and 34	10 and 17	6	2	6	17
11	21 and 36	11 and 18	7	3	7	18
12	23 and 38	12 and 19	8	4	8	19
13	25 and 40	13 and 20	9	5	9	20
14	27 and 42	14 and 21	10	6	10	21
15	29 and 44	15 and 22	11	7	11	22
16	31 and 46	16 and 23	12	8	12	23
17	33 and 48	17 and 24	13	9	13	24
18	35 and 50	18 and 25	14	10	14	25
19	37 and 52	19 and 26	15	11	15	26
20	39 and 54	20 and 27	16	12	16	27
21	41 and 56	21 and 28	17	13	17	28
22	43 and 58	22 and 29	18	14	18	29
23	45 and 60	23 and 30	19	15	19	30
24	47 and 62	24 and 31	20	16	20	31
25	49 and 2	25 and 1	21	17	21	1
26	51 and 4	26 and 2	22	18	22	2
27	53 and 6	27 and 3	23	19	23	3
28	55 and 8	28 and 4	24	20	24	4
29	57 and 10	29 and 5	25	21	25	5
30	59 and 12	30 and 6				
31	61 and 14	31 and 7				

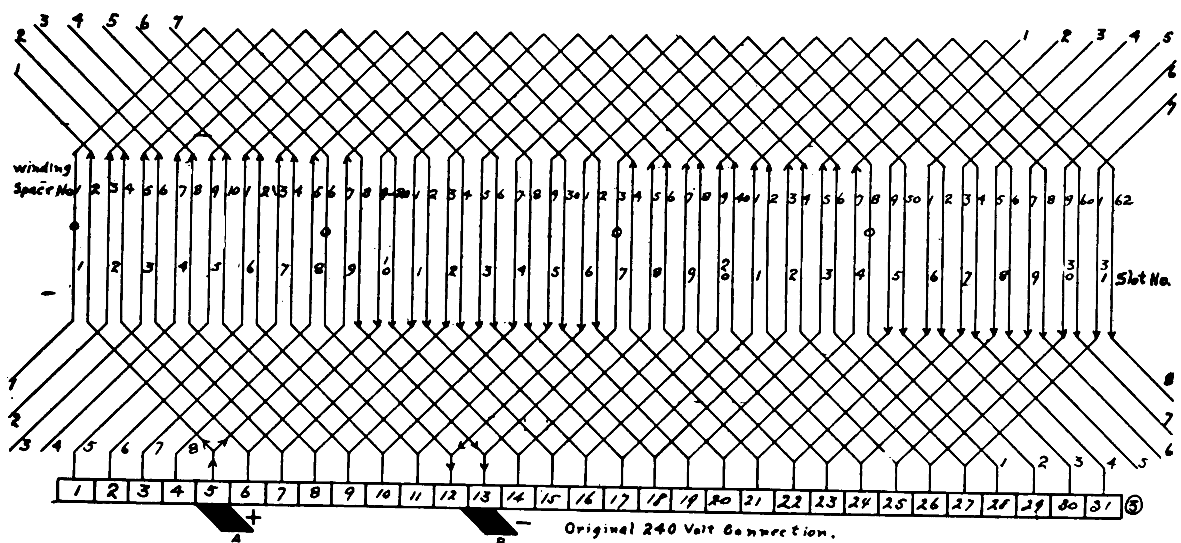


Fig. 3.

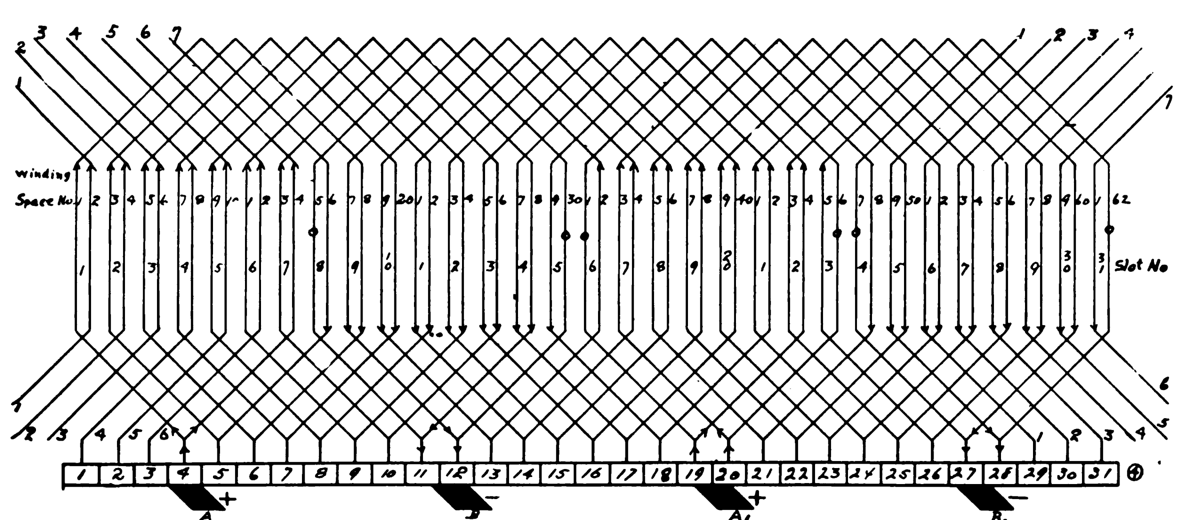


Fig. 4.

26	22	26	6
27	23	27	7
28	24	28	8
29	25	29	9
30	26	30	10
31	27	31	11

By tracing the current from the positive to the negative brush it will be seen that the winding is divided into 2 paths or circuits. To change this winding so that it can be operated on a 120-volt circuit, two methods can be used: First, reconnect the winding so that it will consist of 4 paths or circuits, and add another set of brushes as shown in Fig. 4. The additional brushes are marked A^1 and B^1. Second, connect 2 coils in parallel and still have but 2 circuits in the winding. This, however, will necessitate the dropping of one coil, as shown by the heavy lines in Fig. 5. Only two brushes will be required as shown, if they can be set so that they cover at least 1½ bars, the jumpers A, B, C, etc., can be omitted. The connecting tables for Fig. 4 is as follows:

30	2	30	3
31	3	31	4

The winding as shown in Fig. 4, is a 4 pole lap or parellel winding, with 4 circuits or paths through the winding. The second method of reconnecting Fig. 3 so as to operate it on 120 volts is shown in Fig. 5.

As previously explained, each two adjacent coils will be connected in parallel, and since there are 31 coils on the entire winding, one coil must be dropped. In this winding (Fig. 5) coil No. 1, shown with the heavy lines has no connection with the commutator.

There are 31 bars in the original commutator, so by taking any two bars and putting a jumper across and considering them as one bar, it will re reduced to 30 bars; the connections will be made as shown by the following table:

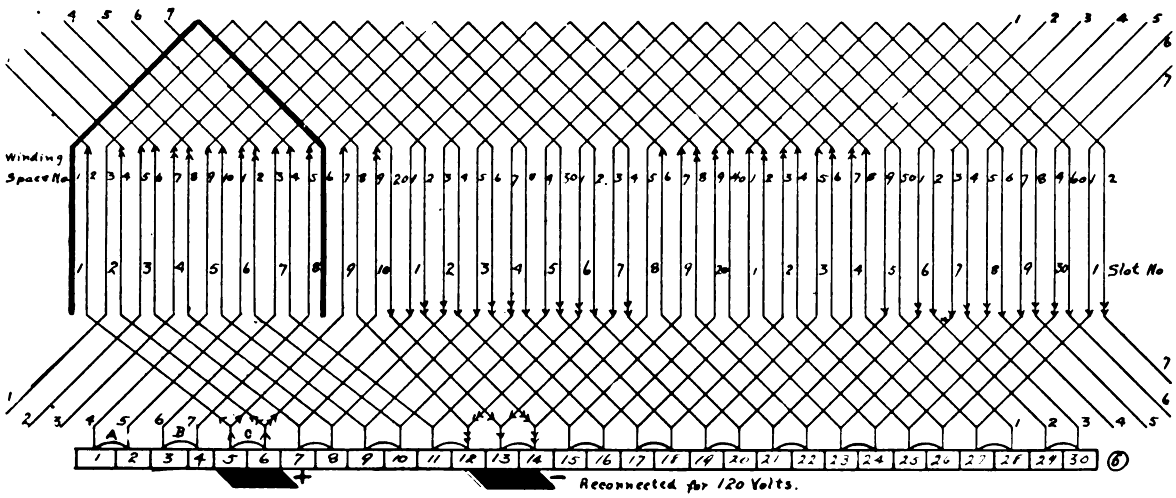


Fig. 5.

Beg. of coil No.	To Bar No.	End of coil No.	To bar No.
1	4	1	5
2	5	2	6
3	6	3	7
4	7	4	8
5	8	5	9
6	9	6	10
7	10	7	11
8	11	8	12
9	12	9	13
10	13	10	14
11	14	11	15
12	15	12	16
13	16	13	17
14	17	14	18
15	18	15	19
16	19	16	20
17	20	17	21
18	21	18	22
19	22	19	23
20	23	20	24
21	24	21	25
22	25	22	26
23	26	23	27
24	27	24	28
25	28	25	29
26	29	26	30
27	30	27	31
28	31	28	1
29	1	29	2

Beg. of Coil No.	To bar No.	End of coil No.	To bar No.
Coil 1 is not connected.			
2	28	2	12
3	29	3	13
4	30	4	14
5	1	5	15
6	2	6	16
7	3	7	17
8	4	8	18
9	5	9	19
10	6	10	20
11	7	11	21
12	8	12	22
13	9	13	23
14	10	14	24
15	11	15	25
16	12	16	26
17	13	17	27
18	14	18	28
19	15	19	29
20	16	20	30
21	17	21	1
22	18	22	2
23	19	23	3
24	20	24	4
25	21	25	5
26	22	26	6
27	23	27	7
28	24	28	8
29	25	29	9
30	26	30	10
31	27	31	11

DON'T BE A POWER PLANT SLACKER

In these days of the universal condemnation of the slacker, says a writer in Here We Are, published by the Georgia Railway & Power Co., it is well to remember that all slackers are not in the military line, to-wit, and for instance. If you are the sort of person that wears skirts and powders its nose, don't imagine that because the bulletin says the working hours are from 8 until 5, that it means to get in five or ten minutes late in the morning and to be all coated, hatted and powdered ready to vanish, when the clock points to 5 o'clock—because, dear cog-in-the-machine, it don't mean anything of the kind. What it really means is to be ready to begin work at 8, and to quit working at 5, the primping, etc., to come after that time, not before.

Should you be the sort of person that wears trousers, and don't powder its nose (except, perhaps, inadvertently) the same applies to you in equal degree. You may argue that you don't powder your nose, except as mentioned above, but, did it never occur to you that, to slide quietly off, out of sight, for an occasional cigarette, was perhaps, considerably worse? Don't do it. The company is buying your time and your ability, and is paying you a fair price for them. It is therefore only fair that you deliver the goods you have sold. It may seem that these are only little things, and not noticed, but, believe me, brother and sister cogs, they are not little things and they are noticed.

Now don't think this article was inspired, for it was not, neither was it asked for. It was written by one of the cogs in the hope of promoting a spirit of better work among the cogs for the lasting well-being of the big machine, and as an inevitable result of the cogs themselves.

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SAVING POWER

The better the vacuum under which an engine or turbine operates, the greater will be its efficiency. This is particularly true of turbines which show a saving in steam consumption of 10 percent. by increasing the vacuum from 26 to 28 in. and a further gain of 7 percent. by increasing the vacuum from 28 to 29 in. Spray systems cool the water sufficiently to afford the highest vacuum with an accompanying gain in efficiency. The power required to operate these spray systems is only about 1½ percent. of the power developed by the engine or turbine, and the net gain in power which the system effects soon pays for its cost. It should be noted that satisfactory results can seldom be obtained in the summer with less than 6 lb. operating pressure.

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INCREASE IN RATES AND FARES

The West Virginia Public Service Commission authorized an increase in fare charged by the City & Elm Grove Division, of the West Virginia Traction Co., from 5 to 6 cents. This was followed on May 29 by another order, permitting the establishment of a new zone, cutting the ride between Wheeling and Elm Grove approximately in half, and charging an additional 4 cent fare in the new zone. It is expected that these increases in fare will increase this division's income by about $75,000.00 a year.

The increase in street car fares throughout the nation generally, as well as the advance in thousands of other commodities identified for years with the nickel, has led officials of the Philadelphia Rapid Transit Company to announce they will join in a movement to ask Congress to authorize a new coin to take the place of a nickel. With many other citizens who have studied the situation, they believe the antagonism to paying six or seven cents for articles which formerly cost five cents is largely caused by the inconvenience of the old pennies rather than the actual increase in cost.

CROSS CONNECTION OF REVERSE-POWER RELAYS

While transmission and distribution systems can readily be sectionalized by the standard application of overload and reverse-power relays, there are often conditions under which these methods do not suffice. Some of these can be handled readily by a balanced system of relays by the pilot wire system and the split conductor system, both of which have been in use for some time. These, however, have certain disadvantages, among which are the expense of the additional cables necessary and, in the split-conductor system, the possibility of trouble occurring on both conductors simultaneously. In the latter case, as is well known, the relays would not clear the trouble.

A later method of balancing relays on parallel feeders, and not having the above disadvantages, is the cross-connection of reverse-power relays.

Fig. 1 shows the connections of cross-connected reverse-power relays applied to a system consisting of a generating station and a sub-station connected by four parallel feeders.

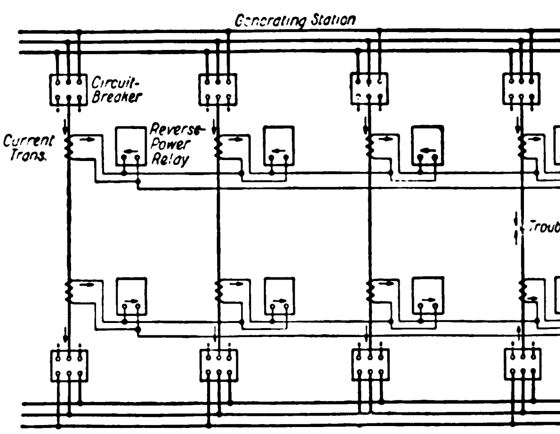

Fig. 1—Schematic diagram of cross-connected relay system (connections shown for only one phase—voltage and trip circuits omitted) arrows show direction of power with short circuit on right feeder as shown.

To simplify the diagram, only one phase of each of the feeders is shown. A complete diagram of connections for a pair of three-phase feeders, except that the tripping circuit is omitted, is shown in Fig. 2.

Figs. 1 and 2 show that all the current transformers in the generating station are connected in series, also, those in the sub-station; and that each relay, which must be a reverse-power (unidirectional) relay, is shunted across its current transformer.

Figs. 1 and 2 illustrate a particular, and a comparatively simple, condition. This scheme can be used with equal success in any part of a complicated network. The cables in the parallel system should be alike, but if their impedance differs this difference can be compensated for by simple means.

Under normal conditions, the load in each of the cables will be the same and, since the relays have a higher impedance than the current transformers, the current from the latter will therefore circulate through all of them in series without coursing the relays. If the trouble occurs at any point outside the section protected by these cross-connected relays, the current through the cables will still be balanced, and, there is no force tending to operate the relays. On the other hand, if trouble occurs on a cable within the section, the current through the defective cable will be stronger than that in the other cables, and the excess current from its current transformers must, therefore, pass through the relays. Though under this unbalanced condition current will flow through all the relays, it will be observed that the current is in the proper direction to cause the relay to act only in the relays at each end of the defective cables (see direction of arrows in diagram).

In Fig. 2 are shown pallet switches connected in the transformer secondary circuit. These are also connected mechanically to the operating mechanism of the breaker, so that when the breaker opens, the current transformers on the feeder

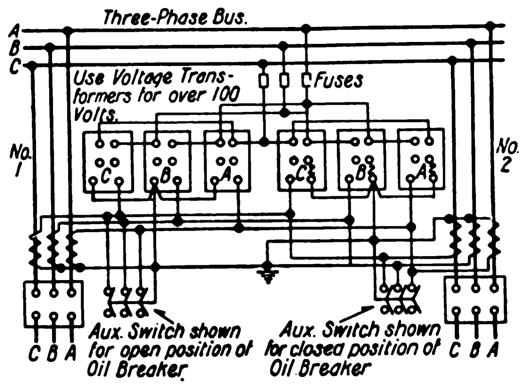

Fig. 2—Diagram of cross-connected relay system—connections shown for three-phase circuit complete except for trip cirsuit

controled will be short-circuited. By this method a cable can be cut out of service without interfering with the electrical balance in the current-transformer circuit.

Fig. 1 shows that when the cross-connected scheme is used on only two cables, the two sets of relays are actually in parallel, and are arranged to operate in opposite directions. The expense of the two-cable cross-connected system can be reduced by using, in place of the two sets of reverse-power

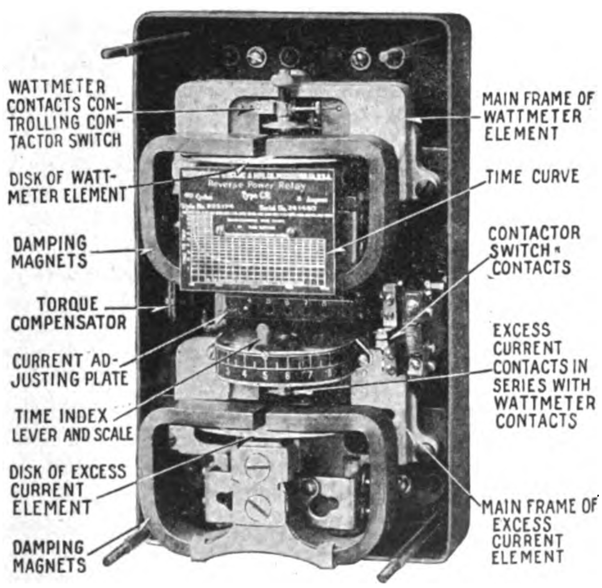

Fig. 3—Type CR relay, cover removed.

relays, one set of special relays having two contacts, one to close when power flows in one direction, and the other, in the reverse direction, Fig 3.

Of the cross-connected system of reverse-power relays it may be said:

1. It may be applied to any system, no matter how complex, if the feeders are run in parallel between the switching points.

2. It is practically instantaneous in operation.

3. It can be set to operate on smaller currents than the full-load of each feeder. This enables the clearing of trouble on a system having the neutral grounded through such high resistance that the total trouble and load current flowing through a single cable may be less than the maximum-load current of that cable.

4. It does not require change of adjustments each time generating stations are cut in or out of service.

5. It is more economical than the split conductor, or the pilot wire system, not requiring so much cable.

6. To avoid the condition arising from trouble occurring at the same time on both conductors of a split-conductor cable, a modified split-conductor scheme, using standard cables but operating them in pairs and disconnecting both in case of trouble on either one, has been tried. Cross-connected reverse-power relays are superior to this method of balancing bcause they cut out only the bad feeder.

The switch itself consists (when single-pole) of a movable arm. When closed, one end of the movable arm is pressed against the bus bar, and the other end against the fuse terminal, thus bridging the gap between them. When the switch is open, both ends of the arm are clear of their respective contacts. The switch is, therefore, double-break, and when open, leaves the entire fuse box dead. The switch arm is laminated, and makes contact under considerable pressure. It opens with a quick snap, no matter how slowly the operating handle on the front of the panel may be moved.

All parts which are not necessary to reach in normal operation are protected by covers held in place by screws. These are readily removed, however, in case of necessity, and every part can be reached for making connections, replacements, etc.

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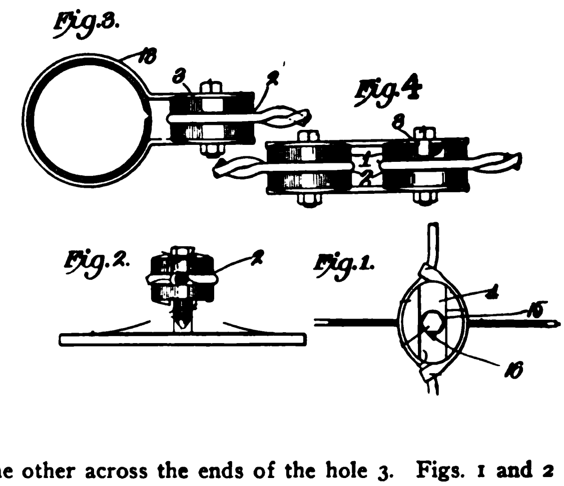
ELECTRIC REGULATOR

Anyone who has had to do with the overhead structure of trolley lines is aware of the great inconvenience caused by the usual practice of having a different kind of insulator for every different purpose. Mr. B. C. Moss of Kansas City, Mo. proposes an insulator which shall be universal in its application to overhead trolley construction. It has a circumferential groove 2, a central bolt hole 3 and grooves 4 extending from one side



to the other across the ends of the hole 3. Figs. 1 and 2 shows it in use for supporting a trolley ear, the bolt being locked and prevented from turning, except to a small degree, by the spring lock washer 15 having the spur 16 coming against the side of the groove 4, while the span wire is secured in the circumferential groove. Fig. 3 shows its use for securing a span wire to a pole, the ends of the pole clamp 18 fitting into the grooves 4 so that it is held securely. Fig. 4 shows its use as a strain insulator in a span wire for high tension systems. Patent No. 1,185,700.

THE TRADE IN PRINT

What The Industry is Doing in a Literary Way

NOTICE TO READER

When you finish reading this magazine cut this out, paste it on the front cover; place a 1-cent stamp on this notice, hand same to any postal employee and it will be placed in the hands of our soldiers or sailors at the front. No wrapping—No address.

A. S. BURLESON,
Postmaster General.

Cooling water with sprays is the title of illustrated Bulletin No. 71 recently issued by the American Spray Co., 26 Cortlandt Street, New York. This cooling system is said to show a saving in steam consumption of 17 percent. by increasing the vacuum from 26 to 29 inches.

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Combustion Engineering Corp., 11 Broadway, New York, has just issued a bulletin which contains a description of its travelling grate. These machines are said to be operated by means of anthracite coal and culm at an unusually high efficiency. They are also burning coke breeze in a large number of the by-product coke plants throughout the country, at much higher ratings than have heretofore been obtained by other means.

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"Scientific Industrial Illumination" is the title of a 36-page illustrated booklet recently issued by the Holophane Glass Co., 340 Madison Avenue, New York. This booklet is divided into four parts. The first part shows the need for scientific illumination and discusses its economic advantage. The second section discusses the fundamental principle of scientific illumination. The third part describes and illustrates new types of industrial lighting units manufactured by the company for shop, factory, office and drafting room illumination and for yard and protective lighting. The fourth section contains a collection of general engineering data which should make this book especially valuable as a ready reference book.

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Lillie Evaporator for Waste Waters—The first booklet relating to the Lillie Evaporator published by the Wheeler Condenser & Engineering Co., Carteret, N. J., is just off the press. The Lillie Evaporator is now manufactured exclusively by this company under agreement with the Sugar Apparatus Mfg. Co., S. Morris Lillie, Pres., owners of the Lillie patents. This new booklet calls attention to the factors which make the Lillie multiple effect vapor reversing evaporator especially suited to the concentration of waste waters or liquors in numerous industries. Five pages of the booklet are devoted to tables that are of especial value in the evaporation industry. An accordian folding page insert gives the principal instructions for operating Lillie Quadruple Effects.

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General Electric Co., Schenectady, N. Y., has recently issued Bulletin 47070 entitled "Direct Current Standard Unit Panels." These panels are 90 in. high, 125 and 250 volts, two-wire, and 125-250 volts three-wire for general power and lighting service. This bulletin is fully illustrated and contains 30 pages of descriptive text and many line cut illustrations.

Other printed matter recently issued by the General Electric Co. includes illustrated circulars on drum-type controllers for use with direct current adjustable speed motors for machine tool service, and similar controllers for series, shunt, or compound wound motors. Another bulletin contains descriptive particulars of drum controllers for slip ring induction motors, 110-550 volts, two phase or three phase. "Portable instruments, Type P-8" are illustrated and described in bulletin No. 46018 A.

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A Bulletin on Automobile Storage Battery Charging Units for use in connection with Delco-Light 32-volt plants has been issued by the Ward Leonard Electric Co., Mount Vernon, New York.

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ELECTRIC TRUCK DATA

The Charity Organization Society, of New York, is using two electric trucks and only five horses in the delivery of kindling wood instead of from twelve to fifteen horses, as formerly. The electrics, the first of which was installed in 1912, have from the start shown themselves to be far less expensive to operate. In fact it was the economies of the first electric that led to the purchase of a second, for the storage battery vehicle could deliver eight cords a day at a total cost of $12.73, while it took two two-horse teams, costing $18.00 a day to do the same work. That saving of $5.27 is the reason why the second electric was bought the following year.

During the year ending September 30, 1917, these two electrics between them delivered 2,663½ of the 3,540½ cords of kindling that went out of the West 28th street yard of the society. The total operating cost of the two vehicles for the year was $5,491.80, or an average of $2.02 per cord. The five horses in the service of the yard delivered only 877 cords, at a total expense of $4,904.74, or an average of $5.59 per cord. The figures are based on an all-year-round service, which in part accounts for the big difference.

DID YOU KNOW THAT-

BITS OF GOSSIP FROM THE TRADE

Smith & Hemenway Co., Inc., Irvington, N. J., is very largely given over to the making of tools for Uncle Sam. The "Red Devil" tools have proven so satisfactory to the Government that Smith & Hemenway Co., Inc., have been obliged to put up a new building which is now being completed. New machinery of the latest design is being installed, and the result will be an increased output and a saving of time in producing it.

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Westinghouse Electric & Mfg. Co., Pittsburgh, Pa., has purchased the property, business, and good-will of the Krantz Manufacturing Company, Inc., Brooklyn, N. Y., manufacturers of safety and semi safety electrical and other devices, such as auto-lock switches, distribution panels, switchboards, floor boxes, bushings, etc. The supply department of the Westinghouse company will act as exclusive sales agent for the products for the Krantz Company, whose business will be continued under its present name. H. G. Hoke, of the Westinghouse Electric & Manufacturing Company will represent the supply department at the Krantz factory.

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PURELY PERSONAL

W. A. Leuenberger, manager of the Tacoma Gas Company, Tacoma, Washington, has been elected president of the Tacoma Rotary Club.

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F. F. Espenschied has resigned as assistant engineer for the Hydro-Electric Power Commission of Ontario to become connected with the Combustion Engineering Corporation, New York City.

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L. J. Corbett, head of the electrical engineering department of the University of Idaho, has been commissioned a captain in the Engineer Reserve Corps and is stationed at Camp Lee, Va.

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R. H. McKibbin, who has been with the Cerro de Pasco Mining Company at Pachachaca, Peru, for the past year on hydroelectric construction, is now electrical engineer for the Southwest Cotton Company at Phoenix, Ariz.

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D. C. Green, general manager of the Fort Smith Light & Traction Company, has been elected president of the Arkansas Association of Public Utilities for the ensuing year. The 1919 convention of the Association will be held in Fort Smith.

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N. C. Draper, manager of the Northern States Power Co., Sioux Falls division, has been elected a member of the Executive Board for the South Dakota Electric Power Association for the ensuing year.

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J. F. McGuire, manager of the Northern States Power Company, Minot, North Dakota, division, has been elected vice president of the Minot Association of Commerce. He was also re-elected director for a two year term.

Charles H. Smith, an engineer of the executive department of the Westinghouse Electric & Manufacturing Company, has received a commission as major in the Reserve Engineers and has gone to Camp Lee to enter the engineering school.

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Oscar S. Straus has resigned as chairman of the Public Service Commission for the First District of New York to become associated with the National Food Administration at Washington, where he will investigate sugar costs and profits.

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P. A. Staples, vice-president and general manager of the Binghamton (N. Y.) Light, Heat & Power Company and general manager of the Sayre Electric Company, has resigned to become associated with Lewis A. Riley, 2d, mechanical and gas engineer, 103 Park Avenue, New York City.

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John W. Slocum, of Monmouth, N. J., has been elected president of the Board of Public Utility Commissioners, succeeding Lieut. Col. Ralph W. E. Donges, who recently resigned to devote his entire time to his duties as a member of the war Department Board of Appraisers.

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A. A. Brown, formerly sales manager of the St. Paul division of the Northern States Power Company, who received a commission as first lieutenant on completion of the second Officers' Reserve training camp course, has been promoted to a captaincy and transferred to the Seventh Division engineers, Waco, Tex.

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Malcolm G. Chace, of Providence, R. I., has been appointed Fuel Administrator for Rhode Island, succeeding George H. Holmes, resigned. Mr. Chace is a partner in the firm of Chace & Harriman, Boston, which has developed the hydroelectric systems now combined in the New England Power Company.

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Dr. A. E. Kennelly, of Cambridge, Mass., acting head of the department of electrical engineering at the Massachusetts Institute of Technology, has been commandeered by the authorities in Washington for special work during the summer months. His position is that of civilian liaison officer to the Signal Corps.

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George W. Hubley, for the last two years general manager and chief engineer of the Merchants' Heat & Light Company of Indianapolis, has resigned to become general manager of the elevator department of the Badenhausen Company of Philadelphia and New York City.

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M. L. Hibbard, manager of the Union Light Heat & Power Company, Fargo, North Dakota, has been elected president of the Fargo Rotary Club for the ensuing year. During the past eight months Mr. Hibbard has been acting President due to the absence of the president in Government service.

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H. A. Hornor, the well known consulting engineer in the marine electrical field, was appointed some time ago as head of the Electric Welding Section of the Educational and Training Department of the U. S. Shipping Board, Emergency Fleet Corporation. He is now located at 140 N. Broad St., Philadelphia, Pa.

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C. A. Hall has been appointed manager of the electric light and power department of the Eastern Pennsylvania Railways Company, Pottsville, Pa., which property is operated by the J. G. White Management Corporation, New York, N. Y. He is a member of the National Electric Light Association and the American Institute of Electrical Engineers.

Duncan Bond, the well-known electrical expert of Denver, Colo., has joined the sales force of The Packard Electric Company, works and general office, Warren, Ohio. He will be a strong addition to the Packard organization. It is said that the company is building some very large transformers for western interests.

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R. M. Hodgson, formerly associated with the Philadelphia office of the General Electric Company, has been elected a director and the vice-president and general manager of the Binghamton (N. Y.) Light, Heat & Power Company, succeeding P. A. Staples, resigned. Mr. Hodgson has also been elected the second vice-president and general manager of the Sayre Electric Company and will be in full charge of the operation of both companies.

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H. E. Young, sales manager of the Minneapolis General Electric Company and Northern States Power Company, recently gave an electrically cooked dinner to the 25 members of his sales force. The menu, which was quite substantial, was prepared by Miss Bernice Bell, domestic science expert of the company and Miss V. I. Thorson, of the sales department with an electric energy consumption of 2.7 kilowatts at a cost of 6.8 cents at the rate prevailing in Minneapolis.

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Walter E. Bush, 109 Highland Ave., Jersey City, N. J., has recently been appointed United States buyer for one of the largest importing corporations in Australia. If any of our readers are not now represented in that market and if their goods are manufactured by and the firm is composed of non-enemy aliens, a large amount of business might be secured for that field, which at this time is more than ever looking for goods of American manufacture. Correspondence is solicited by Mr. Bush.

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R. L. Lunt, Minneapolis, Minnesota, has just become connected with the sales department of The Packard Electric Co., having charge of the Minneapolis Branch. For years, Mr. Lunt was connected as sales engineer of the Western Electric Company's Philadelphia office. From there he went to the Electrical Storage Battery Co., of Philadelphia, Pennsylvania. He has also been in the electrical contracting business for himself—all of which has fitted him for his present position. He is located at 716-718 McKnight Building, Minneapolis, Minnesota.

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Darton L. Babcock has joined the auditing department of The J. G. White Management Corporation, New York City. After spending several years in the service of banking institutions in Binghampton, N. Y. and New York City, Mr. Babcock entered the public utility field as an accountant. In 1915 he became connected with A. B. Leach & Company, New York City, being placed in complete charge of their accounting and financial routine. In 1916 he was appointed manager of the Cincinnati office of W. E. Hutton & Company, stock brokers, severing this connection to make this new business connection.

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OBITUARY

Charles Trowbridge, assistant professor of physics, Columbia University, died suddenly last month of blood poisoning. Professor Trowbridge, who was 64 years old, had been a member of the Columbia faculty since 1892.

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There are now in Washington nearly six hundred operators from the New York Telephone Company and the Bell Telephone Company of Pennsylvania, and the number is steadily increasing.

ASSOCIATIONS AND SOCIETIES

Erie Section of the American Institute of Electrical Engineers held a meeting on May 23, at which the subject of discussion was "The Part Electricity is Taking in the World War."

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Spokane Section of the American Institute of Electrical Engineers was held on May 17. Prof. M. K. Akers spoke on "The Fundamental Mathematics of Alternating-Current Circuits," and P. T. Acland of the Forty-eighth Highlanders of Canada gave his "Recollections of Ypres Salient."

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San Francisco Section of the American Institute of Electrical Engineers held a meeting on May 24, at which Lieut. William S. Leffler, reserve military aviator, described the training given to combat flyers. Before entering the air service Lieut. Leffler was assistant to W. W. Briggs of the Great Western Power Company. Lieutenant Flynn of the British Royal Flying Corps, an instructor at the Fort Worth (Tex.) flying school, also spoke on the work of the air service. J. W. Beckman of the Beckman-Linden Company, read a paper on "Electrochemistry and the Power Industry."

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New York Jovian Outing.—More than two hundred members of the New York Jovian League, with their wives and guests, attended the annual outing and rejuvenation held at the Hotel Shelburne, Brighton Beach, Coney Island, Saturday afternoon and evening, June 15. Tribune George V. W. Pelz, presided over the rejuvenation ceremonies, which took place in the afternoon. He delivered the short form initiatory service and administered the oaths to four new members, Messrs. George H. Williams, Bryant Electric Company, Samuel Levine, General Electric Company, Thomas J. Finn, Electrical Products Company, and Edwin Hirchberger, Electrical Journal. During the shore dinner, served by the hotel management, the revue, "The Shelburne Girl," was specially produced under the direction of Ed. P. Bower, for the entertainment of the Jovians. A cast of forty principals was augumented by a large chorus. The music for the revue was written by Louis Silvers and the lyrics by Ed. Madden. The production was decidedly one of the best features of the outing.

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The Annual Meeting of the New York Electrical Society for the election of offices was held by courtesy of the National Electric Light Association, in the association's board room, the Engineering Societies Building, 29 West 39th Street, New York, Thursday, June 6, 1918 at 4 p. m. The following men were elected officers for 1918-1919:

President, A. L. Doremus; Vice-presidents, E. G. Acheson, C. A. Benton, Philip Torchio; Secretary, George H. Guy; Treasurer, Thomas F. Honahan.

The finances are in excellent condition, the best in the history of the society, and the membership list is considerably larger than it was a year ago. There are now close to 1,000 members. The betterment in the financial conditions of the society is due in large measure to the generosity of Williard E. Case, of Auburn, N. Y., who has recently made the society a substantial cash present. To Walter Neumiller is due the credit for bringing so many new members into the society.

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Fourth National Exposition of Chemical Industries will be held in the Grand Central Palace, New York, during the week of September 23, this year. Dr. Bacon of the advisory committee is now head of the Chemical Warfare Section of the National Army and a member of General Pershing's staff.

The coming exposition will be the largest Chemical Exposition ever held and it will be necessary to use four floors of the Grand Central Palace. The exposition is a war-time necessity and regarding it as such each exhibitor is planning his exhibit so that it will be of the greatest benefit to the country through the men who visit it, all of whom are bent upon a serious purpose—that of producing war materials in large quantities, and constantly increasing this production till the war has been won by the United States and its Allies.

The amount of floor space already engaged is greater than last year, so the managers say, while the exhibits will be much more attractive and a movement is under way to show all exhibits of machinery in operation under actual working conditions as they would be found in the field. The products of the chemicals manufactured and as they enter into the world's commerce will be there as examples of what the chemist has produced in America since the world war began.

ANNUAL CONVENTION A. I. E. E.

The thirty-fourth annual convention of the American Institute of Electrical Engineers was held at the Marlborough-Blenheim Hotel, Atlantic City, N. Y., June 26-28. At the opening of the convention, June 26, E. W. Rice, Jr., delivered the President's address. Following this the President-elect Comfort A. Adams, was formally introduced. In the afternoon the following papers were presented:

"Split-Conductor Cables," Balanced Protection, by William H. Cole, of the Edison Electric Illuminating Co. of Boston.

"Aerial Cable Construction for Electric Power Transmission," by E. B. Meyer, of the Public Service Electric Co., Newark, N. J.

"The Application of Theory and Practise to the Design of Transmission Line Insulators," by G. I. Gilchrest, of the Westinghouse Electric and Mfg. Co., Pittsburgh, Pa.

Following the presentation of Mr. Gilchrest's paper, there was a meeting of the Board of Directors. There was a reception and dance in the evening.

The following papers were presented and discussed during the morning of June 27:

"Lightning Arrester Spark Gaps—Their Relation to the Problem of Protecting Against Impulse Voltages," by C. T. Allcutt, of the Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

"The Oxide Film Lightning Arrester," by C. P. Steinmetz, of the General Electric Co., Schenectady, N. Y.

"The Oxide Film Lighting Arrester," by Crosby Field, Ordnance Dept., U. S. A.

"Design of Transpositions for Parallel Telephone and Power Circuits," by H. S. Osborne, of the American Telephone & Telegraph Co., New York.

In the evening E. Kilburn Scott, consulting of London, gave a lecture on "Electric Power for Nitrogen Fixation." This was followed by an address on "America's Power Supply" by C. P. Steinmetz, of the General Electric Co.

On Friday morning the following papers were presented:

"Pre-Charged Condensers in Series and in Parallel," by V. Karapetoff, of Cornell University, Ithaca, N. Y.

"Method of Symmetrical Coordinates Applied to the Solution of Polyphase Networks," by C. L. Fortescue, of the Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

"Sustained Short-Circuit Phenomena, and Flux Distribution of Salient Pole Alternators," by N. S. Diamant, of Rice Institute, Houston, Tex.

At the concluding session, held on Friday afternoon, three papers were presented and discussed as follows:

"Reactance of Synchronous Machines and Its Application," by R. E. Doherty and O. E. Shirley, both of the General Electric Co., Schenectady, N. Y.

"Protection from Flashing for D-C. Apparatus," by J. J. Linebaugh and J. L. Burnham, both of the General Electric Co., Schenectady, N. Y.

"The Automatic Hydroelectric Plant," by J. M. Drabelle of the Iowa Railway & Light Co., Cedar Rapids, Ia., and L. B. Bonnett, of the General Electric Co., Schenectady, N. Y.

During all three days of the convention there was a conference of Institute officers and delegates of Sections and Branches at the Sections Committee's luncheons.

WHAT THE NATIONAL INSTITUTE OF INVENTORS IS DOING

During the past year the members of the National Institute of Inventors have brought into commercial development more than four hundred and fifty successful inventions. Among the most important in which the institute has collaborated, aided and developed for its members are the following, all of exceptional value at this time:

Pure Iodine Dissolved in Water

The Bollin process dissolves iodine crystals in water only, eliminating all iron and manganese, making an absolutely pure solution, something hitherto deemed impossible by chemists. The Bollin process of dissolving minerals in water promises to revolutionize chemical science. So perfect and complete is the solution that iodine submitted to distillation fails to dismember the water, for the resultant distillation is identically the same as the original iodine water solution, furthermore one drop in a glass of water is perfectly distributed to every other particle of the water in the glass, permitting water solutions from 50% to the lowest degree. For healing and antiseptic purposes this water iodine is far superior to all other forms of iodine, as it is non-irritant, does not coagulate the blood when applied to a wound but assimilates with the tissues, carrying the iodine far into the wound, besides it is absolutely free from any deleterious substances usually found in ordinary iodine. It has been offered to U. S. Government for hospital use.

Submarine Detector

A magnetic device that indicates approach of a submarine or other metallic vessel, its direction and position as well as approximate distance. This device has been offered to U. S. and British Governments and is under test.

Automatic Magnetic Mine Explorer

Automatically explodes a mine upon the approach of a submarine or other metallic vessel, the distance to be adjusted when setting. Already offered to the U. S. and British Governments and tested by them.

Garbage Utilization

Odorless process whereby garbage yields alcohol, glycerine, sugar, glucose, fats and cattle feed, every part being used up with no residue whatever and no incineration. Plant now being constructed in Detroit, Mich.

High Velocity Carburetor

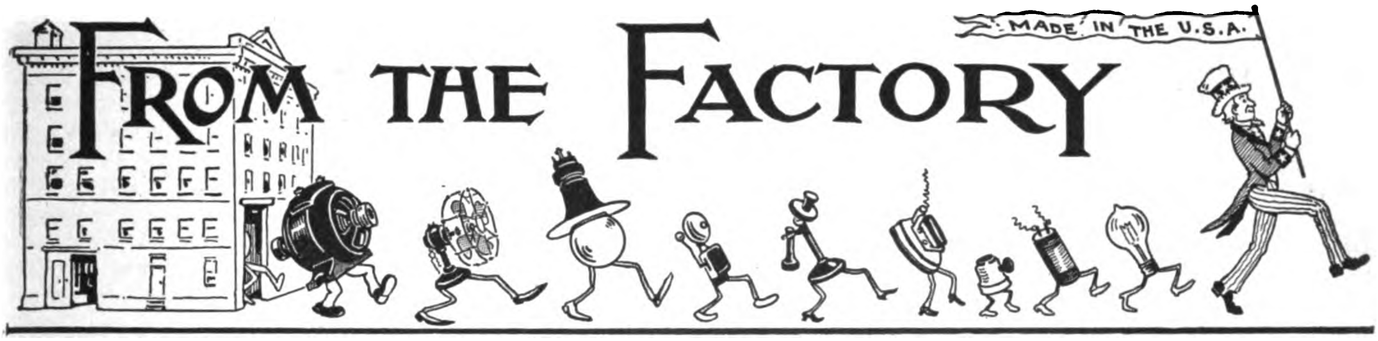
A new carburetor that eliminates any danger of stalling the engine of an airplane or automobile under any condition, provided gasoline flow is not interrupted. It adapts itself to any situation automatically. Uses gas economically. Official tests show 40 miles to gallon of gasoline in a Ford car, 32½ miles in a Buick, etc. With brakes locked and engine running full speed, it was impossible to stall engine. Factory being erected in Detroit with $22,500,000 in Government orders in hand already.

Apostoloff Primary Battery

A new primary monocell battery to sell for 5c per unit, adapted for lighting. Also a storage battery for vehicular motive power as well as for starting and lighting batteries, twice as light as present batteries with twice the power and at half the cost. Will develop 25 watts per pound of weight. Being developed commercially and will soon be on market.

Nitrates From Air

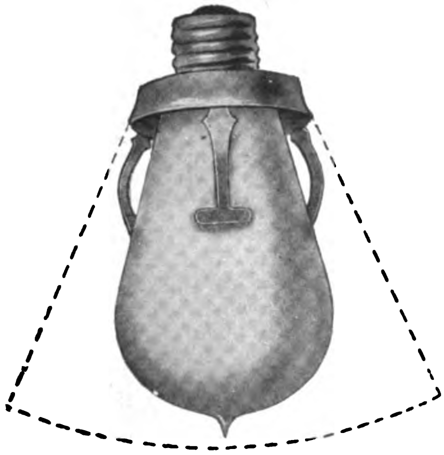
Sanders process is a most simplified method, doing away with towers and use of sulphuric acid. Now ready for development.

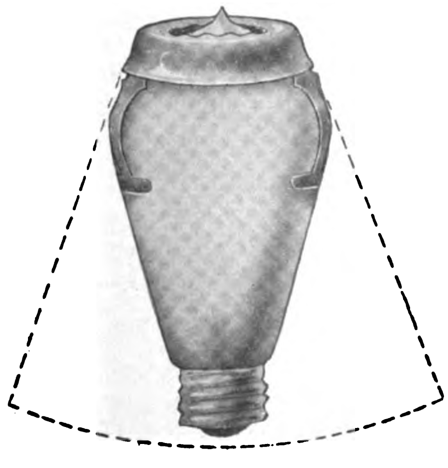


Short Stories About Electrical Goods Offered By Manufacturers

INCANDESCENT LAMP SHADE HOLDER

The accompanying illustrations show two kinds of incandescent lamp shade holders, recently put out by J. A. Whaley & Company, 118-120 Fifth Avenue, New York City.





Holder for use with silk, metal, glass or linen shades. Made by J. A. Whaley & Co., 118-120 Fifth Ave., New York City.

The shoulder which supports the shade has an opening of 2 inches, which is the size of opening provided in the shade when the holder is used. The dotted lines in the illustrations indicate the positions of the shade on the holder.

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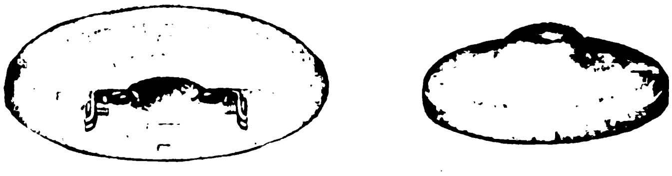
LACO-DALITE GLASSWARE

The Laco-Phillips Company, 131 Hudson Street, New York City, has developed what is to be known to the trade as the Laco-dalite glass, for use in department stores and in industrial lighting where colors of materials are of moment. Standard reflectors can be equipped with this glass by means of a suitable holder.

FUSELESS ROSETTES FOR OUTLET BOXES

The Bryant Electric Company, of Bridgeport, Conn., has recently placed on the market a line of fuseless rosettes for 3¼ in. and 4 in. outlet boxes, all of which are National Electric Code Standard.

These rosettes are made in two types, with and without terminals, the latter for use when the line wires lead directly to the lamp socket. The rosettes for 3¼ in. outlet boxes are 3⅝ in. in diameter, with elongated holes for supporting screws spaced 2¾ in. on centers.



Fuseless rosettes for outlet boxes. Bryant Electric Co. Bridgeport, Conn.

For 4 in. outlet boxes they are 4⅝ in. in diameter with holes for supporting screws spaced 3½ in. on centers. The design of these rosettes is symmetrical and attractive.

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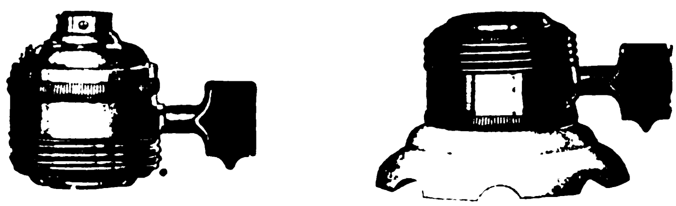
INTERCHANGEABLE SNAP SWITCHES

Two types of switches are shown in the accompanying illustration which have been added to the interchangeable line made by the Connecticut Electric Manufacturing Company, Bridgeport, Conn. The switch shown at the left in the illustration is known as No. BA-285 and constructed as a simple and inexpensive 3-ampere, 250-volt switch with its base and shell interchangeable with the company's key socket for export trade. The switch part can also be used with the company's angle type wall base.



Interchangeable snap switches. Connecticut Elec. Mfg. Co. Bridgeport, Conn.

The pendant switch shown at the right is a combination of the company's socket cap and interchangeable interiors of its No. 285 socket. These fixtures have been designed so that a complete inexpensive combination of sockets and switches with interchangeable caps and bases and with indicating keys is provided for foreign requirements.

LAMP FROSTING COMPOUND

A new compound for frosting incandescent lamps is announced by the Guy V. Williams Company, Inc., 116 Broad Street, New York. It can be easily and quickly applied. The number of lamps that can be frosted depends upon whether they are to be bowl frosted or totally frosted. About 150 110-watt nitrogen lamps can be frosted to a pound of the compound.

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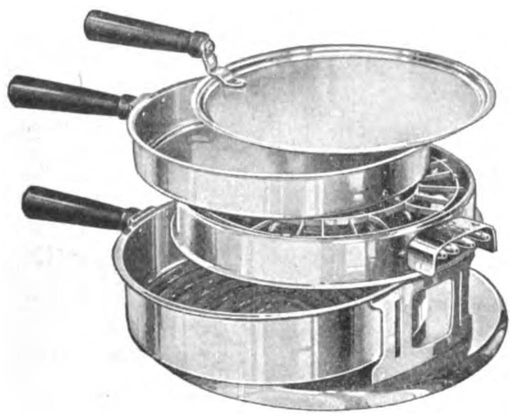
UNIVERSAL FOUR-HEAT ELECTRIC GRILL

This device consists of an electric heating unit and three cooking pans, the pans being one-quarter, one and a quarter and two inches deep respectively. As indicated by the title,



Four-heat grill. Landers, Frary & Clark, New Britain, Conn.

by means of a switch the four degrees of heat can be obtained. It is equipped with six feet of heater cord, a twin connector, and a hubble lamp socket plug. By means of it food can be broiled, fried, roasted, or stewed. It is finished in nickel and consumes 600 watts on full heat. It is made by Landers, Frary, and Clark, New Britain, Conn.

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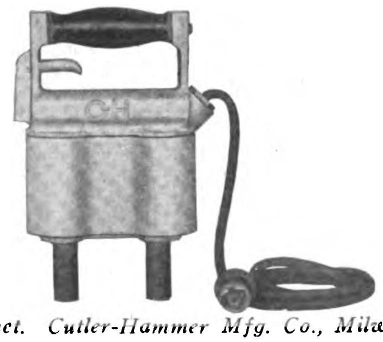
CUTLER-HAMMER HAND MAGNET

The C-H hand magnet is made for operation on 110 or 220 volt direct current circuits and is furnished complete with 5 feet of reinforced flexible cord and a standard C-H separable attachment plug.

The circuit to the magnetic coils is closed and opened by means of a large trigger mounted under the handle in the handle support, which operates a strong quick made-and-break snap switch concealed in the cast aluminum yoke cover. The operation of the trigger is like pulling the trigger of a shot gun;



Hand magnet. Cutler-Hammer Mfg. Co., Milwaukee, Wis.

pulling it toward the handle closes the switch. A slight release of the trigger does not open the switch but when full released the switch opens with a quick break.

The magnetic coils, switch and connections are entirely covered by two aluminum castings. The upper aluminum casting forms the handle supports, switch cover and yoke cover. The lower casting covers the coils and leaves only the soft iron poles projecting.

The hand magnet is used in machine shops for clearing chips and borings out of the machinery or removing them from parts of the work not easily accessible. Dropped tools, bolts, boring bars, etc., are easily recovered with the aid of the magnet from places from which it would be difficult to fish them by ordinary means. The weight of the hand-magnet is only eight pounds about like the household electric iron.

In shops where large quantities of brass and iron chips accumulate, the hand-magnet is useful since brass being non-magnetic is not attracted by the magnet, like iron, thus enabling the two metals to be separated by merely passing the magnet through the mixed metals.

In foundries this magnet may be used to pick up warm or awkwardly shaped castings; smooth plates, which are sometimes difficult to secure a hold on when laying on a flat surface; or for cleansing the molding sand of minute particles of metal.

It is offered by the Cutler-Hammer Mfg. Co., Milwaukee, Wis.

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AUTOMATIC ELECTRIC TOASTER

The Rutenber Electric Company of Marion, Ind., is making a toaster that insures well browned toast on both sides. When the toast is done on one side a touch of the hand on the metal frame automatically turns the toast so that the other side faces the heat. The device also has extra heating surfaces for warming pieces of toast already done.

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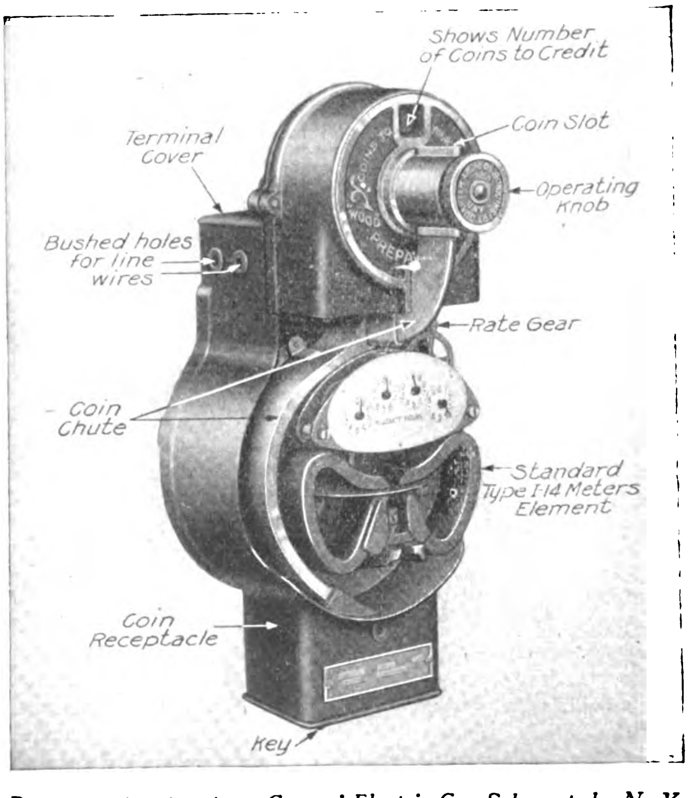
PREPAYMENT WATTHOUR METER

The General Electric Company has developed a prepayment watthour meter called the type 1 P-5 for use on alternating circuits. Electrically it is the widely known standardized type 1-14 G-E watthour meter. The prepayment device which is an integral part of the meter is mechanically operated.



Prepayment wattmeter. General Electric Co., Schenectady, N. Y.

The purpose of this prepayment meter is to make more profitable the accounts of small consumers and the shifting population of to-day by lowering the costs for collection and to eliminate the uncollectable accounts from these sources. By also eliminating flat rates to these classes of customers, consumption of electrical energy and consequently of fuel is reduced, and the apparatus investment can be governed by actual requirement of essential operations. In addition, the central station is saved the trouble and expense of cutting service in and out because equipment is undisturbed.

The prepayment mechanism is actuated by a large coiled spring, wound when depositing the coin. The only load imposed on the driving element of the meter is that of actuating the tripping device. This requires practically no energy.

The insertion of the first coin and turning of the knob automatically closes the controlling switch. (Twenty coins is the maximum for deposit, though the coin box will hold about one hundred.) When energy to the value of the deposit has been recorded the switch is automatically opened until another coin has been deposited.

Every precaution has been taken against tampering or beating the meter. Opening it for inspection does not make the cash box accessible except to those having the special key for that purpose. The rate charge can be changed by inserting a new set of rate gears.

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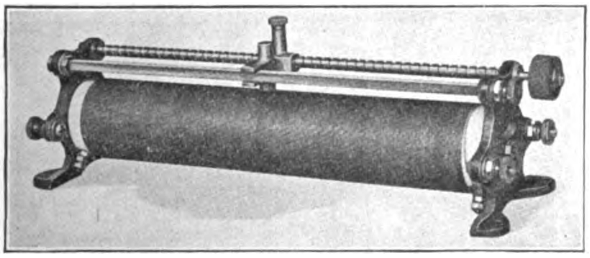
IMPROVED LABORATORY RHEOSTAT

This rheostat is of the sliding contact type. The wire, with heat resisting, oxide insulation, is wound on an enamelled tube about 2 in. in diameter. Contact with the wire is made by means of a shoe carried by the slider. The end supports are castings, and securely held in place by a rod running through the tube. Holes in the supports provide for ample ventilation.

The slider can be moved back and forth by hand, as in ordinary slider rheostats, or it can be operated by means of



Laboratory rheostat. H. G. Crane, Brookline, Mass.

the screw and hand-wheel, as illustrated. The screw mechanism is rendered operative by simply turning a nut on the slider. The rheostats are also made without the screw mechanism when desired.

The rheostats are made with 12 in. and 16 in. tubes, and are rated at 300 to 500 watts. They will stand heavy overloads for short intervals without injury. The many stock sizes cover all ranges from 10 ohms to 500 ohms. The rheostats are supplied with asbestos wood base when desired at slight extra cost.

They have been developed by H. G. Crane, Brookline, Mass.

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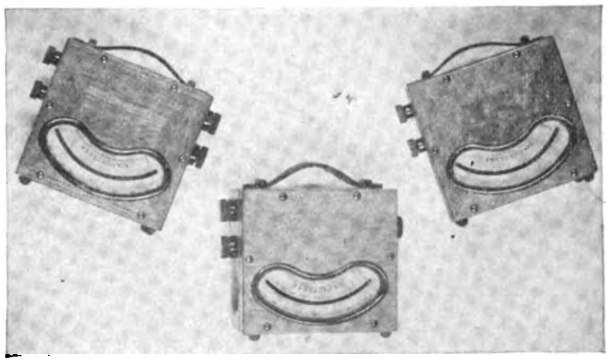
SMALLEST PRACTICAL SET OF TESTING INSTRUMENTS

The General Electric Co., Schenectady, N. Y., has developed what is claimed to be the smallest and lightest practical set of testing ammeters, voltmeters and wattmeters for alternating and direct current set brought out.

The instruments are called the Type P-8 and are applicable to all commercial frequencies and wave forms without appreciable error.

These ammeters and wattmeters are furnished only for series current capacity up to and including 20 amperes. The wattmeter is single phase, but can be furnished with double voltage potential circuit, if desired.



Smallest testing instruments. General Electric Co., Schenectady, N. Y.

Notwithstanding their small size the wattmeter and voltmeter are of the dynamometer type. The ammeter is iron vane type. The windings are magnetically shielded and equipped with an air damper of new design. The needle is dead beat; assuring accurate, quick readings.

The instrument case with a window in the cover over the scale plate forms the carrying case. It is of mahogany with leather carrying handle and weighs less than two pounds. Dimensions are approximately 3¾ by 2 9-16 in.

Voltmeters and wattmeters of this type for 600 volts also have been developed. The cases are slightly larger to care for the additional resistance.

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MOTOR-DRIVEN FLOOR SWEEPER

This type of sweeper is made especially for use in cotton mills and similar linty places by William Forth, 200 Devonshire Street, Boston, Mass. It is equipped with an Edison B-4 storage battery and a 0.10-hp. 12-volt motor directly connected to a special fan which creates a suction that picks up the sweepings and delivers them to a waste receiver. This suction air is passed and screened through the receiver, and the discharging current is regulated to force the lint and waste automatically from the spinning frames and other machinery into opposite alleys and spare floors, to be picked up later by the machine. The motor is started and stopped by means of a key switch.

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CURRENT-LIMIT AUTOMATIC CONTROLLER FOR MOTORS

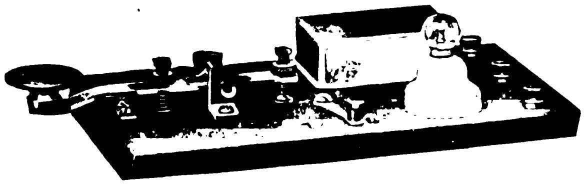
An automatic controller consisting of a number of lock-out accelerating switches having series-wound coils has been placed upon the market by the Industrial Controller Company of Milwaukee, Wis. The rate at which the motor accelerates up to full speed is limited by the current in the armature—under light loads the motor will start rapidly, under heavy loads more slowly. The motor will accelerate to full speed in the quickets possible time consistent with safety.

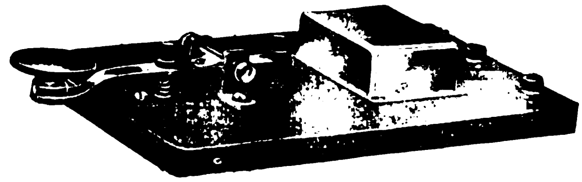
This device is known as a "unit panel construction" controller—that is, each accelerating unit, contactor, overload relay and knife switch which may be used with the complete controller is mounted on a separate panel. The panels are in turn mounted on a frame completing the controller. Each of the accelerating unit panels also carries the necessary resistance units. This panel construction permits easy replacement or additions.

KNAPP TELEGRAPH BUZZER AND KEY

This outfit consists of a telegraph key, buzzer and three binding posts, mounted on a finished base, 7 in. x 4¼ in. It is made by the Knapp Electric and Novelty Co., West 55th Street, New York. By connecting one or two dry cells, the outfit will be complete.

The key has silver contact points as used in more expensive outfits. It has the "click" for learning to send messages in the Morse American Code, and the buzzer will reproduce the sound signals used in wireless.





New telegraph outfits. Knapp Elec. & Novelty Co., New York.

The key may be used alone or with the buzzer; and two outfits placed at some distance apart can be operated for sending and receiving practice by following a wiring diagram.

This company is also making a combination wireless outfit. This outfit is similar to the Knapp buzzer and key outfit with the addition of a lamp, lamp socket and control switch.

Two dry cells connected to the binding posts will produce the necessary bright flash from the lamp, which is operated by the key for sight signalling; the buzzer, operated by the key, gives the wireless sound signals; while the key, without buzzer or battery may be used for American Morse Code practice.

It can be used in many combinations by means of the switch control. Two outfits may be operated at a considerable distance apart.

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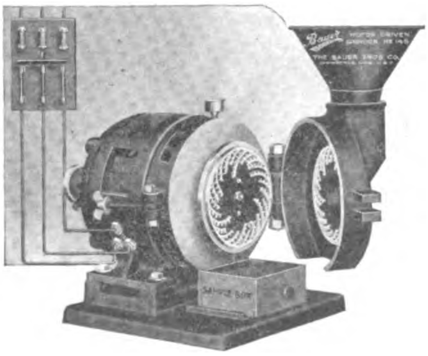
ELECTRIC-DRIVEN LABORATORY GRINDER

An electric-driven grinder for laboratory service has recently been developed by The Bauer Bros., Co., Springfield, Ohio. As shown by the illustration the outfit consists of a Robbins & Myers motor with one end head replaced by the grinder mechanism which is direct connected to the motor shaft. The grinder opens like a watch and all interior parts are readily accessible and easily cleaned so a variety of materials can be ground in the machine without any one sample being contaminated by the others.



Grinder for laboratory service. Bauer Bros. Co., Springfield, Ohio. Operates by Robbins & Myers motor.

The outfit is used chiefly by commercial laboratories for grinding samples of cotton seed cake, linseed cake, corn cake and food stuffs of all kinds, also for coal and nearly any materials which require grinding in the laboratory for analysis. The outfit is also used where small amounts of materials are ground continuously and for this service it is provided with a special base which permits a constant flow of material to pass through the mill.

The dimensions of the outfit are as follows. height overall 24 in., width overall 16 in., length overall, closed, 25 in., open 32 in. The hopper is 10 in. in diameter and the plates are 8 in. in diameter. The speed is 1800 rev. per min. and the weight is 300 lbs.

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HUBBARD WIRE HOLDER *and* INSULATOR

No tie wires are necessary in the insulator recently brought out by Hubbard & Company, Pittsburgh, Pa., that may be attached to any type of support. The insulator has an arc-over voltage of 1900 volts and provides a good safety factor for voltage up to 500 volts. An open-end wall plate is said to prevent ice forming under the plate in winter and forcing the holder from the wall.

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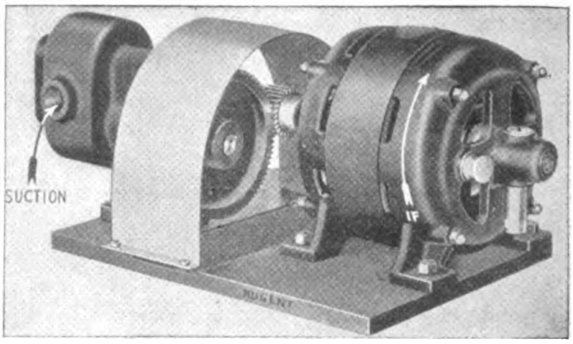
MOTOR DRIVEN PUMP *for* HANDLING OIL

Wm. W. Nugent and Company, of Chicago, Ill., have developed a geared, motor driven rotary oil pump for oiling systems and for pumping oil from a barrel to an overhead reservoir.

Two sizes are obtainable having a delivery of 8 quarts per minute and 40 quarts per minute at 500 rev. per min. of the pump.



Pump for oil. Driven by General Electric motor.

Power is furnishind through a noiseless rawhide pinion by means of a fractional horse power motor made by the General Electric Company for the prevailing current.

The motor is controlled through a rheostat and switch box mounted in a convenient location.

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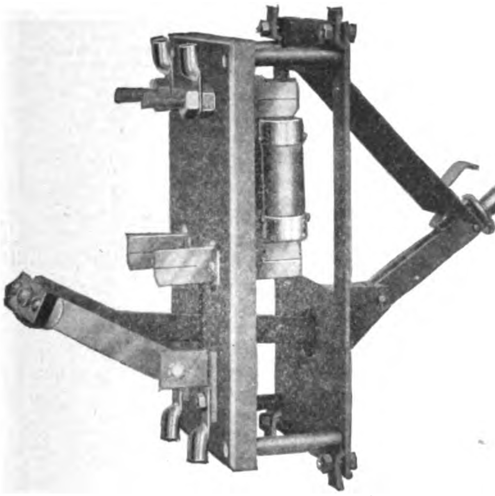
THREE-PHASE CONDUCTOR SUPPORTS

The Delta-Star Electric Co., 2433 Fulton Street, Chicago, Ill., is offering the trade a triangular arrangement of low-tension, high-capacity conductors designed especially for use in mills, mines, railway shops, and on other consumer premises. It makes a compact and shipshape arrangement for electric distribution systems, and allows satisfactory spacing of the conductors.

LOW TENSION DEAD FRONT SWITCH PANEL

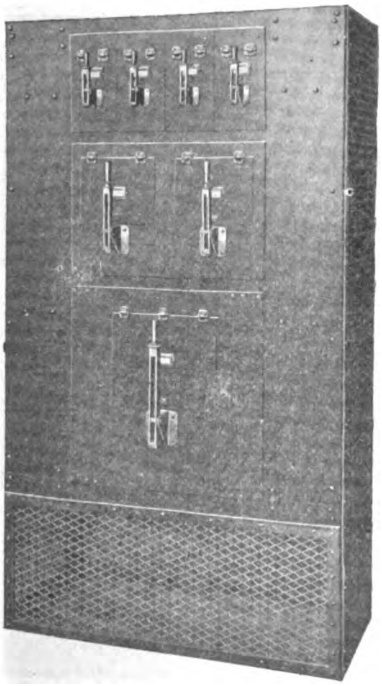
These illustrations typify a line of dead front panel switches made by the General Electric Co., of Schenectady. Primarily the panels are intended as distributing panels for light and power, and for generator and feeder panels for small lighting and power plants, but they present an important safety first development. Due to their high factor of safety they are especially valuable in factories where switchboards are operated by inexperienced or careless employees.



Dead front panel unit.

A switch unit consists chiefly of standard knife switch and fuse clip parts, mounted on a slate base and supported by iron studs at the back of a sheet steel panel. The steel panels are 3-16 in. thick, and their other dimensions are graded so that they present a uniform appearance even when several sizes are mounted together.

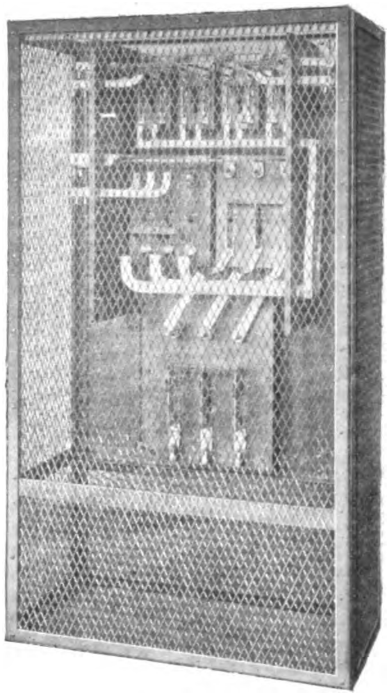
The operating handle has the same general appearance as an oil circuit breaker handle, and is so arranged that it is in the vertical position when the switch is "on" and at an angle of 60



Dead front switch panel, front view.

degrees with the panel when the switch is in the "off" position. The operating link passes through both the steel panel and the slate base. It transmits the motion from the handle to a lever attached to the cross bar of the switch.

The steel panel of the switch unit is provided with a sheet steel door which is hinged at the top, allowing it to open upward as far as the stop on the operating handle behind which it is mounted. This door gives access to the fuses from the front of the panel but cannot be opened while the switch is "on." When this door is open, the switch cannot be closed. Fuses can be inspected or replaced at any time, but the operator cannot come in contact with the live current carrying parts as the fuses are on the load side of the switch, and the fuse clips must be dead before



Dead front switch panel, rear view.

the fuse compartment door can be opened. The switch can be locked in the "off" position by an ordinary padlock. The capacity of the switches is limited by the sizes of 250 and 600 volts enclosed fuses as approved by the National Board of Fire Underwriters. The current ratings range from 60 to 600 amperes.

The panel frame is built of riveted angle iron, and the current carrying parts back of the panel are enclosed in expanded metal. The wires and cables to and from the switches may be brought out at the top or bottom of the panel. The steel panels are not drilled for mounting bolts; but are secured to the panel frame by bolts and a special clamp.

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SOLDERLESS WIRE TERMINAL

Great conductive capacity is said to be obtained by a solderless terminal that has been placed upon the market by the Cruban Machine & Steel Corporation, 2 Rector Street, New York. Each strand of the cable comes in direct contact with the lug body. An absolutely firm contact is obtained, and it is impossible to pull out the wire without destroying either the lug or the wire. The wire can be taken out of the lug without injuring the wire or the lug. The grip of this lug is in no way affected by excessive heating. The cross-section in the illustrations shows the body, the lock nut and the cable. The wire strands of the cable are bent back on to the smooth part of the lock nut. To attach, the end of the cable must be cleaned of all insulation for about 9/16 in. The insulated part is then slightly tapered on the edge, so that the lock nut can be screwed in over the insulation as shown in the figure. This connector is known as the "Cruban" solderless wire terminal.

NEW TYPE OF SAFETY SWITCHBOARD

A novel type of switchboard, known as the auto-lock switchboard, has been placed on the market by the Krantz Mfg. Co., of Brooklyn. This board has two distinctive features; (1) unit construction and, (2) safety to workmen operating the switches, renewing fuses, or walking around the board.

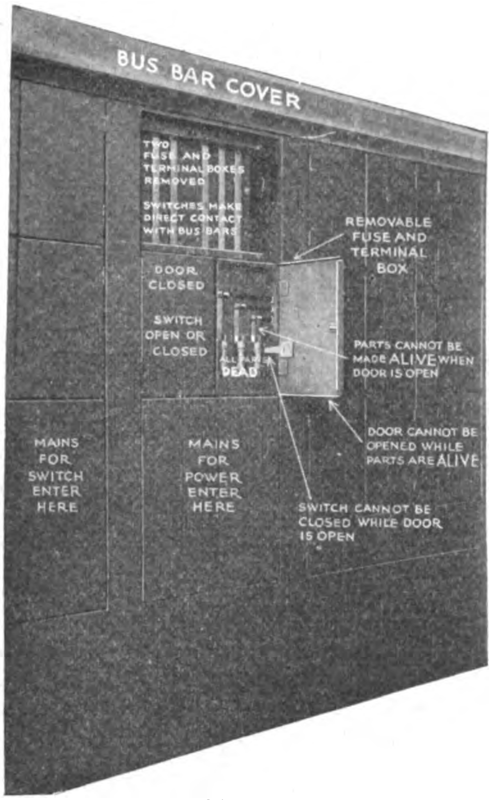


Fig. 1

The unit construction of the board, with each switch in a separate compartment, is best seen from the rear view, Fig. 2. Each of the smaller sections represents a switch unit and each of the larger sections represents compartments, for bus

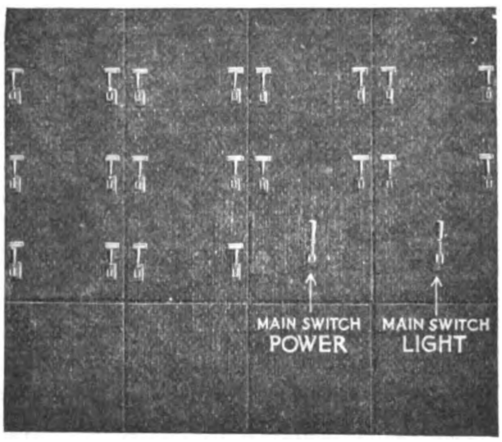


Fig. 2

bars, wiring glutters and pull box. The switch unit, as shown in Fig. 3, consists of the enclosing box, the slate base on which the fuses, terminal lugs, and switch contacts are mounted, the switch proper, and the operating lever.

The bus bars are mounted on the back of the switchboard slate and when the switch unit is inserted the blades of the switch make direct contact between the bus bars and the fuse terminals. These switches are all interchangeable and may be readily re-

Fig. 3. Autolock switchboard. Krantz Mfg. Co., Brooklyn, N. Y.

placed by a switch of larger or smaller capacity, should the occasion arise.

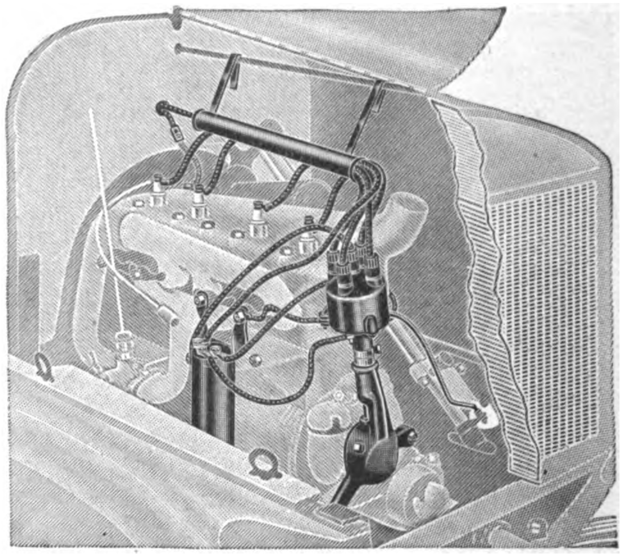
Nothing is mounted on the front of the switchboard (Fig.1) except the switch handles and a card holder to indicate the circuits controlled by the switch. Since the switch handle is not connected with any current carrying part, the front of the board is safe.

♣ ♣ ♣

VIBRATOR-LES COIL IGNITION

The New York Coil Company, 338 Pearl St., New York City, has just placed upon the market a new ignition system especially designed for the Ford car.

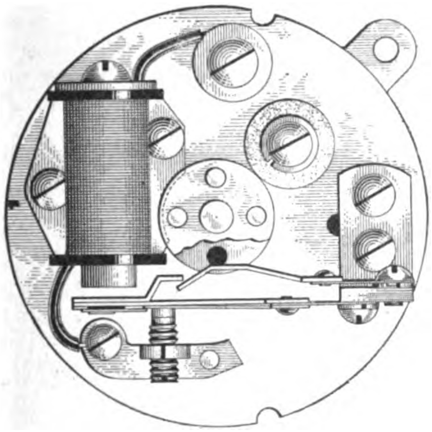
The system consists of an elevating gear bracket upon which a high tension distributor is mounted, which distributor contains rather unusual mechanism to cause a non-vibrating coil to properly function on a Ford magneto.



Vibrator-les coil ignition. New York Coil Co., 338 Pearl St., New York.

The transformer coil is secured by means of a special bracket to the two front studs now employed to hold inlet manifold in position. The conventional four cylinder dash coil is discarded entirely, and in its place an enameled panel is secured by the same four bolts previously holding coil to dash. On this panel, a two point switch is provided, giving practically a clean dash, and allowing the operator additional room.

The main shaft of the instrument has a slot formed in its upper end, and at right angles to this slot are positioned four hardened tool steel pins which, when the engine revolves raises the member "C", allowing the armature to make contact with the adjusting screw "H," thus completing the electric circuit through the magnet, energizing same so that the circuit is readily made and broken, producing a flame of sparks from the secondary of the coil. This continues during the time that pin in shaft is making a mechanical contact with the member "C." After the pin has receded from the



Details of Vibrator-les coil ignition.

member "C" it will be observed that the armature is separated from the contact screw and held against the magnet core, thus forcibly breaking the electric circuit, and preventing the possibility of the contact points welding or sticking together, which is invariably the case when magnetism only is relied upon to interrupt the circuit.

The above company advise us that they have designed this system in answer to a long and persistent demand from their customers for an ignition system for the Ford car, using non-vibrating coil to be used in connection with the regular Ford magneto that would insure a uniform spark in all cylinders, under every operating condition, without the annoyance of sticking contacts and frequent adjustment troubles.

✣ ✣ ✣

GASOLINE SPRAYER FOR AUTOMOBILES

A portable motor-driven device for spraying gasoline as a cleaning medium is being manufactured by the Midvale Machine Works, St. Louis, Mo. This machine can be used for applying waterproofing or finishing coats to automobile tops or for repainting wire or wood wheels. It also finds application for quickly applying any liquid to automobile bodies or metal parts. The machine consists of a Midvale-type duplex-cylinder compressor mounted on a portable roller base, with an air-pressure tank, air cleanser and renovator, relief pressure valve, 6 ft. of rubber tubing, an air cock and a vapor gun with a glass cup container. The outfit complete weighs 190 lb.

✣ ✣ ✣

A vacuum reading is the difference observed by means of a mercury column between the pressure of the atmosphere and the pressure of the steam within the condenser or turbine. From the vacuum reading a true pressure measurement is obtained by subtraction from a simultaneous reading of the barometer after making proper corrections for temperature and other variables. The true pressure may be expressed in pounds per square inch, head in inches or millimeters of mercury at a stated or understood temperature, or, finally, in inches of vacuum referred to the mean atmospheric barometer.

Electrical Engineering

Treating of the Theory and Practice of Electrical Generation and Transmission, and the Utilization of Electrical Energy.

Wm. R. Gregory Co., New York

Vol. 52 AUGUST, 1918 No. 2

ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

By H. A. Hornor

(*Continued from page 18, July issue*)

The march of progress has brought to the solution of this question the use of the electric motor running at constant speed and functioning as the power behind the pump. This type of gear is known as the hydro-electric gear. The main motor at constant speed maintains the pressure required to exert the instantaneous power needed, and the control motor operated from the bridges actuates the valve mechanism. The important point in this type of gear from the electrical side is that the main motor runs at constant speed, and permits the use of either direct current or alternating current moors.

S. S. "La Brea"

All the motor auxiliary development up to the year 1915 had been with the 110-volt direct-current motor. This was to be expected. Direct current at 110 volts had long been the established standard for marine use. However, the designers, and doubtless the owners, of oil tank steamers, hesitated to use a commutating motor around so inflammable a cargo as bulk oil. In the words of Hugo P. Frear in a paper presented before the Society of Naval Architects and Marine Engineers, November, 1916:

"The S. S. La Brea is the first tank steamer equipped with independent submerged cargo pumps in each compartment, port and starboard, operated by electric motors on deck, and also the first to be fitted with reduction gear turbines, so far as the writer knows."

He could have said more, for this vessel has the first application of alternating current for the operation of auxiliaries and has opened a field to other pioneers that bids fair to be profitable. Excellent opportunity was here given to the engineer to compare electric auxiliaries with steam auxiliaries, as the owners of "La Brea," the Union Oil Company, of California, also had under construction the S. S. "Los Angeles," a duplicate oil tanker equipped with the ordinary steam pumping apparatus. The two vessels were completed and delivered to their owners within a month of each other. The details of their several trips in actual service were carefully taken and a full comparison made.

The "La Brea" in every respect showed a superior performance. She discharged on one voyage 71,791.13 barrels of oil in 31 hours against 71,007 barrels discharged by the "Los Angeles" in 56 hours and 17 minutes. The average barrels discharged per hour by the "La Brea" were 2,315.84 against an average of 1,261 by the "Los Angeles." The "La Brea" was 44.92 percent. less time in discharging her cargo, used in port 42.47 percent. less fuel, and pumped 83.65 percent. more barrels of oil per hour. These results speak for themselves.

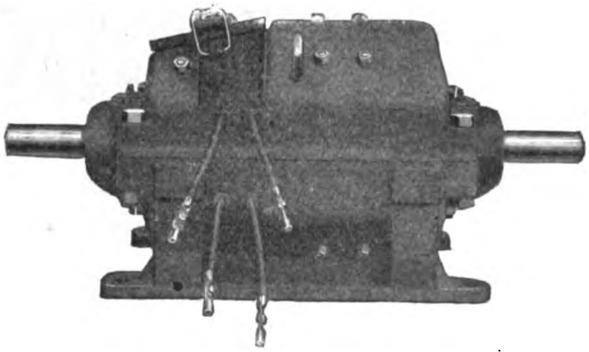
General Application of Alternating Current

Eastern ship owners and shipbuilders studied carefully the operation of the "La Brea," with the ultimate determination of following this successful performance. A number of oil tankers are now under construction with a complete installation of alternating current for both power and lighting service. Up to the present time no difficulties have been encountered that could not be readily overcome and, although the newness of this application has disadvantages, these are being carefully and satisfactorily discounted by the importance of the application.

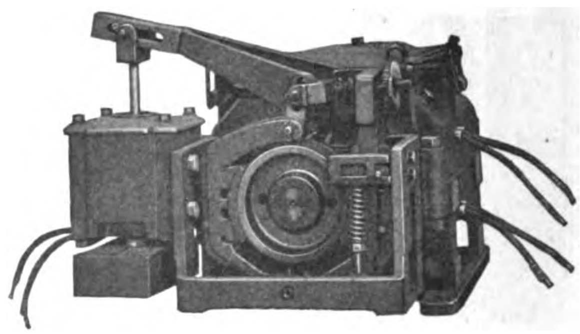
The equipments have been laid out on the lines of standard land practice, for obvious reasons. The alternating current is generated at 220 volts, 3-phase, 60 cycles and the distribution is on a three-wire system. As in the "La Brea," the pump motors are all operated from the engine room. This for two reasons: first, to be under the direction of the engineer; and, second, to avoid any danger connected with switching devices in or about the pump rooms. The switchboard in the engine room is arranged with a set of common starting busbars, thus reducing the cost of separate compensators for each motor.

In certain vessels pole-changing motors will be provided, so that only the necessary speed and horsepower will be employed as required by the quality of the oil or the changed viscosity due to temperature conditions. This is but an intimation of the many precautions taken by those whose responsibility it is to deliver a vessel capable of performing its work not only well but in every sense to the satisfaction of the owner.

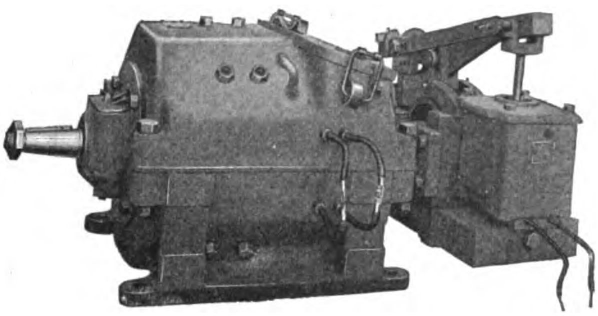
Imbued with the successful performance of the "La Brea" and the detailed investigations for subsequent oil tankers, certain shipbuilders have now turned to the application of



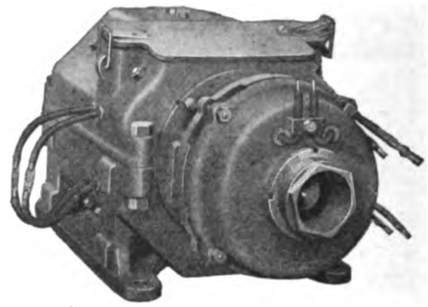
Side view of CO-1800 motor



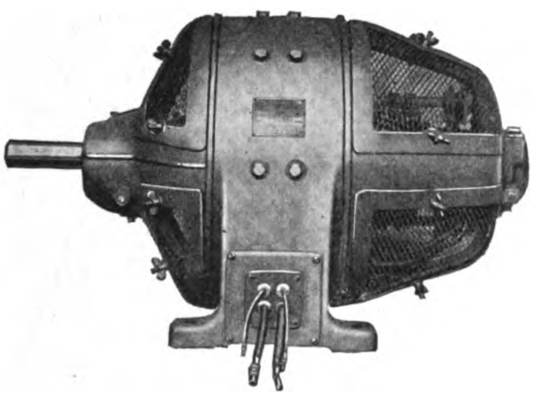
Motor equipped with full torque shoe brake



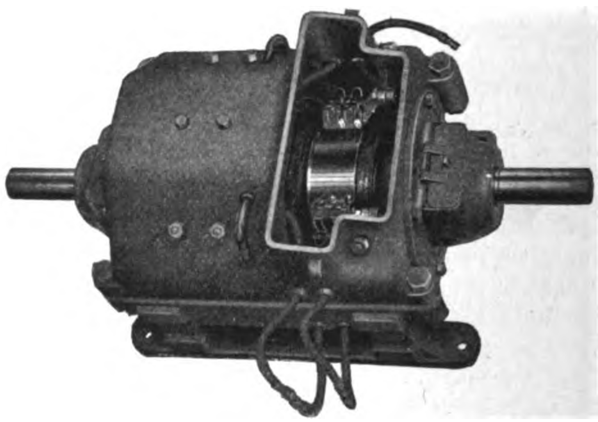
Side view of motor equipped with shoe brake



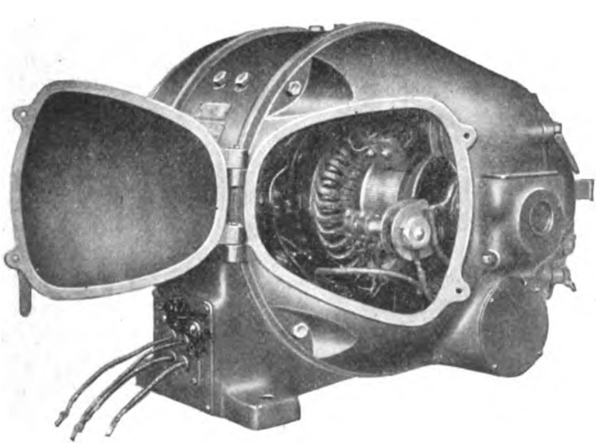
Motor equipped with one-half torque disc brake



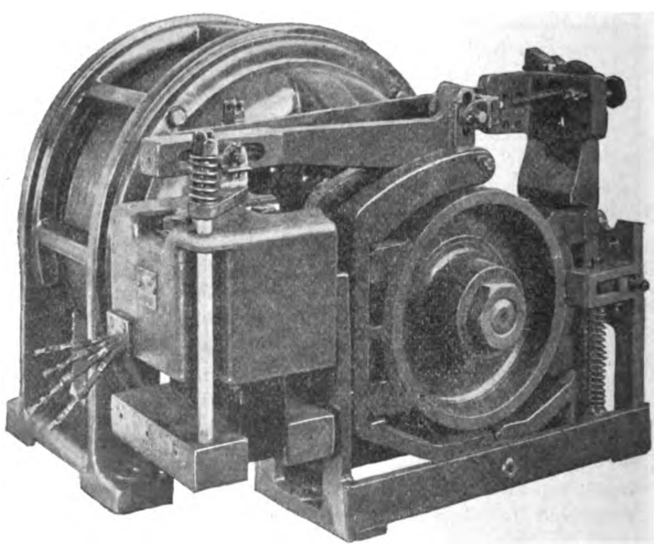
Shunt-wound motor with attachable semi-enclosing hole covers



Motor with hand hole cover removed

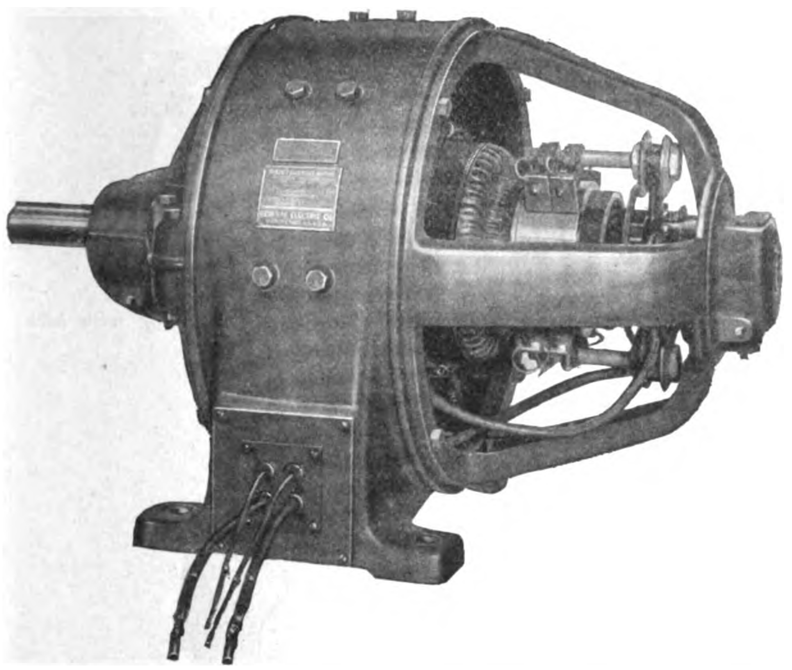


Type R C motor, totally enclosed

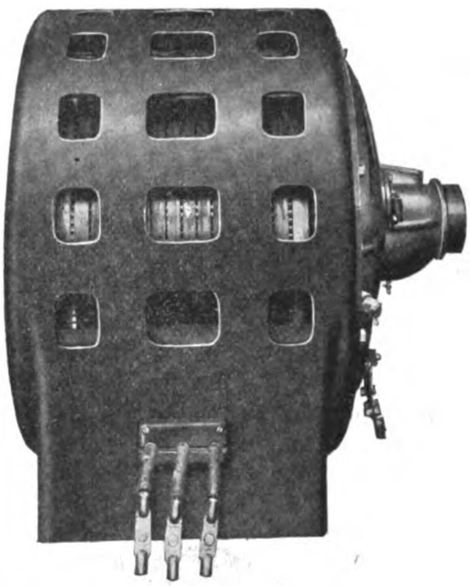


Brake on type ITC-5011 induction motor

Some of the various types of General Electric motors used on shipboard



Shunt-wound marine type G. E. motor without base or pulley



Alternating current G. E. repulsion motor for merchant vessel

alternating current motors for operating the engine room auxiliaries and deck machinery of ordinary cargo vessels. There are a number of such vessels now under construction, and although nothing but prophesies can be made at this time, the careful study and sound principles of marine experience which have guided the design of this installation seem to give sufficient assurance of the stability of this application. Those who are familiar with the various peculiarities of direct-current motors and alternating-current motors need not be reminded of the advantage of the alternating-current motor in point of weight and cost. Although the price may not be of such vital importance at present, the weight is always an essential consideration in the design and performance of any ship. These favoring characteristics are in addition to the technical profit which will accrue in the safety, efficiency, readiness, and cleanliness of the electric motor in comparison with the steam engine.

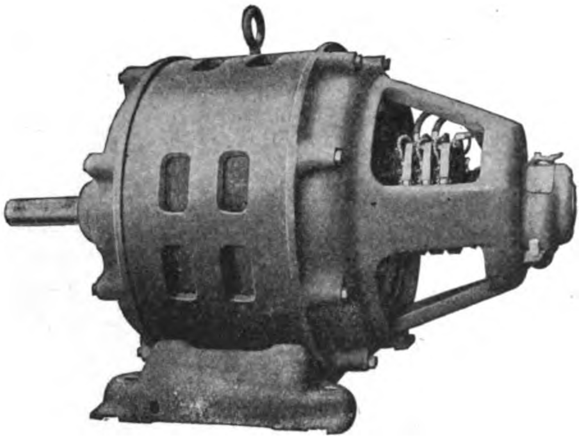
Just one illustration will apply to most of the steam auxiliaries. Deck winches are used for loading and unloading the vessel. The work is intermittent: while the vessel is under way the apparatus is not in use. Steam supply and exhaust pipes must be lead throughout the vessel and carefully covered to reduce radiation losses. In cold weather it is necessary to turn over the winches while the ship is at sea in order to avert the bursting of pipes or injury to the engine and to assure certain operation when the ship arrives in port. As the operation of the winch is intermittent no accurate results are available as to steam consumption, but those familiar with this subject estimate that from 160 to 200 lbs. of steam per indicated horsepower is required. Consider a comparison of this application with that of a motor ready for service at any time without special attention, supplied with energy through a small wire and the ships cargo not subjected to damage by leaky joints in pipes due to the working of the vessel. And "in order to protect the main (engine) condensers from grease and dirt from the steam-driven auxiliaries and deck machinery, an auxiliary or winch condenser is installed with all necessary piping." Is it strange that progressive marine engineers are becoming more interested in the application of electric motors?

Electric Propulsion

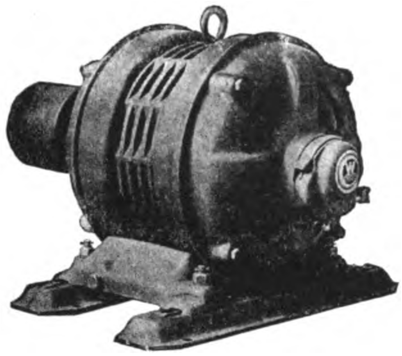
The layman's query: Why transform mechanical power into electrical power and back again into mechanical power? is answered universally in the employment of electrical energy as a means of increasing efficiency. The reasons for applying electricity to the propellers of a ship may differ in detail, but in essence they are similar. The vertical marine reciprocating engine, though possessing excellent speed characteristics, is limited by size, weight, and complicated parts when high powers are required or when two speeds for long periods are essential to the service. The direct connected turbine, though highly efficient at rated full speed, falls off rapidly at reduced speeds, and fails to make an efficient compromise between the low speed efficient propeller and the high speed efficient turbine. The introduction of a mechanical gear between the propeller and the turbine has brought about a general adoption of this form of propelling machinery.

It is perhaps not opportune to question the future success of this type of apparatus, but it can be pointed out with propriety that for high powers and large speed reductions it also has its limitations. Failing to obtain the proper reduction of speed on a single gear, a double gear may be used, admitting of further complication. Besides this the mechanical reduction gear does not provide means for reversal and therefore special turbines running in vacuo under ahead conditions must be carried for the infrequent or emergency purpose of backing.

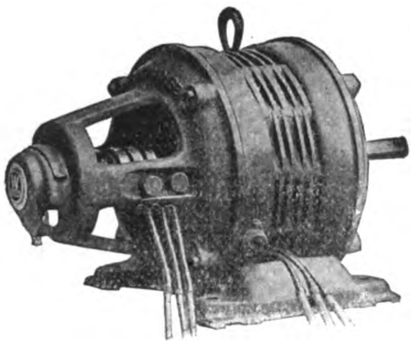
The electrical gear combines inherently a wide range of speed reductions and reversal by the simple change of connections. For high powers and two or three continuous operating speeds the electric gear has no competition from the viewpoint of size, weight, and efficiency. This has been clearly set forth in innumerable papers by the American pioneer of this application, W. L. R. Emmet. He has worked out curves of speed, horsepower, and efficiency which exhibit a straight line efficiency at three or more continuous speeds. This has been accomplished in the familiar manner well known to station operators as the adjustment of the generated power to the load requirements. In other words, the use or disuse of generators in proportion to the horsepower requirements. These are the essential characteristics that give electrical propulsion a preferment in the marine field, but it may be assuredly stated that the other advantages seen in the older applications of electricity will appear in its employment for the more serious work of propelling the ship.



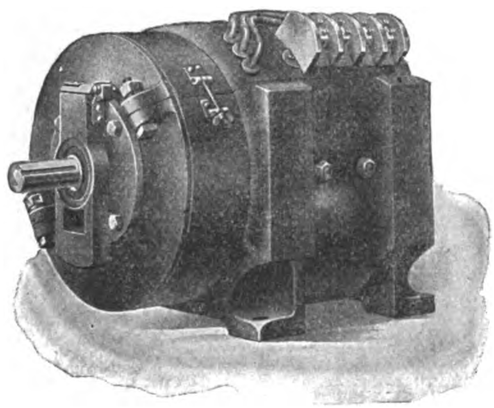
Alternating-current, wound rotor motor, 50 to 100 hp.



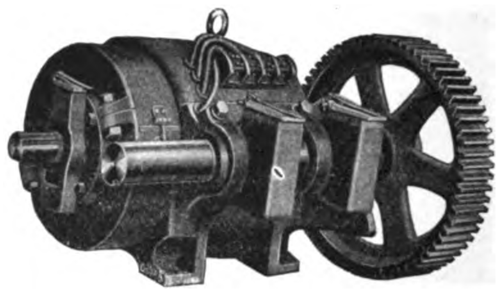
Alternating-current, squirrel-cage motor for constant speed continuous service, 25 hp. and smaller



Alternating-current, wound rotor motor for intermittent service, 25 hp. and smaller.

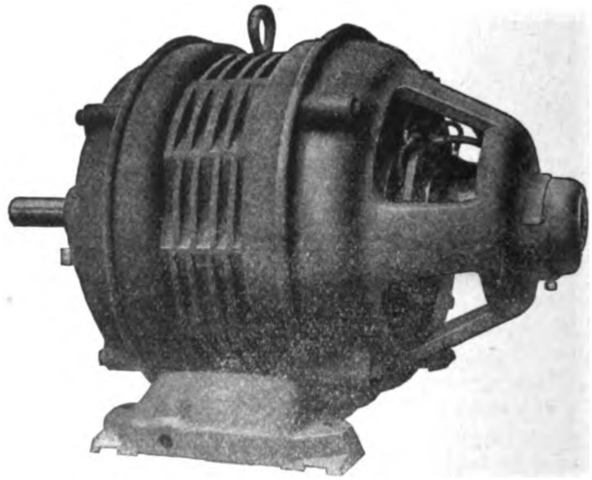


Direct-current, enclosed type, varying speed motor for crane and hoist service

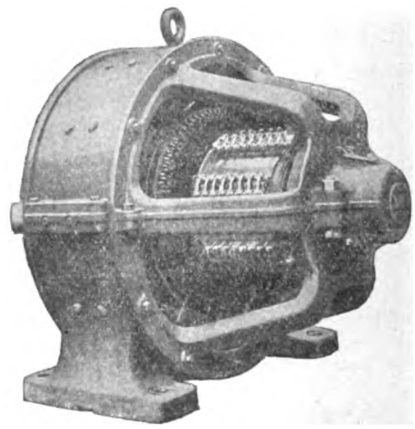


Direct-current, enclosed type varying speed motor with back gear for crane and hoist service

Alternating-current, squirrel-cage motor for constant service, 25 to 125 hp.



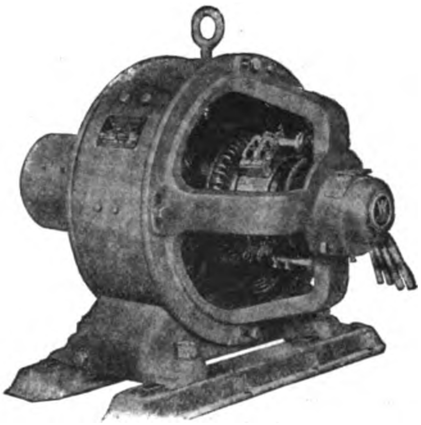
Alternating-current, wound rotor motor for intermittent service, 25 hp. and smaller



Direct-current, 125 hp., constant speed motor

Some of the Westinghouse motors used on shipboard

Direct-current, 50 hp., constant speed motor



Direct-current, 50 hp., constant speed motor

More Westinghouse motors used on shipboard

English Systems

H. M. Hobart in his treatise entitled "The Electric Propulsion of Ships" describes fully the pioneer work of English engineers up to the year 1911. Those interested in the detail development of this subject will find his book of great value. In view of the above statement of opinion it may be of interest to quote one paragraph from the introduction of Mr. Hobart's book.

"For constant speed operation, the mechanical methods which are now being successfully exploited by Westinghouse, Parsons, and Fottinger are admirable. But for astern running, the last mentioned alone shares with electrical systems the advantage of dispensing with the necessity of reversing the prime mover, and (in the case of steam turbines) of providing auxiliary prime movers. None of these three systems comprise any feature endowing them with any such perfection of control in manoevering or in prompt stopping, as can be provided by the electrical method. Moreover, it should not be overlooked that all ships are, on occasions, required, as when in crowded harbors and during foggy weather, to proceed at other than their normal speed. The mechanical systems cannot approach the electrical system in the matter of economy at other than maximum speed, and the superiority of the electrical system is very considerable for ships which must frequently proceed at speeds much below their maximum speed. For strictly constant speed ships, a good case can, however, be made out for the use of mechanical gearing, as it should usually show higher efficiency and lower first cost than the equivalent in electrical machinery. As already mentioned, however, the mechanical method is at a disadvantage in requiring auxiliary turbines for reversing, and in affording a less powerful and exact command of the boat in all manoevering operations."

To this comment may be added the gain in efficiency by the use of high superheated steam. Due to the fact that compactness of design and reduction of windage requires the astern turbine carried in the same casing as the ahead turbine, it is not practicable suddenly to subject high temperature steam (400 degrees plus fahr.) into the astern casing running in vacuo at probably 100 degrees fahr. There are no objections to the use of high superheat on turbo-generators. From the viewpoint of efficiency this is one of the strongest arguments for the application of electric drive.

S. S. "Tynemouth"

Among the pioneers mentioned by Mr. Hobart stands the name of the late H. A. Mavor who designed the propelling equipment for the S. S. "Tynemouth." This vessel was especially built for the exacting trade of the Canadian canals which connect the waters of the St. Lawrence River with the Great Lakes. Here was a case where economy could only be expected by efficiency on different speeds and horsepowers. In the canals a speed of 4 miles an hour was a legal requirement, and for the vessel would require only 150 hp., whereas the currents of the St. Lawrence River could not be negotiated with less than 750 hp. To the solution of this problem Mr. Mavor brought the Diesel oil engine as a prime mover for the generators, and obtained his speed changes by winding his generators for different cycles and arranging for two sets of poles on the motor. The outfit thus consisted of two generating sets of 235 kilovolt-amperes at 500 volts alternating current and one motor of 500 hp. wound for 30 and 40 poles. The generator was wound for 6 poles and the other for 8. By this means he could vary his connections and so maintain economy at the various speeds. He could do more. When a lower horsepower was needed he could shut down one of the generators and thus keep an economical load on the other. But the "Tynemouth" was not a success. The failure, however, was in no sense attributable to the electrical design or installation. The burden fell entirely on the Deisel oil engine. It has been affirmed on good authority that these engines were not designed properly for marine service. However, the "Tynemouth" experiment has caused hesitation in the minds of those who would gladly exploit this combination drive. Many progressive engineers still look towards this generator method as the final solution of the propulsion question. The great advantage gained is the entire elimination of the production and transmission of steam. The future undoubtedly holds this method in store until such time as the development of the oil engine in large powers makes such machinery applicable to ship board.

U. S. Collier "Jupiter"

Contemporaneously with the work of Mavor in England, the electrical propelling machinery of the "Jupiter" was in course of manufacture under the personal supervision of Mr. Emmet. The main purpose of the experiment was simply to ascertain the practicability of the application. This has been amply proved as the vessel has now been in actual service for about four years, and undergone all the ills that ships are heir to. Naturally a great many incidental points of advantage and disadvantage have been discovered. The original guarantee required that the installation should be such that the electrical apparatus could be removed and reciprocating engines substituted. This requirement circumscribed the design in many ways and made necessary the provision of only one generator. That the electrical equipment still remains in the "Jupiter" without a suggestion of ever removing it bespeaks better than words its successful operation.

The evidence is only made stronger by the suggestion of adding an additional generator.

A lengthy description of the machinery of this vessel is not necessary as many articles have been published giving full information concerning both the apparatus and the performance of the vessel. A good description of the "Jupiter's" installation may be found in The General Electric Review of February 1914, and the results of her trials in a paper read before the twenty-second general meeting of the Society of Naval Architects and Marine Engineers. This paper was prepared by Lieut. S. M. Robinson, U. S. N., and entitled "The Applicability of Electrical Propulsion to Battleships, Together with the Experience Gained with It on the "Jupiter." A striking point is made by Lieut. Robinson in the concluding paragraph of his paper.

"After all, the greatest test of the satisfactory working of any machinery is whether the men who are actually handling it and caring for it are pleased with it. If this test applies to the 'Jupiter's' machinery it certainly is an unqualified success. In particular is this true if the matter is referred to the coal passers in the fireroom who have to handle much less coal than do the men on sister ships. The ship can make her contract speed of 14 knots without using forced draft at all."

This speaks well for the sponsors, the makers and the operators of the first electrically propelled vessel of any great size built in the United States.

For the sake of comparison with the other systems of propulsion the main characteristics of the apparatus of the "Jupiter" will be briefly stated.

The vessel is twin screw and a motor is provided for each shaft. One generator rated at 5450 kva, 1990 rev. per min. 2300 volts alternating current, 33 cycles, 3-phase, supplies energy to the two main motors. Each motor is rated at 2750 hp. 110 rev. per min., is of the induction type, and is wound for 36 poles. Exclusive of the slip of the motors the speed reduction ratio is 18 to 1. The displacement of the "Jupiter" is 20,000 tons, and on trial at 19,452 tons consumed 7,151.9 shaft horsepower while making a speed of 14.99 knots, or one knot better than contract speed. At 10 knots the vessel with approximately the same displacement utilized 2,015.04 shaft horsepower.

S. S. "Mjolner"

In the meantime thoughtful engineers in Sweden were addressing themselves to the solution of the problem of applying electricity to the propulsion of modern-sized vessels. The "Mjolner" is owned by the Stockholms Rederiaktiebolag Svea and employed by them in the coastwise trade between Gothenburg and Stockholm. The vessel has a displacement of 2,225 tons, is 225 ft. long, a beam of 36 ft. and a draft at full load of 14.76 ft.

The propelling machinery is described as follows:

"This plant is made up of two similar units, each consisting of one 400 kw. double rotation turbo-generators working at a speed of 7,200 rev. per min. and generating 3-phase alternating current at 500 volts and 120 full cycles per second. The generated current is used to drive two 3-phase motors, which in their turn drive through pinions with inclined teeth, a common gear fastened to the propeller shaft. The motors make about 900 rev. per min. and the propeller shaft 90 rev. per min. Each turbo-generator unit, consisting of one turbine and two electric generators, is mounted directly on top of an ordinary condenser and is provided with electrically driven air, circulation, and feed pumps. The air pump is of the dynamic jet type and the two other ones of the centrifugal type." This installation is the work of Mr. Ljungstrom, and the turbine is of his special patented construction. Complete details of the turbine design could not be covered in the space allowed for this discussion. Suffice it to say that no stationary blades are used in the turbine, the reactionary forces are utilized and thus one wheel revolves clockwise and the other counter-clockwise. This method of turning the generators on each end of the turbine in opposite directions in no way interferes with the operation of the plant. The motors are electrically controlled by specially designed rheostats. Steam is generated at 218 pounds per square inch and 235 degrees of superheat. The forced draft is obtained from the generators in connection with the well-known Howden forced draft system.

The importance of this installation, irrespective of criticisms which may rest upon the complicated design of turbines, lies in the comparative results. The same company owns a sister ship, the "Mimer," equipped with reciprocating engines. For the same operation the "Mjolner" burns 42.3 percent. less coal. This has materially increased the net earnings. It is understood that Mr. Ljunstrom has orders for several more similar outfits and some of larger horsepower. "It is interesting to note in the report of Lloyd's Register for 1916 that two vessels so equipped (electric drive) are being built in the United Kingdom to the Society's class." It is believed that there are larger equipments of the Ljunstrom design. The development of this system will be keenly observed by those interested in the progress of marine propulsion.

Recently Projected Equipments

There are two merchant vessels of 12,500 tons displacement now under construction in the United States which will be the first ocean-going vessels to be driven by electric motors. Proposals for the machinery for these vessels were made by the two large electric companies, the General Electric Co. and the Westinghouse Electric & Mfg. Co. The General Electric Co. was successful in obtaining the contract. It will be interesting, however, to consider both the proposals as indicative of the trend of development in this country.

The proposal of the Westinghouse Electric & Mfg. Co. covered the main propelling and necessary engine room auxiliaries for a 3,000 shaft horsepower, 92 rev. per min. electric propulsion. This power was transmitted to the shaft of a single propeller, through two cross-compound turbo-synchronous generators producing 2,300 volts 3-phase alternating current at 60 cycles. The two generators were tied in electrically so that there would be no trouble involved in synchronizing. The two main motors of the wound secondary induction type were geared to the propeller shaft by means of a double pinion herringbone reduction gear, reducing the speed of the motors (882 rev. per min.) to the propeller speed (92 rev. per min.) In order to secure accurate alignment of the pinions and gear, they were designed to be carried in bearings formed in a flexible frame. Speed control was obtained primarily by throttling steam to the turbo-generators, thus changing the number of cycles. A secondary speed control was provided by means of grid resistance introduced into the secondaries of the motors. For this method of speed control a separate generating set supplying 220 volts, 3-phase, alternating current at 60 cycles was required for all auxiliaries. In order to aid the over-all efficiency, a separate motor-generating set was carried for field excitation. In starting up the main units, and while manoevering, the independent generating set was used for operating all the auxiliaries. When the ship was well under way the auxiliaries were thrown over to a transformer supplying low potential to the auxiliaries from the primary of the main generators.

The steam conditions and guarantees were as follows:

"When operating at full speed and power corresponding to 3,000 hp. and 92 rev. per min. at the propeller shaft, and 250 lb. dry and saturated steam with 50 degrees fahr. superheat, 28 inches vacuum referred to 30 inches mercury barometer, and 70 degrees fahr. cooling water, the steam consumption including all power used for the main drive, circulating, condensate, and oil pumps, and generator excitation will not exceed 11.75 lb. per shaft horsepower hour."

The weight of this equipment including all auxiliaries, control switchboard, etc., was estimated to be 259,975 lb.

In addition to this proposal, the Westinghouse company gave additional data on two variations; viz., an equipment consisting of one main turbo-generator and one geared motor, and another equipment with one turbo-generator and one direct-connected motor. The first of these propositions gave the same propeller speed 92 rev. per min. with a steam consumption of 11.85 lb. per shaft horsepower hour and a total weight for the equipment of 250 475 lb. The second proposition gave a propeller speed of 147 rev. per min. with a steam consumption of 11.8 lb. per shaft horsepower hour and a total weight for the equipment of 214 675 lb. This last proposition is that most desired by those whose experience, or observation, has compelled in them a strong dislike to the employment of the mechanical reduction gear.

The proposal of the General Electric Co. included in general two separate turbine generators, two main motors, one mechanical reduction gear, two exciters, and the necessary control apparatus.

The main generating sets are rated at 1215 kw. 3600 rev. per min., producing 2300 volt alternating current, 3-phase and 60 cycles. The turbines are 19 stage Curtis type specially designed for marine installations. As will be noted later, it is not the purpose to accomplish ship speed control by means of turbine speed changes, but the turbines will be so designed that governor control will be possible in any case of emergency. It is greatly to the credit of those who have engineered this equipment that not one but many means may be employed to control and operate this plant under circumstances of stress and with minimum loss of efficiency.

To the commercially inclined owner, efficiency of a unit of propulsion has some importance but is not so great a factor as the over-all operating efficiency of the vessel. That is to say, if the high propulsive efficiency requires the use of such sensitive elements that breakdowns, or rapid wearing away of parts, necessitate long periods of docking or repairs in port, the first cost of such efficiency is a bad investment. To this thought should be added that involving either more personnel or personnel of a higher and therefore more expensive order. These ideas have had full play in the mind of the engineer in evaluating this design.

At a steam pressure of 195 lb., 200 degrees fahr. superheat, and 28 inch vacuum the guaranteed steam consumption is 13.9 lb. per kw. The over-all dimensions of the generating set are 21 ft. 10 in. long, 7 ft. 8 in. wide, and 6 ft. high. The weight of the set 49,000 lb. The generators require 6,000 cu. ft. of air per min. for ventilation and 13 kw. for field excitation. The generators will be separately excited by two 35 kw. steam turbine units. One set carried as a spare. These exciter sets will also be used for lighting the vessel.

The main motors are the familiar wound rotor induction type designed for a single speed of 514 rev. per min., or a full load, 1,500 hp., speed of 504 rev. per min. The efficiency of this motor at full load is 93.5 percent. The net weight is 19,000 lb. The over-all dimensions approximate 5 ft. 6 in. in diameter and 5 ft. long. Three rings on the armature shaft permit of the introduction of resistance in the armature for speed control.

As the vessel is single screw each motor pinion meshes into the reduction gear. This gear is of the well-known Alquist type rated at 3,000 hp. and reduces the motor speed of 514 rev. per min. to 90 rev. per min. of the screw propeller. It weighs approximately 50,000 lb., requires 150 gallons, of oil, per min. and has the following approximate dimensions: length 9 ft., height 7 ft. 6 in., width large end 11 ft. 2 in. and small end 6 ft. 6 in.

The supporters of electric propulsion, though well recognizing certain advantages in cyclic control, or governor control, such as employed on the U. S. S. "Jupiter," were convinced that for this type of vessel, keeping in mind the principles laid down above, electric control for manoevering was more advantageous and would allay the criticism extensively circulated that electrical methods were not suitable for this service. As previously stated, good control of the propelling machinery in any type of vessel is very desirable if only for such emergency conditions as a long protracted fog area or a very heavy sea. It was considered a wise provision involving no additional cost or loss of efficiency to arrange for both cyclic or steam throttle control and electrical control. The latter to be used for all manoevering and normal operations of the vessel and the former as a "stand-by" in case of accident.

The electrical control consists of a controller located in the turbine generator room. This controller is of standard pattern not unlike an ordinary master controller and has mounted in front of the operator two specially designed ammeters, one for each generator. These are the only electrical instruments used in the operation of this propelling machinery. The turbine generators in this particular installation are located amidships and the motors in a special compartment well aft in the ship. The contractor panel is located near the controller and regulates the amount of resistance introduced or deducted from the armature circuit of the main motors. The controller thus provides for three different speeds in both directions. The resistance is accomplished by two water-cooled rheostats, one for each motor. By a simple contrivance arranged for by the ship builder, the leads to these rheostats may be short-circuited and the entire control accomplished by varying the steam admission to the turbines, thus changing the number of cycles.

One of the most interesting engineering points should here be noted; i.e., that the torque characteristics of the motor remain the same as the number of cycles, and therefore the speed is reduced. This merely means pushing the torque curve nearer to the axis. The practical advantage is that at low speeds high torque is available. This may be emphatically important in backing under extreme difficulties. The contactor panel though normally automatic is also fitted for manual operation and for this reason is to be kept under lock and key. This type of electrical control could hardly be more easy of operation. With the generators up to synchronism the operator has only to await orders and turn the controller in the proper direction and to the desired notch. The ammeters are a guide to prevent the throwing over of the controller too hurriedly. This condition would hardly exist in the present methods of handling a ship as the captain rarely signals so excitedly as to produce such an effect upon the operator, but the wisdom of those responsible for this installation advocated every precaution to avert any hazardous operation.

Summary

Broadly speaking, it is difficult to answer the question of the layman, What means of propulsion is the best? The angles at which this subject needs must be viewed are very many, the commercial, the first cost, the efficiency, the safe, the reduction of upkeep, the cost of operation, etc., etc. However, with the best of intentions, some light may be thrown on this subject by carefully considering the following data. This information has been derived faithfully and with little favoritism as some may discover who know more intimately the sea operating conditions of steam propelled vessels especially those likewise equipped with steam auxiliaries.

Three equipments are compared. Steam conditions are the same in all cases (except "C" where the superheat is increased 200 degrees fahr.) namely, 195 lb. at 28 in. vacuum and 50 degrees superheat. The vessel is supposed to be a cargo steamer with a capacity for carrying 12,000 tons. The designations are: "A," one 3000 hp. geared turbine with steam auxiliaries; "B," one 3000 hp. geared turbine and two 100-kw. turbines for electric auxiliaries; and "C," one 3000-kw. electric generators turbine driven, one 3000 hp. 150 rev. per min. motor with controller and rheostat, one 100-kw. turbine generator for auxiliaries, two 35-kw. turbine generator exciting units, and three 75 kv-a transformers to operate the electric auxiliaries from the main generators. The purpose of the comparison is to show the saving in tonnage and therefore the difference in earning capacity between the various methods.

	"A"	"B"	"C"
Cost of propelling machinery	$91,000	$106,000	$110,000
Weight in tons	145	153	94
Space extra cargo	0	0	300
Steam per S. hp.	11.7	11.7	11
Steam per auxiliary hp.	55	16	11
Coal per day Main eng. tons	38	38	35
Coal auxiliaries 132 hp. per day	7.7	2.3	1.6
Oiling system gallon per min.	300	300	10
Coal total tons per day	45.7	40.3	36.6
Total cost 20-day round trip	914	806	732
Tonnage saved in machinery	8	0	51
Tonnage saved in coal	0	100	182
Tonnage saved total	8	100	233
Increase in earning capacity at a freight rate of $20 a ton	$160	$2000	$4660

SEPTEMBER SERVICE OUTLET CAMPAIGN

Does the use of electrical specialties actually conserve food, fuel, time and money in the household?

If so, a broader, more thorough application of such devices must go a long way toward furthering war work. If not, then the figures of household statisticians, as well as the inherent beliefs of millions of housewives who have bought are are buying such appliances are all wrong.

The remarkable increase in the sale of household electrical appliances and specialties since the war began is not the result of whim, chance, or guesswork on the part of the army of women buyers. On the contrary it is worthy of note that the sale of such labor saving devices increases fastest in those territories where the woman are most active in Red Cross and corresponding war work.

It would be difficult to reconcile the sale last year of more than $10,000,000 worth of washing machines, more than $4,000,000 worth of vacuum cleaners, and more than $7,000,000 worth of other electrical labor saving appliances, with anything but the fact that there is a real and ever growing need for such appliances in the home.

That reason is found in the increasing emancipation of the American housewife from household drudgery and labor.

Electrical appliances that save time, trouble, labor and money are not non-essentials. Aside from the fact that the government has set its formal seal of "essential" on some of them (and is quite certain to do so with others) the matter has been settled in the court of public opinion. The day may come when the government will say to users of electric service, "use electricity to the utmost in labor, time and money saving ways."

These are reasons enough for any intensive campaign or propaganda that helps to deliver the message of greater conservation, greater efficiency, greater economy into every American home. It will hardly be denied, therefore, that The Society for Electrical Development's campaign for a broader, better use of electrical household helps strikes a popular chord. It does not matter so much as to how the appeal is made, or what form the educational matter takes, so long as it is built on sane, sober, serious lines. Such propaganda cannot fail to produce fruitful returns.

The use of more outlets on the present lines of the central stations, need not necessarily result in increased peak. It affords the quickest, easiest means of saturating present lines, of filling the valleys in the 24 hour load, and of furnishing work for salesmen who might otherwise have to be laid off.

A feature of such a campaign is that it automatically adapts itself to any wiring or appliance campaign the contractor, central station or merchandiser may have scheduled for that same period. It will stimulate wiring orders as quickly as it will stimulate appliance sales, even though the drive is concentrated on additional outlets, plugs and receptacles.

The feature of the campaign will be a beautiful poster, in six colors, by Vincent Aderente, the famous poster artist, who won the public choice prize in The Society for Electrical Development poster contest. Hangers for window-displays and other advertising will be sent broadcast, along with other liberal supplies of display material. The society will furnish dealers, contractors and jobbers with special co-operative sales helps: literature, cuts, slides and movies. Complete details will be sent to practically every electrical concern in the country, and the society will gladly furnish any information upon request.

GOVERNMENT DIVISION *of* ENGINEERING

Government supervision of employment for technical men has been inaugurated by the United States Employment Service, through the establishment of a Division of Engineering with A. H. Krom, of Chicago, formerly secretary of the American Association of Engineers, as director. Mr. Korn is a graduate of the School of electrical engineering, Purdue University, and for the past eight years has been actively engaged on utility development and promotional work. Recently, he was engineer in charge of the Chicago office, State Public Utilities Commission of Illinois.

War demands on the engineering profession have already caused a serious shortage of men with mechanical and electrical designing experience and those with practical experience in chemical engineering. At present the professional organizing mediums reach less than 20 percent. of the estimated 300,000 technical men in the country. This is not a satisfactory arrangement for war times. All the technical men of the country must be reached and, in addition, all men with technical experience must be carefully registered so that they will be immediately available. The advantages of such a governmental registering and systematizing of employment will be apparent at once, to the engineer. As a result of tremendous demands for technical service, due to the war, several years might be wasted through scattered individual effort and lack of cooperation between the members of the profession and the technical societies. Greater engineering is needed to win the war and the Government demands unity and efficiency in the technical profession to assure early victory. The highest efficiency is obtained through practical organization.

In consideration of the fact that this is principally an engineer's war, the importance of federal direction of proper distribution and conservation of the technical service of the country, is a very important matter. The service will be started through the office of the Director of Engineering, 29 S. LaSalle St., Chicago. All technical men desiring to register for emergency government work or permanent advancement in positions meeting their qualifications, are urged to volunteer at once for registration, classification and employment.

In the first place coal is rarely dry, on account of being exposed to rain or to leaky vessels during transportation. The heat value of coal decreases in direct proportion as the moisture content of the coal increases, but as Meralco pays for coal according to its heat value, if the coal as received contains 10 percent. moisture, the Company will pay 10 percent. less for the coal per ton than would have been paid had the coal been dry.

However, a real loss due to moisture in coal occurs in the furnace. Some of the heat liberated in the combustion of coal is used to evaporate the moisture it contains instead of being transmitted to the water in the boiler for making steam and generating power. In the Meralco plant the loss from this source is comparatively small except during the rainy season, amounting on an average to about 1 percent. of the total heat in the coal.

The second loss of heat in coal is due to fine coal or coke falling through grates and becoming mixed with the ashes in the ash-pit. In order to reduce this loss to a minimum the width of the air spaces between the grate bars must be adapted to the size and nature of the coal used. Besides this, the fuel bed must not be agitated unless it is positively necessary to do so in order to aid combustion. The loss from unburned carbon falling through the grates may be anywhere between 1 and 10 percent. of the total heat in coal. In the Meralco plant this loss averages about 1 percent.

The third loss of heat in coal is from imperfect or incomplete combustion, due to insufficient air coming in contact with the combustible constituents of the fuel while they are at combustion temperature. The production of smoke and carbon monoxide is the result of incomplete combustion. This loss is caused mainly by poor draft, too thick a fire, careless firing and faulty furnace design that does not permit the proper intermingling of the fuel gases with air, the supporter of combustion.

The loss from imperfect or incomplete combustion may vary from 1 to 5 percent. of the total heat in coal. In the Meralco plant the average loss is about 1 percent.

The fourth loss, and in fact, the greatest loss occurring in the boiler plant, is in the flue gases that escape by the chimney. In a natural draft plant like Meralco, that is a plant employing a large and high chimney, it is positively necessary to lose about 15 percent. of the heat of the coal in the flue gases in order to make the chimney draw the air which supports combustion through the grate bars and fuel bed to burn the coal.

It might be said that coal can be burned without a high chimney, as in the case of artificial draft plants where fans or blowers are used for producing a current of air. While it is true that not so much heat is wasted in the flue gases of an artificial draft plant, there must be a consumption of heat in producing the power required to operate the fans or blowers. It matters not whether the draft is produced by natural or artificial means, in either case heat is dissipated to make the system operative.

However, in employing natural draft there is always more heat lost in the flue gases than is required to provide sufficient draft. Such losses are quite avoidable and their magnitude depends upon the operating efficiency of the power plant employees, more especially the firemen.

For the complete combustion of coal a certain minimum amount of air is required and any excess air admitted to the furnace, either through grate bars or by infiltration through cracked boiler settings, expels through the chimney heat that should evaporate water in the boiler.

Likewise dirty boilers, scale on the inside and soot on the outside, will retard the transmission of heat to the water in the boiler and allow the products of combustion to escape at the chimney at a temperature higher than would have been retained had the boiler been clean.

Deranged baffle walls in the boiler will allow the hot gases a short cut to the flue, thus giving insufficient time for the hot gases to impart their heat to the boiler water.

The unnecessary loss of heat in the flue gases in the Meralco plant is about 5 percent. This together with the necessary loss of 15 percent. makes a total of 20 percent. of the total heat in the coal.

The fifth and last of the more important heat losses occurring in the boiler plant is caused by radiation from the exposed boiler surfaces, piping and setting. This loss may be reduced to a minimum by properly lagging the radiating surfaces with heat-insulating material such as asbestos and magnesia. This loss from radiation, together with some other small losses due to moisture in the air, blowing down boilers, etc., amounts to about 7 percent.

This completes the heat losses in the boiler plant, in amount about 30 percent. of the total heat in the coal. The remaining 70 percent. is absorbed by the water in the boiler and converted into steam. The steam is conducted through pipes from the steam generating plant to the electric generating plant where another series of heat losses occur, both great and small, leaving only a bagatelle to be converted into electrical energy. I will endeavor to explain how these further losses occur.

The electric generating plant does not consist solely of turbo-generators for producing electric current. There is a lot of auxiliary machinery vitally necessary to the successful and economical operation of the main generation units, and this requires steam in order to perform its proper function. For instance, there are pumps for circulating condensing water; there are pumps for removing the air and condensate from the condensers; there are pumps for feeding water into the boilers, as well as oil-cooling pumps, gland-water pumps, etc. The steam used by these pumps represents a certain amount of the heat energy in the coal. In the Meralco plant the total heat disposed of to the auxiliary machinery is approximately 16 percent. Some of this heat, however, is recovered and returned to the boiler. This recovery of heat is accomplished by passing the exhaust steam(after it has performed its work in driving the auxiliary machinery) through feed-water heaters, where the greater part of the heat remaining in the exhaust steam is absorbed by the water to be fed to the boilers. By this means a saving of heat equivalent to 6 percent. is accomplished, leaving 10 percent. to be placed in the list of losses.

There remains now 60 percent. of the heat in the coal to be accounted for and this heat is represented in the steam supplied to the turbo-generator.

Some of this is lost in radiation from the turbine casing, in friction of bearings, internal losses in the generator and in excitation, amounting in all to about 10 percent.

The last and greatest of all the heat losses occurring in this system of generating power, is in the exhaust steam discharge from the turbine into the condenser. It carries with it 40 percent. of the total heat in the coal. This heat is absorbed by the condensing water and runs away to the river.

You may ask why this is so.

It is because of the limited heat range at which steam can be worked. This may be explained by a more obvious example. When we attempt to raise a weight by means of a lever we are limited in the distance we can raise it by the range of movement in the handle before striking the ground. The higher the handle is to start with the further it can be lowered, and by digging a hole in the ground under the handle, the range will be increased and the distance the weight may be lifted increased as well. It is much the same with steam. By increasing the initial pressure or temperature of the steam in the boiler to begin with, and reducing the pressure or temperature in the condenser to end with, the range of steam expansion is increased so as to get more power.

However, there is a limit to the pressure or temperature at which it is safe to operate boilers, and there is a limit as well to the reduction of pressure and temperature in the condenser, depending upon the temperature of the Pasig river water used for condensing. If the river water is ice cold instead of about

90 degrees, it is possible to get over 10 percent. more power out of the steam.

As I have said, the loss of heat to the condenser is 40 percent. There remains now but 10 percent. of the total heat of the coal, and this is accounted for in the electrical energy generated for distribution at the power plant switchboard. It is evident then, that the Company consumes and pays for ten times the heat energy in coal, in order to produce the equivalent, represented by the kilowatt-hour or what may be termed the finished product of the power plant.

However, there is no reason to be disturbed by this showing. Rather we should be encouraged by the improvement obtained in fuel efficiency during the past two years. Two years ago Meralco consumel over 20 percent. more coal than now to produce one kilowatt-hour of electrical energy.

A good part of this saving was brought about by the increased operating efficiency of the power plant employees. There are opportunities for still further improvement, not only among the employees and with the present plant, but by the installation of new and more efficient equipment.

WEIGHT OF DIRECT CURRENT MOTORS

*By A. Brunt**

Keen competition and the introduction of commutating poles are responsible for the progress made in the development of direct-current motors during the last ten years. The manufacturer who, with a reasonable profit, can produce a motor that meets all requirements naturally will be the most successful. The component parts which make up the cost of a motor are material, labor, and indirect expenses. Whereas the last item is largely a question of factory management, labor and material costs are determined by the design of the motor. All progressive steps have been taken in the direction of decreasing one or both of these items.

Direct-current motors should meet the following requirements:

1. Commutation should be good at all loads.
2. Heating should be within allowable limits determined by the insulation material used.
3. Speed characteristics should meet the requirements of the driven machine.
4. High efficiency.
5. Satisfactory mechanical and insulation strength.

The output of a given machine was limited at one time by the first two items in the order given. During the further development the last three considerations in the order given will limit the output of a direct-current motor.

The maximum output obtainable from the old non-commutating pole motor was determined by commutation while in regard to allowable heating the output of a certain motor could have been increased, commutation would not permit this. With the introduction of commutating poles, this commutation barrier was removed. Not only did this make it possible to obtain the same output with less material, but at the same time a highly improved motor was produced. The improved commutation increased the overload capacity and eliminated sparking at all loads in well designed motors, consequently greatly increasing the life of commutator and brushes, the parts of non-commutating pole motors that require most attention and renewing.

The commutation limit being removed, another obstacle arose. The increased output of a certain motor could not be obtained without an increase in losses which had to be counteracted by improved ventilation in order to avoid too high temperatures damaging to the insulation. Efficient ventilation may be obtained by employing the fanning action of the end windings together with a motor construction that will allow a free movement and outlet of the air (naturally ventilated construction), or a fan may be mounted at the rear end of the armature that will produce an air draught through the motor in an efficient way (directed ventilated construction).

Recently another step has been taken in the direction of obtaining maximum motor output with minimum material. It is recognized that no advantage is obtained by designing motors so that the temperature is lower than the temperature the insulating material could stand continuously without deterioration. For cotton insulation, generally employed in general utility motors, this temperature has been determined as 105° (Standardization Rules A. I. E. E.). Considering that the actual temperature cannot be measured, since thermometers only can be applied to outside surfaces, and allowing a 15° centigrade hot spot correction on this account, the maximum allowable observable temperature rise will be 90° centigrade which, with an air temperature of 40° centigrade, gives an allowable temperature rise of 50° centigrade. Whereas in the past it has been the general practice to rate continuously running motors on the basis of a 40° centigrade temperature rise, due to the preceding considerations the rating based on a 50° centigrade rise is being used more and more for motors used in applications of which the power requirements are accurately known and which are not subject to overloads sustained for any length of time, (blowers, compressors, etc.)

That the efficiency of direct-current motors has been improved together with its other qualities, is shown by Fig. 1, in which curve A gives the full load efficiencies of a line of non-commutating pole motors preceding the line of 40° centigrade commutating pole motors, the efficiencies of which are represented by curve B. In both cases average speed motors have been taken. In regard to motor rated on a 50° centigrade basis, it may be stated that the efficiencies are approximately equal to those of 40° centigrade motors, the higher losses in the 50° centigrade motor not being so much higher as to lower the efficiency taking into account, of course, the increased output.

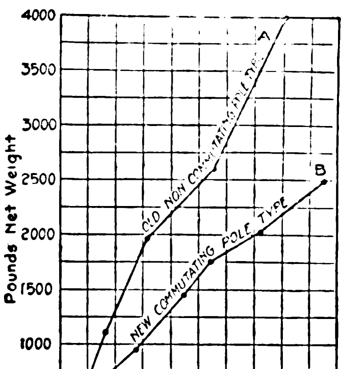


Fig. 1—Relation between weight and torque for commutating-pole and non-commutating pole motors.

In order to give an idea of how much more economically the material is being used in the modern motors, curves have been plotted giving the motor weight as a function of the torque

*Engineer, Westinghouse Electric & Mfg. Co.

(Fig. 2) both for an up-to-date line of commutating pole motors (curve B) and a preceding line of non-commutating pole motors (curve A.)

After showing that direct-current motor development is moving in the direction of lighter motors, it will be interesting to compare different makes of motors in regard to their weight. The curves of Fig. 3, representing seven different makes of general utility direct current motors manufactured in this country, show a great difference in weight between different motors of the same output.

In order to be competitive the different manufacturers have to sell a motor of a certain output at the market price, and the purchaser of a motor will naturally ask whether he should buy the light or the heavy one. The motors will be designed to have the same temperature guarantees, and, assuming that the speed

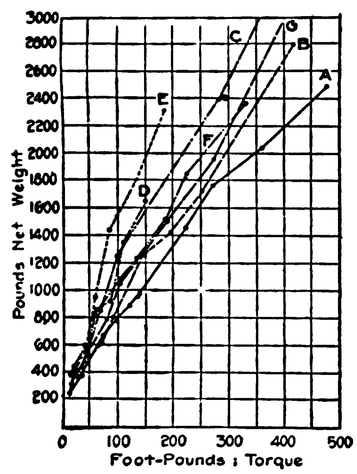


Fig. 2—Relation between weight and torque for present lines of motors, A, B, C,—various makes of apparatus.

characteristics will be satisfactory and the efficiencies equally good, what then are the advantages of the one over the other? Many purchasers of direct-current motors will think that by buying the heavy motor they are getting more for their money. A careful comparison of the two motors, however, will show that this is not so. If the heavy motor should have more excess capacity this should also show itself in dimensions of shaft and bearings. However, an examination of the pulley end bearing diameter for two competitive lines of motors manufactured by prominent concerns show that there is very little difference between shaft diameters of competitive motors.

The lighter motor necessarily must be the better ventilated one which means that the motor is so constructed that the cooling air comes in thorough contact with those internal parts in which the heat is generated. Thus it follows that the excess of actual external temperature over the temperature measured by applying a thermometer to outside surfaces must be smaller in the light well-ventilated motor than in the heavy motor, with consequent smaller danger of damage to the insulation. In this respect the light well-ventilated motor is decidedly to be preferred over the heavier one. Furthermore, light motors can be handled easier and also have a lower freight rate, which is an advantage to the purchaser in case the motor is to be shipped outside of a free delivery zone.

That great weight is not necessarily an equivalent of superior qualities is well illustrated by the weight curves of Fig. 1. Efficiency, and especially commutation, in the commutating-pole motor, are decidedly superior to efficiency and commutation in the very much heavier non-commutating pole motor.

From an economic standpoint the excess weight of a heavy motor, over the lighter motor that could have been built to give the same satisfaction, represents a waste of valuable materials. The magnitude of this waste can be approximated roughly as follows:

The records of a prominent manufacturing concern indicate that the average size direct-current general utility motor sold has a torque of 60 ft.-lb. This size of motor can be bought with a weight varying between 605 and 1080 lb. (Fig. 2). Assuming the average weight of motors of 65 ft.-lb. torque to be 845 lb., and further assuming a total production in this country of 30,000 motors per year, the waste of material by using the average motor instead of the lightest motor will be (845-605) x 30,000, or 7,200,000 lb. per year.

This figure is appalling, especially under present conditions. Economy with all the resources of this country is of the greatest importance under the present conditions, it being just as important to economize with copper and steel as it is to economize with wood and coal. In order to pay off the immense war debts it will be imperative for this country to make the best possible use of its resources, of which copper and iron ore are prominent components. The policy of economizing will have to be carried through into details for which reason it may be well to call attention to it in connection with the production of general utility direct-current motors.

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ELECTRICAL RATE INCREASES

The Editors of the N. E. L. A. Rate Book have prepared a compilation of electric rate increases for distribution by the National Electric Light Association.

The data collected in the preparation of the 1917 and 1918 issues of the N. E. L. A. Rate Book have been gone over for the purpose of listing the increases in rates, and, although it is not claimed that this compilation is entirely complete, in a general way, it is a statement of the electric rates that have been increased in the larger American and Canadian cities in 1917 and 1918. The data in the editor's files cover cities having populations of 40,000 or over from January 1, 1917, to May 1, 1918, and cities between 25,000 and 40,000 population from January 1, 1918, to May 1, 1918.

In the first group, there are 173 cities of 40,000 population or above, and in 96 cases (55½%), rate increases have been put in effect during the sixteen month period ending May 1, 1918.

In the second group, there are 119 cities between 25,000 and 40,000 population, and in 31 cases (26%), rates have been increased during the first four months of 1918. It is probable that, if the data were available for the smaller cities, for as long a period as for the larger ones, the proportion of these cities where rates have been increased, would be found fully as large.

During the period under consideration, practically all changes in rates have been increases. Scarcely a rate has been decreased and in most instances where reductions have been made, increases have soon followed. During the first few months of 1918, the electric companies have been very active in seeking increases in rates and most of the State Commissions now have large numbers of such applications before them for consideration. Undoubtedly the near future will see many more increases going into effect.

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POCKET WIRING CHART FOR COUNTRY HOME LIGHTING

The engineering department of the National Lamp Works of the General Electric Company has lately issued a wiring chart for use in selecting the proper size of wire for country home lighting installations. The chart, together with installation suggestions for country home lighting, is printed on a white card of convenient pocket size and is contained in a neat protecting envelope. Electrical contractors and dealers who are engaged in the installation of country home lighting outfits will find the chart of great convenience.

ELEMENTS *of* ILLUMINATING ENGINEERING

As restated in our July issue, the proper lighting of buildings, both interior and exterior, and public highways has developed into a science during the last fifteen years. During the development period the essential fundamentals have not received the attention demanded by the importance of the subject. The premier part of the subject has been neglected. The importance of having a clear conception of the fundamentals is recognized by Ward Harrison, Illuminating Engineer of the National Lamp Works of the General Electric Company, and with this in mind he has compiled a primer of fundamental concepts. In our June and July issues, by courtesy of the General Electric Review, we republished for the benefit of our readers who haven't access to that journal, the first and second treating of intensity measurements, quantity of light, methods of plotting curves, and other illuminating elements. By courtesy of that same journal we now reproduce Part III of this series, which takes the form of a primer on illumination design.

For example, it is assumed that a jewelry store in a small town may be brightly lighted at an intensity of 4 foot-candles, whereas a jewelry store located on a prominent business street in a large city will require, to be considered well lighted, an intensity of perhaps 6 or 8 foot-candles. Again, the cloak and suit department of a large store will require a higher intensity than will the white goods department. An industrial plant engaged in rough-box manufacture would be well lighted at an intensity of 3 foot-candles; in a high-grade machine shop at intensity as high as 6 or 8 foot-candles would be desirable. The values given in Table I have been established by experience and used by various authorities as standard in current practice. Bearing in mind the character of the work, the fineness of detail to be observed, and the standard of lighting of the immediate surroundings, one should be able to select a suitable intensity from the range of intensities given to serve as a basis for illumination calculations. It should be remembered, though, that the intensity so chosen can rarely be exactly provided in practice, and it should be considered simply as an assumed desirable value which permits the calculations to be carried through.

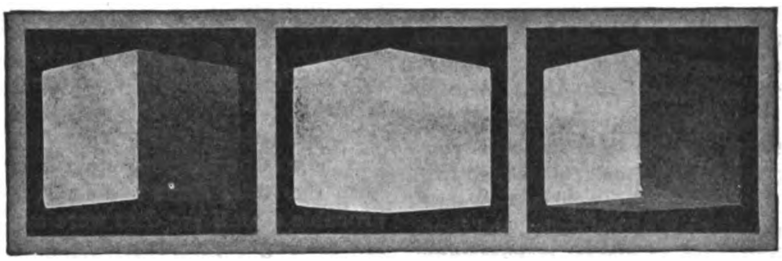


Fig. 13. A white cube lighted from various directions

The average light output of mazda lamps throughout rated life is about 94 percent. of the initial value, and the collection of dust on the lamps and reflectors in service will produce an additional loss of light, the amount depending upon the frequency of cleaning and the conditions of service. Open reflectors cleaned at regular intervals of from two to six weeks ordinarily show a loss of from 5 to 20 percent. at the end of the period. Experience has shown that an increase over the desired average intensity of 20 percent. may be taken to cover both the decrease in lamp output and the dust depreciation for usual conditions; in a foundry, or a roundhouse, an increase of 40 percent. would not be excessive. Since the actual intensity received from a lighting system should average not less than the value selected from the table the value selected should be multiplied by a "depreciation factor" of from 1.20 to 1.40, depending upon existing conditions, in order that the decrease from the initial intensity will not cause the average intensity to fall below the desired value.

Coefficients of Utilization

Due to the loss of light through absorption by the reflector of enclosing glassware, by the fixture, and by the walls and ceilings, only a part of the total light emitted by a lamp reaches the designated plane. Of the light sent in directions other than those where it is used, some will be redirected by the ceiling, walls, and other surfaces on which it falls, and the percentage of the total lumens emitted by the lamp which ultimately reaches the desired location will, therefore, vary widely with the proportions of the room and the nature of the surroundings. Contrary to the general belief, the absolute height in feet at which units are mounted has in itself no influence upon the percentage of light utilized, so long as the same proportions are maintained. For example, if there are two buildings, one 20 feet by 50 feet and 10 feet in height, and the other 40 feet by 100 feet and 20 feet in height, it is clear from Fig. 14 that the effective and hence the efficiencies of the lighting systems in the two buildings will be the same. If the small building is illuminated by 8 100-watt lamps on 10-foot centers and the large building by the same number of 400-watt lamps on 20-foot centers, the average intensity of illumination will be the same,* and its distribution will be similar. On the other hand, the proportions of a given building or room have a very important bearing upon the percentage of light utilized. In Table II are shown the coefficients of utilization, as the percentages are called, for the common reflecting equipments when used in square rooms. For rooms in which the ratio of width to ceiling height is small, a low utilization obtains because, as shown in Fig. 15, a relatively greater portion of the light strikes and is absorbed by the walls than is the case for a large room. For rooms of sizes between the limits specified, proportionate values should be used; where the room dimension exceeds five times the ceiling height, the increase in the coefficient is so slight as to be negligible, and the coefficient for a ratio of 5 should be used. For rectangular rooms, the coefficient of utilization may be obtained by finding the coefficient applying to a square room whose ratio of width to ceiling height is equal to the ratio of the narrow dimension of the rectangular room to its ceiling height, and adding to this value one-third of the difference between it and the coefficient applying to a square room whose ratio of width to ceiling height is equal to the ratio of the long dimension of the rectangular room to its ceiling height. For example, the coefficient of utilization applying to dome-shaped porcelain-enameled steel reflector units used in a mill room with dark ceiling and walls 30 feet wide by 150 feet long with a 30-foot ceiling is found as follows: The coefficient for a room 30 feet square and 30 feet high is 0.37; the coefficient for a room 150 feet square and 30 feet high is 0.63; the coefficient for the room 30 by 150 and 30 feet high is then 0.37×1/3 (0.63—0.37) = 0.456 or, in round numbers, 0.46. It should be noted that this figure is not the same as would be obtained by finding the coefficient applicable to a single square room of equal area, or to a single square room whose length and breadth are equal to the average of the length and breadth of the rectangular room.

The total lumens required for any room is, then, the product of the desired intensity in foot-candles and the area of the surface to be illuminated in square feet divided by the coefficient of utilization. It should be remembered that the value for the desired intensity should be multiplied by a depreciation factor of from 1.20 to 1.40 in order to insure an average intensity in service equal to that originally chosen.

Location of Light Sources

From an analysis of distribution curves of the different units, fairly definite ratios of maximum spacing distance to hanging height which will insure a high degree of uniformity in illumination have been determined for various classes of reflecting equipment. Table III, with its footnotes, presents values which may be used with the knowledge that if the ratios are not exceeded, uniformity of illumination will result. It may be emphaseized at this point that closer spacings than those calculated can be used without hesitancy; uniformity of illumination will suffer only from too great a distance between units, never from too little. Although units are obtainable which give a high degrees of uniformity with wider spacings than those given for the units listed in the table, the long heavy shadows which result from units widely separated discourage the use of wide spacings in interior lighting. On the other hand in many locations, as a restaurant, ballroom, or the home, uniformity of illumination and absence of shadow are not only unnecessary but actually undesirable, and in such places "rules" are, of course, to be disregarded.

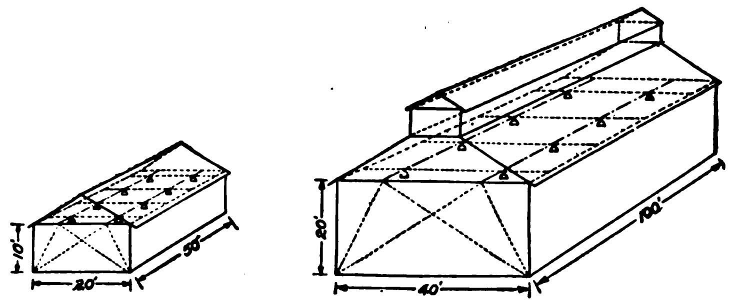
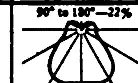
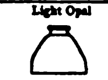
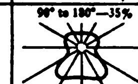
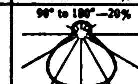
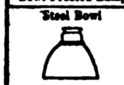
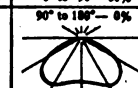
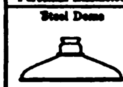
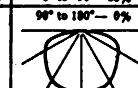
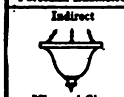
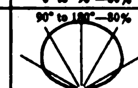
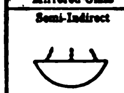
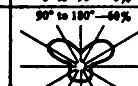
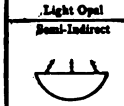
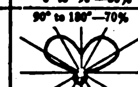
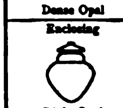
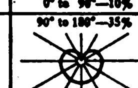
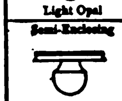
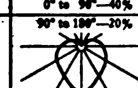


Fig. 14—Three-way switch circuit feeding from below.

In many cases, the construction of a building divides it into a number of bays, and, for the sake of appearance, the units should usually be placed symmetrically in these bays if compatible with uniformity of illumination. Panel designs on the ceiling, or other decorative features, also call for a

COEFFICIENTS OF UTILIZATION

This table applies to installations in *square rooms* having sufficient lighting units symmetrically arranged to produce reasonably uniform illumination. To obtain the coefficient for any rectangular room, find the value for a square room of the narrow dimension and add one-third of the difference between this value and the coefficient for a square room of the long dimension.

Reflection Factor	Ceiling		Light 70%			Medium 50%		Dark 30%
	Walls		Light 50%	Medium 35%	Dark 20%	Medium 35%	Dark 20%	Dark 20%
Reflector Type	Light Output	Ratio = Room Width / Ceiling Height						
Prismatic Glass	90° to 180°—22%	1	.42	.38	.35	.36	.34	.33
		1½	.50	.46	.43	.44	.42	.41
		2	.56	.52	.49	.50	.47	.45
		3	.63	.59	.55	.56	.53	.51
Bowl-Frosted Lamp	0° to 90°—65%	5	.70	.66	.63	.63	.60	.57
Light Opal	90° to 180°—35%	1	.31	.27	.24	.24	.21	.18
		1½	.37	.33	.30	.30	.27	.24
		2	.43	.39	.35	.34	.31	.27
		3	.49	.45	.41	.39	.36	.31
Bowl-Frosted Lamp	0° to 90°—50%	5	.56	.52	.48	.45	.42	.36
Dense Opal	90° to 180°—20%	1	.41	.37	.34	.35	.33	.32
		1½	.49	.45	.42	.43	.41	.39
		2	.54	.50	.47	.48	.46	.44
		3	.60	.56	.53	.53	.51	.49
Bowl-Frosted Lamp	0° to 90°—60%	5	.67	.63	.59	.59	.57	.54
Steel Bowl	90° to 180°— 0%	1	.38	.36	.34	.35	.33	.33
		1½	.45	.43	.41	.42	.40	.40
		2	.49	.47	.45	.46	.44	.44
		3	.54	.52	.50	.51	.49	.49
Porcelain Enameled	0° to 90°—65%	5	.59	.57	.55	.56	.54	.54
Steel Dome	90° to 180°— 0%	1	.43	.40	.38	.39	.37	.37
		1½	.52	.49	.47	.48	.46	.46
		2	.57	.54	.52	.53	.51	.51
		3	.63	.60	.58	.59	.57	.57
Porcelain Enameled	0° to 90°—80%	5	.69	.66	.64	.65	.63	.63
Indirect	90° to 180°—80%	1	.22	.19	.17	.14	.12	.07
		1½	.27	.24	.22	.17	.15	.09
		2	.31	.28	.26	.20	.18	.11
		3	.36	.33	.31	.24	.22	.13
Mirrored Glass	0° to 90°— 0%	5	.42	.39	.37	.28	.26	.16
Semi-Indirect	90° to 180°—60%	1	.27	.24	.21	.20	.17	.14
		1½	.34	.30	.27	.25	.22	.18
		2	.39	.35	.32	.29	.26	.21
		3	.45	.41	.38	.34	.31	.25
Light Opal	0° to 90°—25%	5	.51	.47	.44	.40	.37	.29
Semi-Indirect	90° to 180°—70%	1	.24	.21	.19	.16	.14	.10
		1½	.30	.27	.24	.20	.18	.13
		2	.34	.31	.28	.23	.21	.15
		3	.39	.36	.33	.27	.25	.18
Dense Opal	0° to 90°—10%	5	.45	.42	.39	.32	.30	.21
Enclosing	90° to 180°—35%	1	.23	.20	.17	.18	.16	.14
		1½	.30	.26	.23	.24	.21	.19
		2	.35	.31	.28	.28	.25	.22
		3	.41	.37	.34	.33	.30	.26
Light Opal	0° to 90°—40%	5	.48	.44	.41	.39	.36	.31
Semi-Enclosing	90° to 180°—20%	1	.32	.28	.26	.27	.25	.23
		1½	.40	.36	.33	.34	.32	.30
		2	.45	.41	.38	.39	.37	.35
		3	.52	.47	.44	.45	.42	.40
Opal Bowl	0° to 90°—60%	5	.59	.54	.51	.51	.48	.46

symmetrical spacing, but it must always fall within the limits of the table with regard to the height of the units above the working plane if uniformity is desired. When there are no natural divisions in the room, and the outlets are not already placed, the room should be divided into a number of areas approximately square, and the units placed at the center of each, the maximum distance between units falling within the limits of Table III. With such a location the distance from the nearest row of units to the wall is one-half the spacing distance; the distance of the units from the walls may sometimes, however, be made somewhat less than half the spacing distance in order to avoid shadows and to maintain a high intensity close to the walls.

The mounting height, it should be noted, is the vertical distance between the working plane and the lamp—not the distance between the floor and the lamp—except for direct and semi-indirect systems, in which cases the height is the distance between the working plane and the ceiling, for with such units the ceiling acts as the light source. The use of a larger number of units than is required for the limiting spacing as previously mentioned does not detract from the uniformity of illumination; the considerations of higher costs for the equipment, as well as the arrangement and shape of the room, will usually be determining factors.

Table III

Recommended Maximum Spacings and Minimum Mounting Heights for Various Units

(Mounting height equals distance of light source above plane of illumination)

Equipment	*Ratio = Spacing / Mounting Height	†Ratio = Mounting Height / Spacing
Prismatic, Mirror, or Aluminum		
Intensive	1 1/2	2/3
Focusing	3/4	1 1/3
Extensive	1 2/3	3/5
Indirect or Semi-indirect	1 1/2‡	2/3‡
Opal or Porcelain Enamel		
Bowl	1 2/3	3/5
Dome	1 2/3	3/5
Totally Enclosing Glass	1 2/3	3/5
Semi-Enclosing	1 1/2	2/3

*To get maximum spacing distance, multiply ratio by mounting height.
†To get minimum mounting height, multiply ratio by spacing distance.
‡Height equals distance between ceiling and plane of illumination.

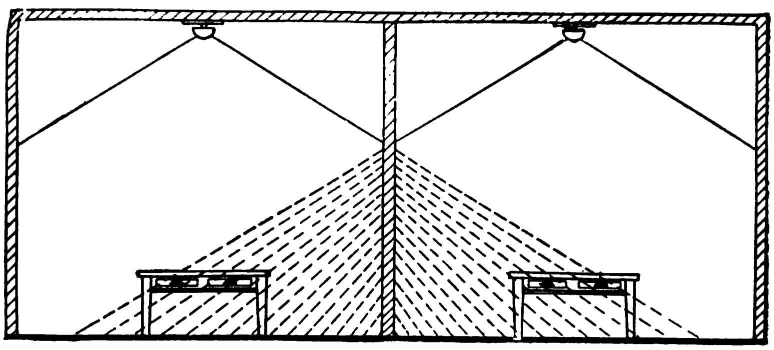


Fig 15. The coefficient of utilization is dependent upon room proportions. The light striking the partition is largely lost

Mazda Lamps

Multiple mazda lamps for use on 110-125 volt lighting circuits range in size from 10 to 1000 watts. The light output in lumens ranges from 75 to 18,000. The many sizes in which these lamps are available and their simplicity of installation and operation go far toward making them a universal illuminant. Typical mazda lamps are shown in Fig. 16.

In the smaller sizes, mazda lamps are regularly manufactured in either round or straight-side bulbs; with modern reflecting equipment, however, the straight-side lamps are used almost exclusively. Lamps larger than 100 watts are standard only in pear-shaped bulbs.

Mazda lamps designed for operation on 110-125 volt circuits up to and including the 60-watt size are all of vacuum construction and are known as mazda B lamps. There is also available a 100-watt mazda B lamp. Mazda C lamps, which employ an inert atmosphere within the bulb to permit more efficient operation, are made in sizes ranging from 75 to 1000 watts. In these lamps the filaments operate at a higher temperature, and a comparison of a mazda B and a mazda C lamp will show that the light of the latter is noticeably whiter. Mazda C-2 lamps are available in sizes ranging from 75 to 500 watts. These lamps employ a scientifically selected blue bulb which screens out a portion of the red and yellow rays and transmits a light of afternoon sunlight quality. Mazda C-2 lamps are especially adapted to those many places and occupations where light of approximate daylight quality is desirable and where light of true north sky quality is not required.

In Table IV are given the light output in lumens and other data applying to the more common mazda lamps of the 110-125 volt class. Attention is called to the fact that lamps of the 220-250 volt class are less efficient than those for 110-125 volt service. For this reason, and because of the fact that 220-250 volt lamps are more expensive and less satisfactory in service, the use of 110-125 volt lamps is recommended in all but very exceptional cases.

TABLE IV. SPECIAL DATA ON 110-125 VOLT MAZDA LAMP

Watts	Total Lumens	Watts Per Spherical Candle	Lumens Per Watt	Bulb Diam. in Inches	Maximum Over-all Length, Inches	Light Center Length, Inches	Base	Position of Burning	Rated Average Life, Hours
				Straight-side Mazda B Lamps					
10	75	1.67	7.52	2 1/8	4 5/8	2 7/8	Med. Screw	Any	1000
15	128	1.47	8.55	2 1/8	4 5/8	2 7/8	Med. Screw	Any	1000
25	230	1.37	9.17	2 3/8	5 1/4	3 1/4	Med. Screw	Any	1000
40	378	1.33	9.45	2 3/8	5 1/4	3 1/4	Med. Screw	Any	1000
50	476	1.32	9.52	2 3/8	5 1/4	3 1/4	Med. Screw	Any	1000
60	585	1.29	9.74	2 5/8	5 1/2	3 7/16	Med. Screw	Any	1000
100	1010	1.24	10.13	3 3/4	7 7/8	5 3/16	Med. Sc. Sk.	Any	1000
				Pear-shape Mazda C Lamps					
75	865	1.09	11.53	2 3/4	6 1/8	4 5/16	Med. Screw	Any	1000
100	1260	1.00	12.57	3 1/8	7 1/8	5 3/16	Med. Screw	Any	1000
150	2050	0.92	13.66	3 1/8	7 1/8	5 3/16	Med. Screw	Any	1000
200	2920	0.86	14.61	3 3/4	8 3/8	6	Med. Screw	Tip Down*	1000
300	4850	0.78	16.11	4 3/8	9 3/4	7	Mog. Screw	Tip Down*	1000
400	6150	0.82	15.32	5	10	7	Mog. Screw	Tip Down*	1000
500	8050	0.78	16.11	5	10	7	Mog. Screw	Tip Down*	1000
750	12800	0.74	16.98	6 1/2	13 3/8	9 1/2	Mog. Screw	Tip Down*	1000
1000	18000	0.70	17.95	6 1/2	13 3/8	9 1/2	Mog. Screw	Tip Down*	1000
				Pear-shape Mazda C-2 Lamps					
75	600	1.58	8.0	2 3/4	6 1/8	4 5/16	Med. Screw	Any	700
100	870	1.44	8.7	3 1/8	7 1/8	5 3/16	Med. Screw	Any	700
150	1400	1.34	9.4	3 1/8	7 1/8	5 3/16	Med. Screw	Any	700
200	2000	1.25	10.1	3 3/4	8 3/8	6	Med. Screw	Tip Down*	700
300	3350	1.12	11.2	4 3/8	9 3/4	7	Mog. Screw	Tip Down*	700
500	5600	1.12	11.2	5	10	7	Mog. Screw	Tip Down*	700
				Round-bulb Mazda B Lamps					
15	123	1.53	8.21	2 5/16	3 3/4	2 1/4	Med. Screw	Any	750
15	132	1.43	8.79	3 1/8	4 3/4	2 3/4	Med. Screw	Any	750
25	222	1.45	8.67	2 5/16	3 3/4	2 1/4	Med. Screw	Any	750
25	240	1.35	9.31	3 1/8	4 3/4	2 3/4	Med. Screw	Any	750
40	386	1.33	9.45	3 1/8	4 3/4	2 3/4	Med. Screw	Any	750
60	630	1.23	10.22	3 3/4	5 1/2	3 1/8	Med. Screw	Any	750
100	1100	1.18	10.65	4 3/8	7 1/4	4 1/2	Med. Sc. Sk.	Any	750

*Orders for Mazda C lamps should specifically state if lamps are for use in other than pendent position.

Method of Procedure

The problem which confronts the engineer designing illumination is to secure from the available lamps and reflecting equipments light of the proper quality and quantity and to distribute this light with a proper degree of uniformity. This involves, first of all, the selection of a type of reflecting equipment—direct, semi-direct, or totally indirect—which will give the proper quality of light for the purpose at hand. The next step is to decide from a survey of the existing conditions and from data such as are given in Table III, what groupings of units—numbers of units and their location—will provide a satisfactory degree of uniformity. It will sometimes be found that the choices are closely limited by the structural features of the room or building. In such cases, the problem is only one of selecting a size of lamp which will supply the required intensity. In other cases, a choice of several arrangements of outlets is afforded, and here the problem is to determine which arrangement, in view of the lamps readily available, can best be employed to fulfill the requirements.

The lumens which the lamps must furnish initially are calculated by multiplying the area in square feet of the room to be lighted by the intensity desired for the particular purpose, multiplying this product by a depreciation factor as previously explained, and dividing the final product by the co-efficient of utilization determined from consideration of the type of unit, the nature of the walls and ceiling, and the proportions of the room to be lighted. The number of lumens each lamp must give is then determined by dividing the total lumens by the number of lamps it is desired to use. These relations may be expressed in the following simple equation:

$$\frac{\text{Desired Foot-candles} \times \text{Depreciation Factor} \times \text{Area in Square Feet}}{\text{Coefficient of Utilization} \times \text{Number of Outlets}} = \text{Lumens per Outlet}$$

slightly higher expense than originally planned and a slightly lower one, but between a system which will prove adequate illumination and one which may not; when it is considered how closely artificial lighting intensities approach the lower limit at which good vision is possible, it will be seen that the safest course is to employ the larger units. Where the number of outlets which can be employed advantageously is not so definitely fixed, a greater choice in the selection of a size of lamp exists, and no difficulty should be experienced in selecting a size which will provide an intensity approximating that originally assumed as the desirable value. Here again, when a choice must be made, a higher intensity than that originally assumed should receive the preference over a lower one.

The chart below has been prepared to show at a glance the important factors entering into illumination design. It may be mentioned that the order of operations can readily be varied to suit the requirements of individual problems.

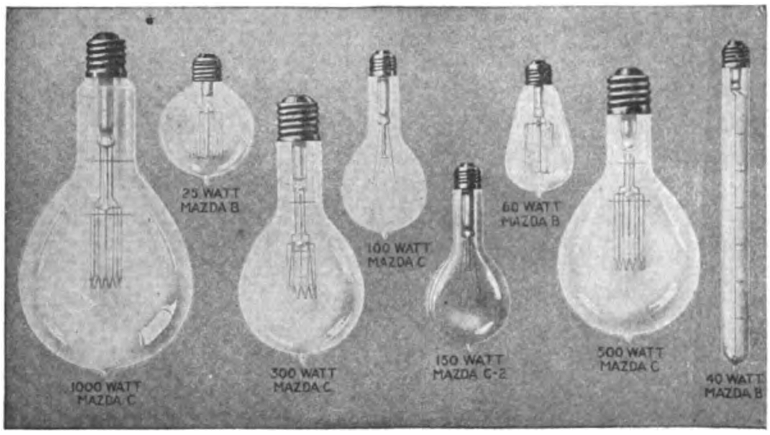


Fig. 16. Typical mazda lamps

Chart of Important Factors in Illumination Design

Choice of System	Glare and Reflected Glare Shadow Illumination of Vertical Surfaces Efficiency Wall Brightness Available Units
Choice of Intensity	Nature of Work Advertising Value Table No. I
Depreciation Factor	Depreciation of Lamp in Service Depreciation of Equipment and Lamp Due to Collection of Dust
Coefficient of Utilization	Light Absorbed by Reflecting Equipment Light Absorbed by Ceiling and Walls Size of Room Table No. II
Location of Lamps	Relation of Spacing Distance to Hanging Height Construction Features of Rooms or Building Table No. III
Mazda Lamps	Up-to-date Values of Lumen Output Color Quality of Light Table No. IV
Calculation of Lumens per Outlet	$\frac{\text{Foot-Candles} \times \text{Depreciation Factor} \times \text{Area in Sq. Ft.}}{\text{Coefficient of Utilization} \times \text{Number of Outlets}} = \text{Lumens per Outlet}$

From Table IV, a size of lamp can be selected which will give the required number of lumens. In case the location of outlets is closely limited by structural features, it will be necessary to make a choice between a size of lamp which will provide a lower intensity than that assumed as a basis for calculation and one which will provide a higher intensity. In such cases, the choice is not simply between a

For example, if it is desired to check the illumination intensity secured from a given system, the formula may be written in the form

$$\frac{\text{Coefficient of Utilization} \times \text{Number of Outlets} \times \text{Lumens per Outlet}}{\text{Area in Square Feet} \times \text{Depreciation Factor}} = \text{Foot-candles}$$

EDITORIAL

OUR POWER PLANTS EXPRESSED IN MAN POWER

If the electric power plants of the country should be destroyed, says a well-known and conservative power plant operator, there are not enough hands in the United States to do the work they have been doing. Apart from the ordinary conveniences and economies of daily domestic and social life, the output of the electrical power driven machinery of the country in munitions, war supplies, food products, coal handling and ship loading represents the daily labor of more millions of hands than could be put to work. This, in brief, tells what electricity is doing here in the way of helping to win the war. In the way of combining the arrogance and greed of the Hun, electricity is no slacker. And 'twill be no slacker, either, when it comes to the point of giving the Huns the spanking they deserve in order to teach them their place. Our power plants lay no claim to prowess as warriors, but they do their bit to keep the troops supplied with all they need in the shape of munitions, clothing, food, shelter, and hospital supplies.

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MONEY VALUE OF ENGINEERING

Under this heading we purpose making a few midsummer comments on an engineer's comments on the cost of living versus the cost of engineering. The engineer we have reference to is taking his professional brethren to task for not measuring their services in terms of the present purchasing power of the dollar instead of in terms of its pre-war purchasing power. As engineers, says this mentor, these men look at the dollar as either a rectangular figure made of silk-threaded paper, or a circular figure made of metal and capable of being represented in value by other pieces of circular metal whose values may represent one-half, one-quarter, one-tenth, one-twentieth, or one-hundredth the value of the dollar itself. They apply all sorts of mathematical analysis to the dollar, he claims, but the sort of mathematical analysis that has to do with its value of a medium of exchange. Taking these engineers to task for their seeming lassitude in allowing the value of their services as engineers to deteriorate, by accepting in return something that will buy only about half the necessities that it bought five years ago, he goes on to say that others of our fellow wage earners, men who have invested little, if anything, in education, who have the most rudimentary training, who are employed as day laborers under our direction, are getting larger rates of pay. We have come to regard as a matter of course the anomaly that the engineer or trained assistant in charge, the man who is supposed to supply the training and exercise judgment is getting less than the carpenter, mason, or plumber working under his orders. Yet he must—according to our tradition—live in a little better house and maintain his family and educate his children in a more expensive way. It is getting harder and harder to do this, and now the breaking point is about reached. Some are solving the difficulty by actually going into manual occupation. Men who have been assistant engineers in charge have found that they can get better wages by taking up the saw and hammer and entering the ranks of day labor. The question is why do not more go, leaving this relatively poorly paid profession. They are held to it by the love of the work, but their devotion cannot be penalized much longer or a still larger proportion must go into various trades or occupations where the rates of pay are being adjusted to the cost of the necessities of life. He urges that the engineering societies take it upon themselves to give priority to the human materials and forces that sustain the societies themselves, to look after the material welfare of their members in the way of living wages rather than deluge them with volumes of "literature" which is invariably filed away in attics and spare rooms, to read "when I have the time."

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KILOVOLT-AMPERE RATING

What, asks a reader, is the object in using kva. in giving expression to the capacity of an alternator, instead of kw. as in the case of a direct-current generator? This query has come to us so frequently of late that it seems advisable to explain somewhat at length why kilovolt-amperes is used in one case and kilowatts in another. Let it be known, then, that kva. is the abbreviation of the term "kilovolt-ampere," just as kw is the abbreviation of the term "kilowatt." The capacity of direct-current apparatus is expressed in terms of kilowatts, or for short, kw, because the two components that go to make up the energy output; that is, the volts and amperes, are working in the same direction at the same time. They pull together. The power factor is unity. The capacity of aternating-cur-

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Patriotic citizens by the thousands are subscribing to the war savings stamps issued by the United States Government. An average of $20 per capita—$20 for each man, woman and child in America—is asked during 1918 from this source. The putting across of this splendid scheme is most helpful to the government at this critical period in our national life, and at the same time it is the most remarkable plan for encouragement of thrift among the young and old ever initiated. Are you doing your part? Are you saving your pennies, nickels and dimes?

rent apparatus, on the other hand, is expressed in terms of kilovolt-amperes, or, for short, kva, because, most likely, the two energy components, the volts and amperes, are not pulling in the same direction at the same time. A certain electrical angular displacement caused by the "inductance" or the "capacity" of the circuit results, in alternating current electrical apparatus, to what is equivalent to lost motion in a bit of mechanism. Some of the energy of the electrical apparatus is not effective; for the time being it is nullified by the throttling down or the displacement of one of the energy components. The energy components, the volts and amperes, are then said to be "out of phase" or "not in synchronism." They are not in step. Now the power factor is something less than unity. When the volts and amperes are out of step—and they often are in alternating-current operation—the generator may be working at full capacity, and gets just as hot as if it were doing one hundred percent. effective work. As a matter of fact it may be doing only seventy percent. of the work it is capable of doing, though it is actually carrying load to full capacity. For this reason alternating-current apparatus is rated in kilovolt-amperes instead of in kilowatts. If it were rated in kilowatts the operator might expect it to deliver the full rated kilowatts when loaded to maximum capacity, regardless of whether or not it were operating under abnormal conditions, as on an inductive circuit. In reality the machine may be operating so as to deliver its full rated kilovolt-ampere capacity, but only part of its efforts are being utilized in effective work. On account of the radically different conditions under which direct-current and alternating current apparatus operate, it is necessary that they be rated differently. Their effective outputs are likely to vary widely under identical load conditions. For example, a 6600-volt alternator whose rated current is 500 amperes could deliver 3300 kw. on a non-inductive load; but, for the same rise in temperature, it could deliver only 2640 kw. to a load of 80 percent. power factor. For this reason it is also advisable, in rating alternating-current machinery, to specify the power factor on which its rating is based. That is why direct current apparatus is rated in kilowatts and alternating current apparatus in kilovolt-amperes.

ZONE SYSTEM OF POSTAL RATES

Ths postal zone law enacted by Congress last year concerns every reader of this paper because it means, if the law is not repealed or modified, that out of the pocket of the reader will have to come the increased cost of distributing it to the remote zones. The unfairness of this law is so pronounced that anyone with any capacity at all for prospective can easily discern its destructive nature as far as the trade press of this country is concerned. Well-informed men in both public and private life have pronounced against it. Charles E. Hughes, late Justice of the United States Supreme Court says of it: "In my judgment the zone system for second-class mail matter is unjust to the publisher and unjust to the public. It not only imposes upon the publisher the additional rates upon a sectional basis, but it makes necessary the added expense for the necessary zone classifications at a time when every economy in production and distribution is most important. It introduces a complicated postal system to the inconveniences of the publisher and public when there should be a constant effort towards greater simplicity. There is no more reason for a zone system of rates for newspapers and magazines than for letters.

Newspapers and magazines are admitted to the second-class postal rates on the well established policy of encouraging the dissemination of intelligence, but a zone system is a barrier to this dissemination. If it is important that newspapers and magazines should be circulated, it is equally important that there should not be sectional divisions to impede their general circulation through the entire country.

We are proud at this moment of our united purpose, but if we are to continue as a people to cherish united purposes and to maintain our essential unity as a nation, we must foster the influences that promote unity. The greatest of these influences, perhaps, is the spread of intelligence diffused by newspapers and periodical literature. Abuses in connection with second-class mail matter will not be cured by a zone system of rates. That will hurt the good no less than the bad, and perhaps some of the best sort of periodical literature will be hit the hardest.

We do not wish to promote sectionalism, and 'one country' means that in our correspondence and in the diffusion of necessary intelligence we should have a uniform postal rate for the entire country. The widest and freest interchange is the soundest public policy.

I hope that Congress will repeal the provision for the zone system which is decidedly a looking-backward and walking-backward measure."

DOES YOUR MOTOR HEAT?

Warm weather always brings a number of complaints in regard to heating of small motors, says the Emerson Monthly. These complaints are usually from dealers or users who are possessed with the idea that if the motor-body does not feel nice and cool to the hand, the windings are in imminent danger of burning out.

The latest standardization rules of the American Institute of Electrical Engineers provide that, in motors the temperature as recorded by a thermometer, should be within a limit of 90 degs. Centigrade. This is equivalent to 194 degrees Fahrenheit. No one would care to place his hand in contact with the frame of a motor at anywhere near that limit.

Let us say, for instance, that a small motor has a temperature rise of 40 degrees Fahrenheit when operated continuously. Such a motor operating on a day when the normal air temperature is 70 degrees, would reach a temperature of only 110 degrees, which would feel only comfortably warm to the hand.

The same motor, operating on a mid-summer day when the thermometer runs from 90 to 95 degrees, will attain a temperature between 130 and 140 degrees Fahrenheit. Any temperature over 120 degrees is quite uncomfortable to the touch and gives rise to alarm on the part of the inexperienced motor user.

However, a motor with a surface temperature of 140 degrees is in no danger of injury from overheating, and motor users who make complaint of the heating effect under such conditions should be advised to continue operating their motors until it is apparent that the windings are being damaged. Unless there is some odor of burning insulation, the motor cannot be considered in danger.

Users are perfectly familiar with the well-known heating effect of the common incandescent lamp, and only the very inexperienced still think of enclosing a lamp in inflammable material or of trying to hold the hand on a burning lamp.

THE ECONOMICAL USE OF FUEL

At the Spring Meeting of The American Society of Mechanical Engineers, held at Worcester, Mass., June 4-7, 1918, sessions were held for the discussion of the all-important subject of fuel economy. In preparation for this session the Committee on Meetings invited the Fuel Conservation Committee of the Engineering Council to formulate a set of questions which was sent out to a list of fuel engineers throughout the country, and over 60 of whom responded with contributions.

The country now faces a coal shortage of 80,000,000 tons this year. We need 100,000,000 tons more this year than last, or 220,000,000 tons more than ever before mined in one year. Military draft has taken about 35,000 miners and there is a serious shortage of open-top equipment to haul coal. Every fuel user must exert his greatest effort to effect fuel economy and every engineer owes it as a public duty to render his utmost assistance to this end. Some of the opinions contributed are published below.

WHAT INSTRUMENTS ARE USEFUL and DESIRABLE in the BOILER ROOM as AIDS in SAVING COAL?

E. G. Bailey. The answer to this question is: Meters that will actually *assist* the fireman to carry the load required of his boilers and at the same time obtain the maximum efficiency. The old idea of having meters and recorders to "show him up" if he did not do his work well, when he usually did not know how to do it better, is wrong.

The word "meter" is used here in its broad sense to include all instruments, pressure gages, thermometers, etc., down to coal scales and wheelbarrows when they are used to obtain knowledge of the operating and efficiency conditions.

Controllable Losses in Boiler Operation

In selecting meters, the principal object is to obtain knowledge of the boiler capacity and efficiency and also the individual losses, especially those which are controllable. To accurately know the losses is of much more importance than efficiency, for efficiency can only be increased by reducing losses, and if one knows that the losses have been reduced, he is positive that the efficiency has been increased. The principal controllable losses in boiler operation are : (1) combustible in ashes and refuse, (2) excess air, (3) unburned gas, and (4) high temperature of flue gases. There are also other factors from an operating standpoint that are of importance, such as the steam pressure, superheat, rate of steam output from each boiler, evaporation per pound of coal, etc.

Meters are divided into four general types. Those which show condition; total; rate; ration.

Meters which show condition include pressure gages, thermometers, water level gages, etc. which in a boiler plant are used to measure steam and draft pressures; steam, flue gas and feed water temperatures; water level in the boiler and other similar factors. These meters may be either recording or indicating.

Meters which give total values or quantities, include coal and ash weighing or measuring devices, also integrator meters for water, steam, etc. These are usually indicating only.

Meters which show rate can be either recording or indicating, and include boiler feed, steam flow, air flow, stoker, speed, etc. They may also be combined with integrating meters of the second type.

The three foregoing types are those with which we are most famliar and they have been developd and their general use extended in the same order in which they are named, while from an operating standpoint the value of these different types is practically in their reverse order. For instances, it is better for a fireman to know the rate of steam output from each boiler continuously than to wait until the end of his shift and learn the average rate from a water meter that integrates total only.

Results Should be Known Promptly

The real valuable results from complete boiler tests, such as those made by Dr. D. S. Jacobs at Detroit some years ago, are not obtainable until the many calculations involving averages and totals are made and the relations between the various factors are determined. In other words, the total evaporation or even the rate of evaporation gives no information whatever as to efficiency until we know how many B.t.u. were expended in producing this steam, or at least know how many B.t.u. were lost in making it. Time is an important factor in boiler operation and the fireman should know final results promptly and continuously. It is, therefore, desirable to have meters of the fourth type which indicate and record the relation between certain important factors as well as the condition, total and rate.

One of the important relations desired is that between rate of steam generation and rate at which fuel is burned. With liquid or gas fuels of uniform quality this is possible; but with coal, about the closest approach is the relation between a steam flow meter and tachometer on the stoker drive. The latter, however, is a crude means of determining the rate at which the B.t.u. are supplied to the furnace, and this is the real factor desired. It is doubtful if this will be satisfying attained, in the near future at least, due to the varying amount of coal fed per revolution of the stoker shaft and the varying quality of the coal, as well as variations in the amount of coal on the grate.

Relation of Steam Flow and Air Flow

There is another relation, however, that is analogous to the steam-fuel ratio that is readily obtained and of even greater value. It is the relation between the rate of steam flow from the boiler and the rate of air flow which supports combustion for the generation of this steam. Air is a fuel just as much as carbon or hydrogen, and the amount of air required to develop a given number of B.t.u. is practically independent of the character or quality of coal being used. In fact, there is only 6 percent. difference between the B.t.u. developed per pound of air used to burn carbon and natural gas. This is much closer than most people are able to maintain the excess air in coal fired furnaces. Natural gas is mentioned in this comparison because it contains a higher percentage of available hydrogen than any other commercial fuel.

There is ample evidence available to show that the relation between the steam flow and air flow is of value in assisting the fireman to maintain the most economical fuel bed and prevent undue losses in either excess, or unburned gases This relation is also of great assistance to the fireman in obtaining maximum capacity from his boilers, for he quickly learns that it is impossible to make steam without the proper supply of air and if the maximum air supply is equivalent to only 200 percent. boiler rating, then 200 percent. boiler rating is all he can get, unless he is willing to sacrifice efficiency and produce high percentages of unburned gases. Such a loss is plainly shown by this relation as a deficiency of air.

Another important relation in boiler operation is that existing between flue gas temperature and rate of steam output. We have only to refer to data plotted by Mr. Azbe to see that there is a wide difference between results obtained from various boilers in different plants. While this relation depends upon the position of baffling and other features of designs, it is perfectly definite for any one design, and a certain flue gas temperature should exist for each rate of steam output. Any deviation from this indicates dirty heating surface or leaky baffles, providing the proper relation exists between the rate of steam flow and air flow. Either a decrease or increase in excess air from the most economical amount will result in an increase in flue-gas temperature, except that a large percentage of excess air will reduce the temperature.

In boiler-plant operation there are several other factors which should be combined to continuously show the relations existing between them for the benefit of the fireman or operating engineer, whereby they can get at the true conditions and their causes with little mental effort and delay. A meter which shows a relation is in reality an automatic calculating machine which takes two or more factors and produces a tangible result, which would otherwise require the reading of two or more instruments and reference to charts or tables.

The question often arises in selecting any of the four types of meters as to whether they should be indicating or recording. Some of the best power-plant engineers were strongly in favor of indicating meters for boiler plant work a few years ago, but have now changed to be the strongest advocates for recorders. Practically the only argument that can be advanced in favor of indicating meters is lower initial cost and the lower cost of operation by elimination charts.

Advantages of Recording Meters

Some of the many advantages of recording meters are: Permanent records to show conditions existing throughout the twenty-four hours; averages, totals and operating characteristics may be checked at any subsequent time; and of even more importance is the fact that it helps the fireman to see, not only the conditions at that instant, but also what the conditions have been immediately previous, and thereby ascertain whether they are changing, and if so, in which direction. This alone is of sufficient value to warrant the use of recording meters in practically every instance, providing they are located in the position where the man in charge of operation can readily see the chart record in detail. A water tender will do much better work when he has a recording feedwater meter within sight, than if the recorder were located in the engine room.

The firemen and operating men must have meters which serve as eyes whereby they can see through steam pipes and brick walls, so to speak, and actually know what is taking place. The meters that will give them true pictures in the most realistic and concrete form are the most useful in saving coal.

Walter N. Polakov. While the generation of power, and more specifically of steam, is the domain of the scientifically trained engineer, power-plant practice is conspicuous by the lack of accurate measurement of conditions and results.

Unless the results attained are known, no opinion as to perfection of operation can be formed; furthermore, the practice is necessarily wasteful unless means are available to observe the conditions under which the process is performed. All instrument equipment of the boiler house can, therefore, be grouped into two classes; those for recording the results; those showing the conditions.

A plant of which it is known how many pounds of coal are used per 1000 lb. of steam, how the load is distributed among the units and throughout the day, etc., by necessity wastes fuel. The knowledge of these data does at least open the eyes of those responsible for its success, and further progress is thereby made possible.

The first group of instruments then comprises:

Quantity

- Recording coal sales
- Recording steam or water meters.

Quality

- Coal calorimeter and moisture scales
- Feedwater thermometer
- Steam pressure gage and thermometer.

The second group of instruments is intended to direct the processes by controlling conditions:

Condition

- Individual flow indicators
- Individual draft gages
- Individual flue-gas thermometers
- Flue-gas analyzer.

Substitution of flow indicators by coal or oil meters is undesirable, as it leaves obsecure the output for given input; draft gages may be substituted by pitot tubes. Other modifications are sometimes desirable, but the above equipment is necessary and sufficient in general cases.

Any investment in instruments is a pure waste of money, and will lead to demoralization unless means are provided for:

a Training men to use them properly
b Stimulating men in the proper use of them
c Complete, exact, and continuous recording.

Location and arrangement of instruments should be such as to:

a Permit simultaneous readings and their comparison
b Permit plain view of units from instrument board and vice versa
c Afford an opportunity to use one instrument for diverse units
d Eliminate unnecessary fatigue of observing scattered instruments
e Assure ease and simplicity for testing.

These requirements are combined in the type of instrument boards devised by the author.

The complete cost of such installations, including labor and material, averages $2000, and the returns secured on this investment are usually equal to or better than told in the following report from a plant using from 150 to 250 tons of coal per week:

"........It is evident that in the four months preceding the installation of the boiler control board, the savings on fuel, due to various steps taken, averaged $435.00 per month, while, in the four months following the installation of the instruments, the savings computed on the same basis averaged $1145.00. In other words, the increased savings, due solely to the ***intelligent use*** of instruments on the boiler control board, was $710.00 per month, or $8520.00 on the annual basis, which means that the expenditure of $2080.46 for instruments of the said board is an investment which, in our case, yields over 400 percent. return."

The fallacy of economizing on instrument equipment or ignorant attempts to select "the most important" ones have only one rival in absurdity—the tendency of installing instruments without giving the employees the opportunity to use them to advantage. Obviously, the operating men have no time, no ability for research work, and little inducement, to carry out investigations, standardize methods, and set tasks. It should be the duty of the management to give them the necessary training and to assume responsibility for results.

A. R. Dodge. Pressure gages and water-gage glasses are absolutely necessary to the operation of steam boiers. Next in importance is a stem-flow meter for the purpose of showing the amount of steam being delivered by each individual boiler.

Steam-flow meters in service have shown that in nearly every case a battery of boilers as a whole may be generating the required amount of steam, but the several boilers making up the battery fall far short of assuming equal subdivisions of the total.

Steam-flow meters installed on each boiler show at once a boiler which is "loafing," or one being forced too hard, conditions which cannot readily be detected in any other way. With this knowledge the necessary changes can be made in drafts, fires, etc., to equalize the steam output of the boilers. With the outputs equalized the danger of priming and burning out tubes and brickwork, due to excessive overload, is minimized.

Results obtained in many plants prove conclusively that the flow meters are a great aid to the firemen themselves in showing the results of their work. As soon as they learn that the flow meters show them the effect of changing the draft, fires, rate of feeding water, etc., they will be found using them as a working guide.

Holes and dead spots develop in fires, reducing the efficiency of combustion by allowing an excess of air. Should this occur, the steam output instantly drops and with a flow meter installed on each boiler, the fireman is warned that something is wrong.

Flow meters have been the means of indicating many other conditions which seriously affect the economy, such as leaky settings admitting quantities of air, burned-out baffles permitting a short-circuit of the gases, incorrect adjustment of feedwater regulators, or poor hand regulation, etc.

The use of draft gages, CO_2 recorders and a thermometer to show the superheat of the steam, in conjunction with a flow meter, enables the power-plant operator to keep a complete check on the performance of the boilers and furnaces, and to quickly eliminate faulty conditions as they occur and thereby to keep up the efficincy of the plant.

E. A. Uehling. The continuous CO_2 record shows up the process of combustion for every minute of the day. The indicator at or near the boiler front keeps the fireman continuously informed of what he is doing. It shows him in a few minutes the effect of any change in the rate of fuel and air supply that may be necessary to keep the steam pressure level.

What The CO_2 Shows

In hand-fired boilers the continuous record not only shows whether the proper percent. of CO_2 has been maintained, but also how often the fire was replenished, how long the fire doors were kept open, when the fire were cleaned, how long it took to clean them, and the improvement in the fire resulting from it. With an occasional check analysis by an Orsat the continuous CO_2 record becomes an unchallengeable exposition of combustion efficiency.

Combustion efficiency is the foundation of boiler efficiency, but it does not necessarily follow that maximum combustion efficiency will always result in maximum boiler efficiency. There is another factor of nearly, if not quite equal importance, viz., absorption efficiency. Absorption efficiency depends, first, on combustion efficiency; second, on the relation of heating surface to the rate of combustion; third, the routing of the gases through the boiler; fourth, the cleanliness of the heating surface inside and out, and fifth, air infiltration. The CO_2 meter should therefore be supplemented by at least two other instruments, viz., the pyrometer and the boiler draft gage, preferably the draft analyzer, which shows both the furnace draft (resistance through the fire) and the boiler draft (resistance through the boiler.) The pyrometer does not by itself give reliable information, but if its readings are cordinated with those of the CO_2 meter and the boiler draft gage, a complete and reliable control over absorption efficiency is had. The boiler draft gage gives immediate notice of broken down baffling, and in combination with the percent. of CO_2 its readings furnish an approximate index to the rate of combustion.

It would be useful to have, in addition to the above, a steam-flow meter on each boiler, since they would furnish a quantative check on every boiler and fireman in addition to the chemical and physical qualitative control which I have mentioned as necessary and adequate to attain and maintain maximum boiler efficiency dependent only on plant—fuel—and operating conditions. The installation of a steam-flow meter is therefore to be highly recommended.

It is evident from all this that no boiler plant large or small should be without an Orsat, that the CO_2 recorder should take precedence over other more or less expensive equipment. Although the CO_2 recorder gives all the information necessary to control combustion efficiency, a pyrometer and draft analyzer are necessary in addition to control boiler efficiency. In general any instrument that will give useful information is a desirable addition to the equipment.

Wholesale control by means of water and coal weigher is most valuable to the manager in many ways in addition to those already mentioned, and any plant the size of which warrants the expense should install them.

There are many other instruments and apparatus of greater or less importance and utlity which the prescribed space and time does not permit me to discuss. I may say, however, that all have their talking points and in a measure fulfill their advocated functions; but since they ignore the fundamental principle of combustion, they cannot give information adequate for complete control over boiler operations.

R. P. Brown. The temperature in the furnace and the distribution of this heat throughout the boiler must be learned carefully. The firebox is at such at high temperature that except for test purposes it is not practical to install an instrument at this point. An electric pyrometer can be used to secure by test the temperature in the firebox using a platinum-rhodium thermocouple, but most frequently the pyrometer is installed so that the tmperature of the last pass, or in the uptake, is secured.

The temperatures in the firebox are approximately 2500 or 2750 deg. fahr., which is too high for a permanent installation. In the last pass the temperatures average about 1000 deg. fahr. and in the uptake about 400 or 600 deg. fahr. At these lower temprautres base-metal couple may be installed without danger of rapid deterioration. The temperatures in the last pass and uptake have been found to be comparative to those in the firebox; so that a working temperature is secured to which the fireman can work.

If actual practice shows that 500 deg. in the uptake or a corresponding temperature of 1000 deg. in the last pass of a boiler results in securing the maximum efficiency, then the fireman should use this temperature as a guide. The slightest irregularity in firing or change in furnace conditions are readily noted before the corresponding change in pressure may occur. If the flues are dirty and sooty the heat cannot be absorbed and instead pass up the stack, and a correspondingly high stack temperature is secured. If the baffle walls become cracked or broken down the heat will not circulate properly, and again high stack temperatures.

In addition to the usefulness of temperature and pressure recording instruments, there has recently been evidenced an increased interest in electric tachometers for registering the speed of the shafts on automatic stokers. The rate of firing, naturally bears a close relationship to the amount of coal used. A small generator is attached to the end of the stoker shaft by means of gear or sprocket and chain drive. It is so geared that about 15 to 25 volts are generated at a speed of approximately 1000 r.p.m. of the generator. This voltage is carried to the instrument by means of wiring. As this can steadily be strung for long distances, the instruments may be located wherever most desirable.

C. W. Hubbard. The evaporation figure might strictly be classed as a "half truth." When this figure has been arrived at, without supplementary data, one man's guess is as good as another's as to whether the results obtained are all they should be.

The most useful instruments in the boiler room are draft gages, an Orsat apparatus, a CO_2 recorder, and recording thermometers for the feedwater line and the flue-gas temperatures. in addition to this, systematic tests of coal and ashpit refuse are necessary, for it is obviously unfair to expect the plant to operate at a given standard when it may be, and probably is the case, under present conditions, that the fireman is being furnished with greatly inferior coal.

It has been a common experience of the winter to be able by thus studying the preventable losses in the plant, to make a saving of from 10 to 20 percent. within a period of a month, and when I say 10 to 20 percent. I do not mean in power saving but I mean actual tons of coal wheeled into the boiler room.

R. H. KUSS. The question requires two sets of answers, because for the fuel engineer the entire range of instrument equipment may be made useful, whereas for the operating engineer of the usual grade, a very limited number of instruments are of any special service.

Instruments an engineer can use to advantage are those which he can understand; those that prove useful are such as require little attention to keep operating and which reveal maladjustment by simple test. The most useful and simplest instrument for the boiler room is a draft gage, preferably of the differential type. A draft gage or draft-gage system, if continuously used, will show to the careful observer—

a Development of leaks, uncleanliness, baffle failures, etc.

b Poor fuel-bed construction.

Less difficult to interpret but much less useful than draft gages are thermometers or pyrometers. The difficulties in using pyrometers are those only of placing the bulbs or couples in the proper places so that the indication may be a true one of the condition investigated.

Gas-analysis instruments, while highly necessary for more refined investigations, are so seldom used by operators of plants of the middle or smaller size that as a general proposition it is useless to place them in the operating engineer's hands. The writer strongly endorses the use of coal-weighing and water-measuring systems.

The great difficulty with the subject is that, however useful the instrument may be, the supervising or engineering forces of boiler plants neglect to employ them to an extent their value justifies. The conclusion is inevitable that they should be few in number but of the recording type rather than indicating alone. The reason is that a record affords the opportunity of not only checking up the operating performance while going on, but gives the managerial forces the opportunity of checking up the operating engineering forces.

WALTER E. BRYAN. When a number of boilers are connected to the same stack, it is particularly advisable to have each boiler equipped with a draft gage so that the gas passages can be regulated in the individual boilers, with the result that more work will not be required of some boilers than others. Steam-flow meters are also advisable in stations where turbines are used and the flow is not pulsating. Readings of stack temperatures, CO_2, etc., should be taken to at intervals, the latter with a view to calling attention to leaks in settings, etc. A recording CO_2 instrument arranged with connections to the various boilers is a valuable adjunct to the fireman.

B. J. DENMAN. I believe the most useful instrument in the boiler room to be the one which indicates the percentage of CO_2 in the flue gas. In larger stations, with boilers of 1000 hp. or more, an automatic CO_2 recorder is justified. In smaller units, each boiler should be equipped with a gas collector and the Orsat apparatus, to determine the percentage of CO_2. Samples should be analyzed at least once during each watch. We regard the steam-flow meter as essential and as important an instrument as an ammeter or a wattmeter on a generator, and even more important from an efficiency standpoint. It is important that efficiencies of all the boilers be known over a wide range of loads and that they are operated at the most efficient point. It is not of much value to determine the efficiency curve unless its indications are followed, and this can only be done by the use of a steam-flow meter. These will show not only the number of boilers to have in service, but the division of the load between the units. With the underfeed type of stoker, we believe it is necessary to have instruments indicating the draft over the fire and at the damper, as with this type of stoker practically balanced draft can be carried, and this is the furnace condition which is most conducive to conomy, through a reduction in the infiltration of air. Flue-gas-temperature recorders are desirable, but not essential, as the release temperature will take care of itself, if the boilers are kept clean and operated at the most efficient point, except for short periods during the peak.

A. G. CHRISTIE. Our university plant contains Babcock & Wilcox boilers and Taylor stokers with steam-pressure regulation on the blast and a balanced-draft system on the flue-gas damper. We have found that the instruments which receive the attention of our firemen and enable them to obtain the best results are draft gages on the blast and over the fire, a pyrometer in the breeching and a CO_2 recorder. The latter takes much skilled attention but produces results. We have been experimenting with a new blast regulator which promises to give better results than the usual type. Steam meters combined with coal-weighing devices are most desirable additions to the plant. Then records of coal and water consumed can be posted daily for the information of the fireroom shifts.

C. E. VAN BERGEN. We regard the draft gage as necessary on every boiler. It is not possible for a fireman to know what amount of air is passing through or over his fires, by simply looking at them. A steam-flow meter is valuable in showing the output of each boiler and all plants, except small ones, should have a continuous record of CO_2.

It is our belief that any plant expending $5000 or more per year for fuel cannot afford to be without these instruments. The draft gage has shown us that we formerly did not have proper adjustment of stack damper and ashpit door. The steam-flow meter has given us valuable information on our monthly and yearly output and the flue-gas analyzer shows us the result of careless firing.

WOOD AS FUEL

ROBERT H. KUSS. The writer's experience includes the burning of wood refuse coming from kiln-dried manufacturing operations of both hard and soft wood and "hog stuff" produced at logging mills in northern Minnesota. Kiln-dried wood refuse when burned alone constitutes no particularly difficult problem. If a sizable proportion is sawdust or planer shavings this material must be burned in a complete firebrick furnace, the fuel being introduced by gravity, and most of it being burned in suspension with very little air from the ashpit.

Where coal and wood refuse are burned together, difficulty is encountered if the major portion of the fuel is sawdust. Planer shavings in large quantities set up extremely difficult conditions. In any event, the combination of fuels must be burned in a complete firebrick furnace, so that the sawdust portion may be burned in suspension.

When "hog stuff" is produced from bark, edgings, etc. (as is the case in lumber-producing mills), it is best burned in a complete firebrick furnace where the fuel is introduced so as to form cone heaps over the grate surface, very little air being introduced by way of the ashpit, and the fire being most brisk at the grate surface around the edges of the cones.

ALBERT A. CARY. I have had to handle wood as a fuel under a wide variety of conditions which have called for different constructions in furnaces, as wood from a lumber camp, where undesirable tree trunks, boughs and branches were burned; in saw mills where the fuel was labs, edgings and sawdust; in wood-pulp mills where the wood refuse was burned; in woodworking establishments where the fuel was the refuse from the saws, planers and other wood-working tools.

It must be remembered that fully one-half the weight of the wood is found in the volatile gases passing off during the process of combustion. With properly designed furnaces, the greater part of the air required for the combustion of these gases can be made to pass through the grates and fuel bed, where they become warmed to such an extent that they will not suppress the combustion of the gaseous portion of the fuel in the combustion chamber. An ample and well-designed combustion chamber is also essential to obtain efficient results.

Two objections commonly offered to the use of wood fuel are the production of objectionable smoke, and danger from fire due to burning firebrands ejected from the chimney. With a properly designed and operated wood-burning furnace, however, the smoke nuisance can be so reduced as hardly to constitute a nuisance, and I have found no difficulty in stopping the trouble from sparks and hot cinders by using cinder screens enclosing the top of the chimney.

Heating Value of Wood Fuel

In the boiler-test code of the Society we have been instructed to regard 1 lb. of wood as equivalent to 0.4 lb. of coal; or, in other words, 2½ lb. of wood are equivalent to 1 lb. of coal.

The value of *dry* wood used as a fuel may be slightly greater or considerably less than this equivalent of bituminous coal, according to the design of furnace used and the manner in which the fire bed and its air supply are handled. The percentage of moisture carried materially affects the heating value of wood fuel, and therefore it is most desirable to have the wood as dry as possible.

Wet fuel, however, must often be used, and I have burned pulp-wood chips or shavings running as high as 30 to 40 percent. in moisture. Such very wet wood fuel must be burned in a reverbatory furnace with a heavy bed of burning fuel maintained, to dry the moist wood rapidly as it is fed continuously into the furnace.

Newly cut wood contains a large percentage of moisture, which varies in the different varieties of wood, but from one-third to on-half of this moisture will disappear if the wood is air-dried from six to twelve months.

Examples of Successful Wood-Burning Furnaces

In burning forest wood such as trunks, boughs and branches, I have found that much better results could be obtained with a wide furnace than with a long, narrow furnace in which wood is charged lengthwise through a front opening. With the long furnace it is difficult to maintain a good level fuel bed and have the grates evenly covered. I have obtained the best results for such fuel with a furnace about 5 ft. wide and 7 ft. deep. This had a charging door, running across the width of the furnace and about 12 in. high, which lifted vertically above the dead plate along the outer face of the front wall, being counterweighed and properly balanced, and the door was perforated with a number of ½-in. holes to admit and evenly distribute small streams of air over the fire bed.

The cut lumber was piled in front of the door so that it lay lengthwise, running from one side wall to the other. When the door was lifted the lumber, thus arranged, was pushed over the dead plate on to a grid of sloping grate bars dropping downward at an agle of about 30 deg. At the lower end of these sloping grates and about 18 in. from the bridge wall, I arrange another grid of sloping bars, dropping down from the bridge wall at an angle of 45 deg., thus forming a V-shaped grate surface having a long and a short leg.

With this arrangement, the lumber was rolled or shoved down the bars from the dead plate in such a manner as to maintain a fairly thick and more or less compact fire bed over the lowest position formed by these sloping grates and very little difficulty was found in keeping the upper end of the grates (nearest to the door) covered with fuel. The charging door was kept open for the shortest possible time.

I designed and installed some very successful furnaces, built on the same general lines, for a large manufacturer of wooden cars, near Buffalo. The grates (under water-tube boilers) were placed a short distance above the floor level, thus obtaining a very high combustion chamber. An ashpit was excavated about 24 in. below the floor level with a trench along the outer face of the boiler fronts through which air entered. This trench was covered with removable plates in front of each of the large lifting charging doors to permit easy cleaning of the ashpits.

The refuse from the woodworking shops was delivered to the boiler room through chutes and consisted of large and small pieces, chips, shavings and sawdust. The fireman piled the refuse in front of the upward-sliding doors, which were balanced in order to operate easily. When the doors were opened the fuel was shoved in quickly upon the large flat grate surface and the doors immediately closed. Two boilers, of about 200 hp. each, were operated in this manner most successfully.

In another woodworking shop in the west, manufacturing furniture, I supervised the installation of another form of wood-burning furnace placed under water-tube boilers.

Here the boilers were set very high above the grate surface and the wood refuse was continuously spouted down tubelike pipes, shooting into the furnace directly through the boiler fronts and landing upon the fuel bed below. A supplementary fire of coal was maintained upon the grates, and thus the plant obtained an ample supply of steam.

I do not know who was the designer of this system, but I protested against its installation on account of danger from fire running back along the wood-conveying spouts. About two years afterwards this plant burned and there was some question raised as to whether or not the cause was due to this system of feeding wood refuse to the furnace.

I have designed and supervised the installation of several different forms of extension furnaces for burning wood refuse, which have given satisfaction. Some of these have their fuel charged through top openings in the covering arch, above the grate bars. The principal defect in this type of furnace is the pyramiding of the fuel on the grates directly below the stoke holes. This can be overcome to a large extent by building up a grate construction under the stoke holes, shaped like a pyramid. This insured a good penetration of air throughout the entire fuel bed and did away largely with the poking necessary to free up the other form of fuel bed.

Grateless Furnace For Wood Burning

One of the most successful forms of wood-burning furnaces for woodworking shops that I have installed is a grateless furnace similar in its general form to the well-known bee hive type of coke oven. It is circular in shape, with a semi-spherical, dome-like cover over the top. I owe my first conception of this type of furnace to my friend, the late F. W. Edwards of the Standard Oil Company, who was deeply interested in the study of furnace equipments.

In this furnace the refuse wood is first run through a disintegrator, consisting of a disk having heavy knives inserted near the circumference of one of its faces. This disk is revolved at a high rate of speed inside of a casing, the larger pieces of wood refuse being fed into the disk chamber.

Thus the size of the wood is reduced until it is small enough to be carried by an air blast through conducting tubes. The end of these conveying tubes terminate in a centrifugal separator head, where the greater part of the air used for flotation is discharged. The wood refuse is then dropped through a tube from the bottom of the separator, accompanied by air under sufficient pressure to project the fuel into the furnace.

The wood passes into the furnace in a tangential direction, which causes it to travel around the circular face of the round furnace, and with the very high temperature maintained the wood ignites and burns very rapidly, somewhat after the manner in which pulverized coal is burned.

An opening, running in a normal or radial direction out of one side of the circular furnace, carries the burning gases directly into the firebox chambers of adjoining boiler settings.

A slowly burning fire bed of coal is maintained upon the grate bars of the boiler furnace and the combustible gases burn rapidly above this coal fire bed, without smoke production, and by this means the most efficient results are obtained from the wood refuse.

In case the supply of wood refuse gives out a damper is closed between the wood furnace and the boiler furnace and the boilers are operated in the regular manner with coal.

I have designed several variations in the construction of this type of furnace and in one case I fed wet spent licorice root down through the top of the furnace while operating the furnace proper in the way described above, with wood refuse from a large neighboring box shop.

A. G. Christie. At a recent meeting of the Baltimore Section of the society Henry Adams stated that he had burned wood on several occasions in furnaces designed to use soft coal and had obtained satisfactory results. However, only about 60 per cent. of the rated boiler capacity could be obtained under average conditions. Another local member stated that he had found it advisable to lower the bridge walls when using wood in furnaces designed for coal.

COAL ECONOMICS IN SMALL PLANTS

E. H. Kearney. We would be lacking in the gift of foresight if we allowed ourselves to be lulled into the belief that at the present time, by virtue of existing conditions, a form of fuel conservation hysteria were sweeping over the country and that at the termination of a few months or a few years a return would be had to normal conditions—and to normal conditions is meant a relapse to pre-war price, production and consumption. In all probability, not in our day and generation will we again see the time when the commodities which enter into power- plant operation can be secured with the same facility which obtained previous to the present tightening-up-all-around period.

This is a thought which should occupy our minds to the exclusion of lesser things in dealing with present and future power plant conditions—we as engineers are the nation's fuel conservators.

In order to bring about the best possible efficiency in the plant the operating engineer should, figuratively speaking, "camp" in the boiler room. Not a single detail of its operating conditions should escape his personal attention—methods of firing, condition of fires, leaks in settings, adjustment of draft, temperature of feed water and condition of feed pumps are but a few of the many things which should engross his attention. In short, the engineer does well who keeps constantly in mind the truth of the old adage, "If you want a good job done, take pains to do it yourself."

For several years preceding the war period there was a growing tendency upon the part of owners and engineers of medium-sized plants to install apparatus in the boiler room by which a closer check could be had upon fuel consumed, water evaporated, quality and temperature of gases, etc. Larger plants were equipped with these aids to economy as a matter of course, and the beneficial results which attended the operation of these more modern systems had set a worthy example for less pretentious plants to follow.

If increasing scarcity and cost of fuel had been the only factors to be dealth with, it is easily seen that firms dealing in scientific power-plant apparatus would have been swamped with orders. Had prices and delivery remained a fixed quantity, there would have been a scramble on the part of engineers of smaller plants to obtain apparatus which during the 24-hour period would enact the part of watch dogs of the coal pile.

But while war conditions brought about a scarcity and soaring price of fuel, they also affected the apparatus manufacturer in like degree, with the result that the modest plant owner found himself between two fires; either to install checking apparatus at a tremendously increased cost, provided he could secure it at all, or to continue under the old order of things by obtaining the best results possible with what had had in hand. Right here is presented a problem for the plant owner who is interested not only in the matter of his own fuel costs, but in the larger scheme of national fuel saving as well.

There is no question but that many plants which are now being operated without adequate provision for bookkeeping the cost checking could make a decided improvement in the appearance of the monthly balance sheet without the expenditure of extravagant sums. It should be the ambition of every power-plant owner and engineer to ascertain beyond reasonable doubt, through the medium of practical expert advice if necessary, whether or not his plant is being operated under conditions which square with good practice.

Reduced to its lowest terms the whole fuel problem as far as we engineers are concerned is just this: *Vountary* fuel saving there *should be;* if not, *compulsory* conservation there ***must*** be. We as engineers must accept as a duty our share in the great task which now confronts the nation.

D. C. Faber. The possibility of improvement in boiler-room equipment and firing methods in small steam plants was very forcibly impressed upon engineers connected with the fuel-conservation work done in Iowa under the direction of the Fuel Administration last winter. In connection with this work, combustion conditions were investgated in about one thousand small steam plants, for the purpose of determining what could be done to improve boiler-room efficiency. While it is not possible to enumerate here the conditions found, there are a number of faults which are common to most plants of this type. In many of these plants the firemen have other duties which take them away from the boiler room for the great part of the time, so that firing instead of being a principal duty becomes merely an incidental one. Under such conditions the firemen usually do about all that is expected of them, which is to shovel enough coal from the pile into the furnace to keep up steam regardless of how or when this is done, so that carrying too thick a fire, firing too large quantities at one time ,and failure to regulate fire with damper in uptake are common faults. Air leaks in boiler settings, bare steam pipes and failure to remove soot and scale at frequent intervals account for a large percentage of the fuel losses in such plants.

Many of these faults can be done away with only through education of owners and operators. Right now, on account of the general interest in fuel economy is the time to start such educational work. Supervision under direction of the Fuel Administration could well be a part of such educational work. Results can be secured now in the small plants which would be impossible under other circumstances.

Geo. H. Diman. One of the best ways to save coal is to save the heat units. This can be done in many ways. First, be careful not to have the rooms in the manufacturing plants overheated. Do not allow steam on in rooms with windows open. This summer, see that all the window frames are properly pointed so as to admit no cold air. If operating dye-houses, utilize all the available heat units in the dyehouse and finishing departments.

Let me illustrate what I mean. In one of our large mills, some years ago, the dyeing and finishing departments got behind with their work. In order to get the goods into the market we stopped the mill, running nothing but the dyeing and finishing departments. When the mill was running full we used about 6000 hp. and burned 1000 tons of coal per week. This power was generated by two pairs of cross-compound engines sacrificing on the vacuum, and keeping the discharge water in the condensers at 110 deg. All this water was stored in the finishing department in tanks for washing the goods.

A simple engine of 2400 hp. furnished exhaust steam for use in dyeing.

When we ran two weeks with only the dyehouse and finishing room we used direct steam, and ran only one engine. It took 275 hp. to turn the shafting of the dyehouse, and we burned 775 tons of coal per week.

It will be seen that the first case, where the heat units were utilized as far as possible, we got 6000 hp.; while in the other case, where direct steam was used, we got only 275 hp. and burned three-quarters as much coal as before.

B. J. Denman. It is our belief that even in large plants, insufficient attention is paid to intelligent operation of the various boiler and engine units. Efficiency curves of boilers, engines and turbines should be made, and the units operated at their most efficient point. Great savings are possible in many plants if this is done.

One point frequently overlooked is the temperature of the hotwell in condensing units. The amount of circulating water pumped should be varied with the temperature of the circulating water, and the temperature of the hotwell kept as near that corresponding to the vacuum as possible, to reduce the heat loss to the circulating water.

A. G. Christie. This question was discussed informally at one of the meetings of the Baltimore Section last winter. It was pointed out that inefficiency in small plants was generally due to the following causes:

a Practically all horizontal return tubular boilers in the Baltimore district have been set too close to the grates owing to the fact that a local concern cast boiler fronts from a pattern which allowed only about 20 in. between boiler and grate surface. This had beeen increased in several cases to 6 ft. with decidedly satisfactory results.

b Air infiltration through cracks in the setting.

c Failure to keep the heating surfaces clean.

d Improper firing methods.

It was pointed out that economies could be secured by:

a Offering a bonus for coal saved.

b Keeping careful records of coal used and posting these.

c Providing a sufficiently large combustion space over the grates.

d Insisting on clean tubes.

e Using prepared mixtures to make the setting airtight. Several are on the market. The settings must be inspected periodically to see that they are kept tight.

f Elimination of steam leaks through joints, faulty traps, etc.

Carl J. Fletcher. The question as to coal economics that can be effected in small steam plants in the aggregate is one of the most important questions asked. The fuel cost in these plants is too small to permit the proper expert supervision and the posibility of saving much greater than in the larger plants. After an examination of a great many small plants, I have two suggestions to offer which would result in a very great saving:

Most plants clean the inside of their boilers well; but it is my observation that when soot is removed by hand blowing (done at night when the pressure is low), it is one of the most neglected jobs around the boiler room. Automatic soot blowers should be installed and should be used several times a day.

One other possible saving is in the use of the damper on the individual boilers. Plenty of advice has been given regarding this feature, but I find in most plants that the dampers are inconveniently placed, and often not in real operating condition. As the first, step, the plant management should insist that dampers are in good condition, equipped with levers which are within easy reach of the firemen. The damper should be easily controlled by means of a proper handle, placed where the fireman would not have to walk behind boilers to reach it.

P. W. Thomas. Economies approaching 50 percent. of the requirements in small steam plants of, say, 200 to 500 hp. can often be effected by simply putting the plants in shape. We have a record of one plant using 22 tons daily which now uses 11 tons, and the owners bought no fuel-saving equipment except fire-brick, baffle brick, asbestos and fireclay. The 11 tons were saved by the proper education of the men in the boiler room.

Walter E. Bryan. Probably the greatest loss in such plants is due to dirty boilers, improper firing and handling of dampers. If this fact, together with the remedy, could be placed in the hands of the managers of industries who are operating small plants, considerable saving would result.

C. E. Van Bergen. As long as the war lasts, no plant using coal for generating steam or for heating purposes can be considered too small to require the careful attention of some one within the organization.. Fuel must be saved, no matter how small the quantity, and this is just the point which must be emphasized: "Every plant must save some coal." And along with this is another thought that unless each one of us saves, we may experience a worse coal shortage next winter. And each of us should preach coal saving on all occasions.

NATURAL GAS AS A FUEL FOR POWER PURPOSES

Samuel S. Wyer. The natural gas industry is in a transition stage, changing from the large-volume, how-price-per-unit basis, to the relatively small-volume and larger-price-per-unit basis. The reasons why natural gas cannot and ought not to have an extensive use of steam-boiler work in the future may be enumerated as follows:

a The number of domestic consumers, now over 2,363,000, is increasing much faster than the number of producing wells.

b The initial production and the routine available production coming in are much lower than for wells that came in five years ago. This is due to the general depletion of existing fields, and the extensive underground drainage from past production.

c New fields are not being discoverd fast enough to replace the rapidly declining present supplies.

d The general shortage of coal for domestic heating in the past and the inevitable continuance of this condition for some time in the future, at least during the period of the war, has placed enormous additional demands for domestic heating on the natural-gas resources where natural gas is now and will be used in lieu of solid fuels for heating homes.

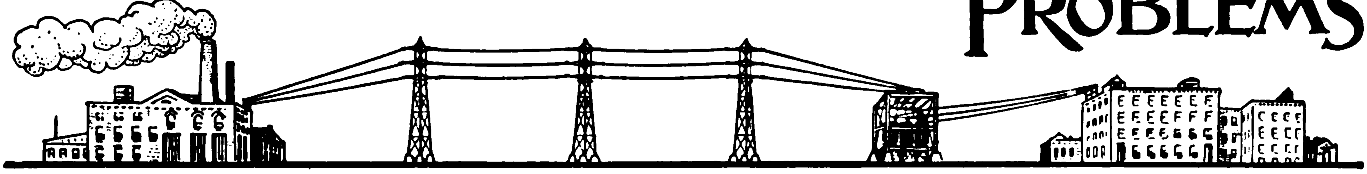
Natural gas is preeminently a domestic fuel. Its high heating value, practically twice that of any manufactured gas available, its purity, and ease in handling make it the premier fuel for home use. While low-grade solid fuels can be efficiently used under steam boilers with proper stoking equipment, they cannot be satisfactorily or efficiently used for house heating. For this reason it is a matter of conservation to use the fuel for domestic service that in the long run will yield the greatest good to the greatest number.

The tests recently made in the Home Economics Department of the Ohio State University on cooking various meals with natural gas, soft coal, coal oil, gasoline and electricity, show conclusively that natural gas is by far the cheapest fuel for the domestic consumer's use for cooking. Thus, in cooking a dinner for six people, the total fuel costs, with natural gas at 40 cents per 1000 cu. ft., soft coal at $6.50 per ton, coal oil at 15 cents per gallon, gasoline at 27 cents per gallon, and electricity at 3 cents per kw.-hr., were substantially as follows:

Natural gas	0.88	cents
Soft coal	2.5	cents
Gasoline	4.6	cents
Electricity	5.0	cents
Coal oil	5.4	cents

The rendering of domestic natural-gas service is a public-utility business. Practically all of the states where natural gas is now produced and sold have public-utility commissions with broad powers in matters of rate regulation and quality of service. The general tendency, and the one that is in accordance with sound public policy, is to give the domestic consumer first preference and curtail the consumption of natural gas for industrial purposes.

POWER PLANT, LINE AND DISTRIBUTION PROBLEMS



A Record of Successful Practice and Actual Experiences of Practical Men

REWINDING AND RECONNECTING DIRECT CURRENT ARMATURES FOR A CHANGE IN VOLTAGE

By T. Schutter

The windings under discussion in the July issue were all wound with one wire in hand and were called "simplex" windings. The windings discussed in this article are wound with two wires in hand and are known as "Duplex" windings. The same results can be accomplished by winding two windings, using one strand (two simplex windings) at a time. In a winding of the duplex type there are usually twice as many commutator bars as there are slots, and each of the two wires is connected to separate bars. The brush, however, will cover at least 1½ to 2 commutator bars, as shown in Fig. 6, which is the winding and connection for a 120-volt lap-wound armature.

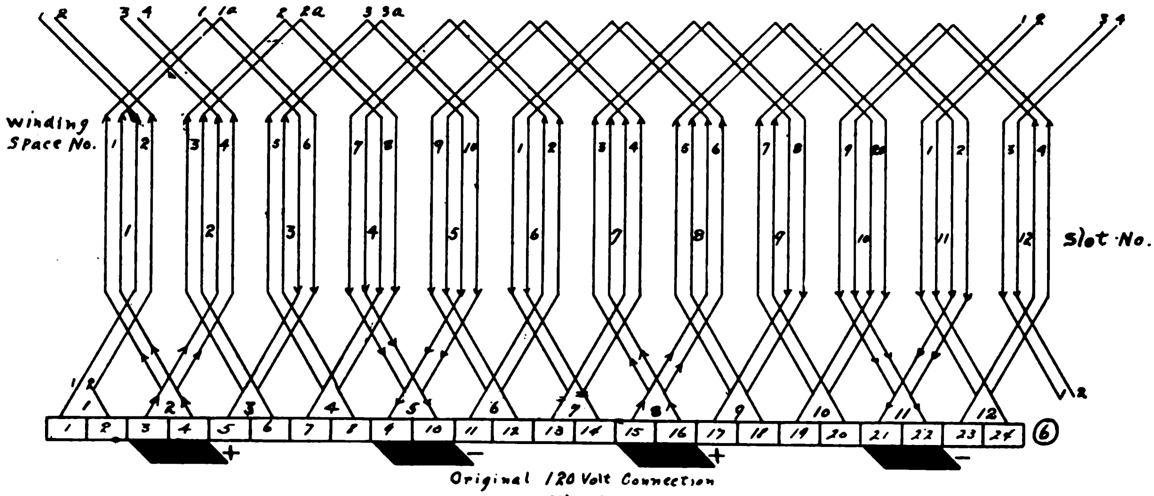


Fig. 6.

The reader should bear in mind that each coil will consist of two parts, which will be called Section 1, and 1a, Section 2 and 2a, Section 3 and 3a, etc. The following is the winding table for Fig. 6.

Coil No.	Wound in Spaces No.	In Slots No.
1—1a	1 and 6	1 and 3
2—2a	3 and 8	2 and 4
3—3a	5 and 10	3 and 5
4—4a	7 and 12	4 and 6
5—5a	9 and 14	5 and 7
6—6a	11 and 16	6 and 8
7—7a	13 and 18	7 and 9
8—8a	15 and 20	8 and 10
9—9a	17 and 22	9 and 11
10—10a	19 and 24	10 and 12
11—11a	21 and 2	11 and 1
12—12a	23 and 4	12 and 2

The connecting table for Fig. 6 is as follows:

Start of Coil No.	To Bar No.	End of Coil No.	To Bar No.
1	3	1	5
1a	4	1a	6
2	5	2	7
2a	6	2a	8
3	7	3	9
3	7	3	9
3a	8	3a	10
4	9	4	11
4a	10	4a	12
5	11	5	13
5a	12	5a	14
6	13	6	15
6a	14	6a	16
7	15	7	17
7a	16	7a	18
8	17	8	19
8a	18	8a	20
9	19	9	21
9a	20	9a	22
10	21	10	23
10a	22	10a	24
11	23	11	1
11a	24	11a	2
12	1	12	3
12a	2	12a	4

As previously stated, this winding is wound to operate on

120 volts. It is to be changed so that it can be operated on a 240-volt circuit.

As seen in Fig. 6, Sections 1 and 1a of coil 1 are connected in parallel through the brush connections, and by changing the connections so that Sections 1 and 1a will be in series instead of in parallel, it will then be possible to operate the winding on a 240-volt circuit.

The winding table for Fig. 7 will be the same as for Fig. 6, but the connecting table will be as follows:

Start of Coil No.	To Bar No.	End of Coil No.	To Bar No.
1	1	1	2
1a	2	1a	3
2	3	2	4
2a	4	2a	5
3	5	3	6
3a	6	3a	7
4	7	4	8
4a	8	4a	9
5	9	5	10
5a	10	5a	11
6	11	6	12
6a	12	6a	13
7	13	7	14
7a	14	7a	15
8	15	8	16
8a	16	8a	17
9	17	9	18
9a	18	9a	19
10	19	10	20
10a	20	10a	21
11	21	11	22
11a	22	11a	23
12	23	12	24
12a	24	12a	1

The brushes used on Fig. 7, should only be as wide as one commutator bar. By tracing the current through the winding in Fig. 6, it will be seen that there are three coils in series in each of the paths or circuits from the positive brush to the negative brush. In Fig. 7 there are six coils in series in each path or circuit, or twice as many as before the reconnection.

If the winding in Fig. 6, had been connected to a 12-bar commutator instead of a 24-bar commutator, the reconnecting from 120 volts to 240 volts would have been somewhat different.

In Fig. 6 the numerals from 1 to 12, which are placed above and between each two bars, will give the reader an idea of how the connections would look. For instance, Sections 1 and 1a of coil No. 1 would be connected across bars Nos. 2 and 3, instead of Section 1 to bars 3 and 5, and 1a to bars 4 and 6.

Then to reconnect the winding from 120 volts to 140 volts when only 12 commutator bars are used, Sections 1 and 1a of coil No. 1, would have to be connected in series, but not through commutator connections as in Fig. 7. By omitting the connections of commutator bars No. 2, 4, 6, 8, and 10, etc., and simply splicing the end of Section 1 to the beginning of Section 1a of

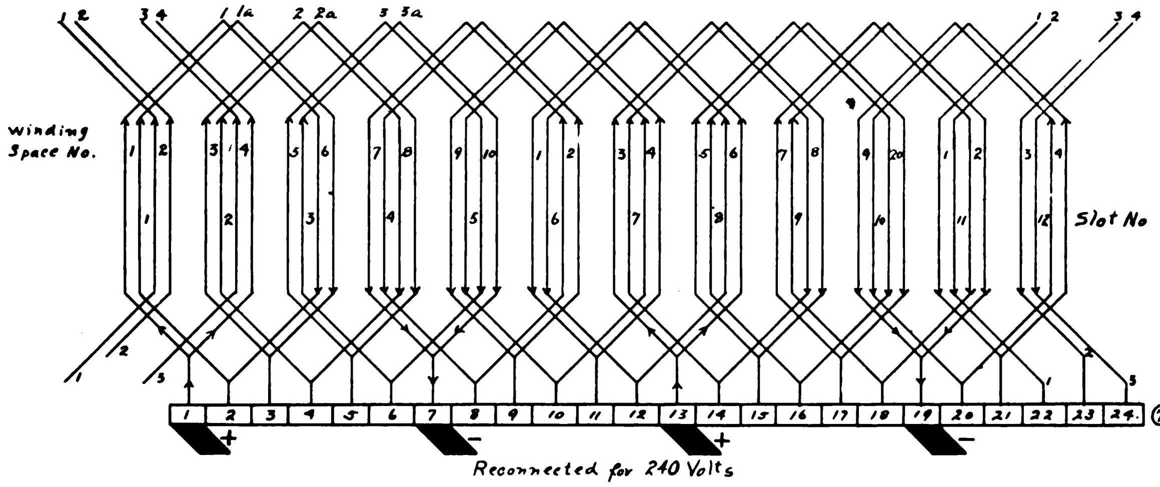


Fig. 7.

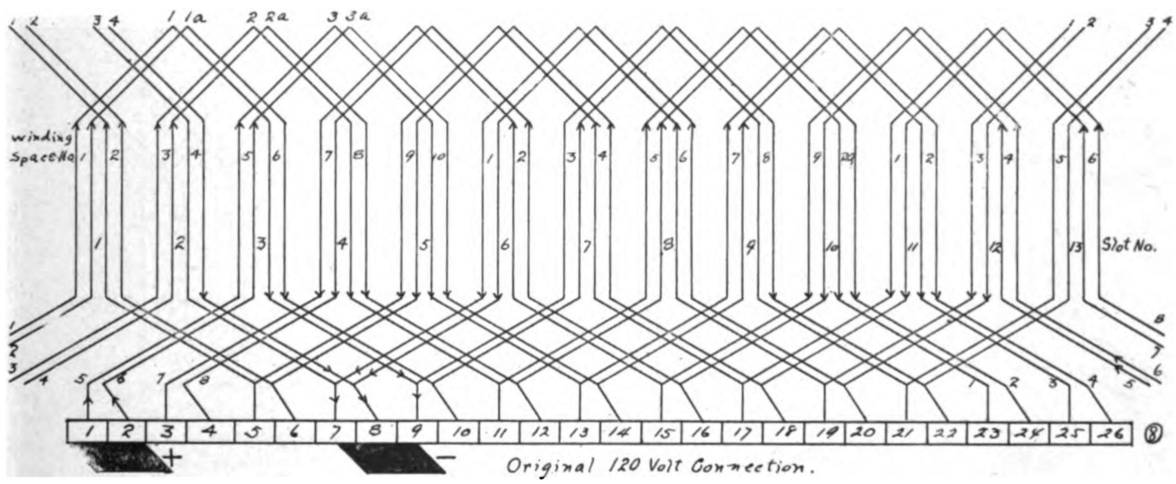


Fig. 8.

coil No. 1, the same results will be obtained by using only 12 commutator bars.

Fig. 8 is a "duplex wave" winding for operation on a 120-volt circuit. This winding consists of 13 coils wound with 2 strands of wire and is connected to 26 commutator bars. This winding could also be connected to a 13-bar commutator.

The winding table for Fig. 8 is as follows, each coil being considered as two Sections, 1 and 1a.

Coil No.	Wound in Spaces No.	In Slots No.
1 and 1a	1 and 6	1 and 3
2 and 2a	3 and 8	2 and 4
3 and 3a	5 and 10	3 and 5
4 and 4a	7 and 12	4 and 6
5 and 5a	9 and 14	5 and 7
6 and 6a	11 and 16	6 and 8
7 and 7a	13 and 18	7 and 9
8 and 8a	15 and 20	8 and 10
9 and 9a	17 and 22	9 and 11
10 and 10a	19 and 24	10 and 12
11 and 11a	21 and 26	11 and 13
12 and 12a	23 and 2	12 and 1
13 and 13a	25 and 4	13 and 2

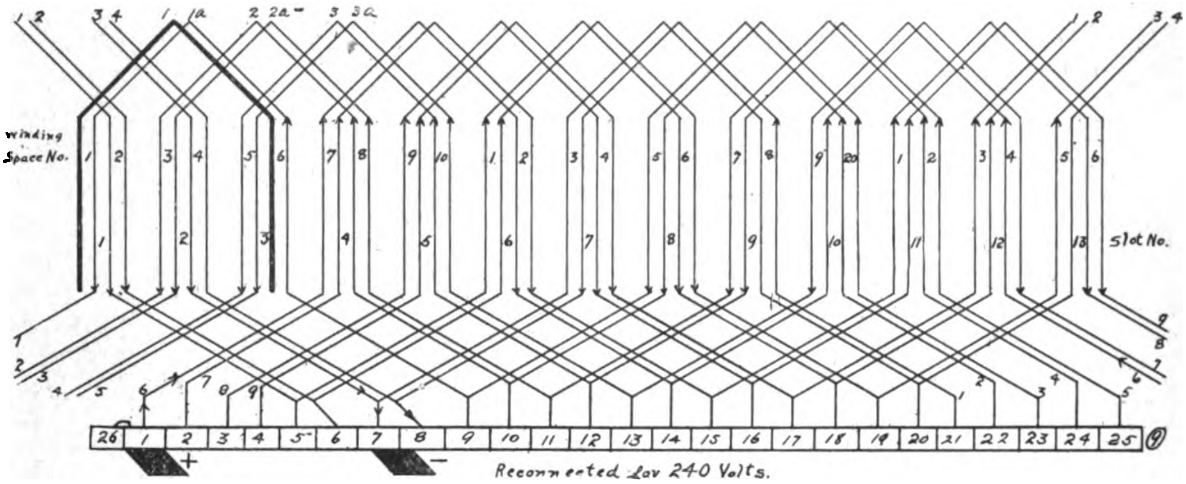


Fig. 9.

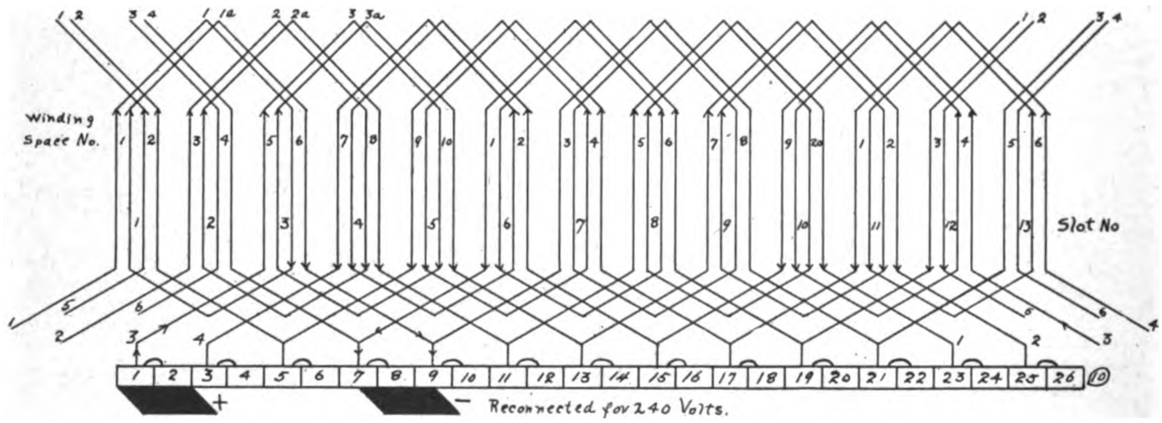


Fig. 10.

The following is the connecting table for Fig. 8.

Start of Coil No.	To Bar No.	End of Coil No.	To Bar No.
1	23	1	9
1a	24	1a	10
2	25	2	11
2a	26	2a	12
3	1	3	13
3a	2	3a	14
4	3	4	15
4a	4	4a	16
5	5	5	17
5a	6	5a	18
6	7	6	19
6a	8	6a	20
7	9	7	21
7a	10	7a	22
8	11	8	23
8a	12	8a	24
9	13	9	25
9a	14	9a	26
10	15	10	1
10a	16	10a	2
11	17	11	3
11a	18	11a	4
12	19	12	5
12a	20	12a	6
13	21	13	7
13a	22	13a	8

The winding as it is now placed and connected will operate on a 120-volt circuit. It is desired to change it so that it will operate on a 240-volt circuit.

There are two methods by which this can be accomplished.

The first is shown in Fig. 9. In this Fig. it will be seen that Section 1 of coil 1 is dropped; that is, it is not connected to the commutator. This may be done so that a rule in wave windings can be complied with. Instead of connecting the different sections of a coil in parallel through the commutator and brush connections, they are now connected in series in the same way.

The connecting table is as follows:

Start of Coil No.	To Bar No.	End of Coil No.	To Bar No.
1a	21	1a	9
2	22	2	10
2a	23	2a	11
3	24	3	12
3a	25	3a	13
4	1	4	14
4a	2	4a	15
5	3	5	16
5a	4	5a	17
6	5	6	18
6a	6	6a	19
7	7	7	20
7a	8	7a	21
8	9	8	22
8a	10	8a	23
9	11	9	24
9a	12	9a	25
10	13	10	1
10a	14	10a	2
11	15	11	3
11a	16	11a	4
12	17	12	5
12a	18	12a	6
13	19	13	7
13a	20	13a	8

It will be seen that bar Nos. 26 and 1 are bridged and are acting as one bar. This is due to the dropping of Section 1 in coil No. 1 for reason given above.

By tracing the flow of the current from the positive to the negative brush in both Fig. 8 and Fig. 9, will be found that there are twice as many coils in series in Fig. 9 as there are in Fig. 8. It is, therefore, possible to operate Fig. 9 on a 240-volt circuit.

The other method of reconnecting Fig. 8 so as to operate it on a 240-volt circuit is shown in Fig. 10. The coils in this Fig. have been placed the same as in Figs. 8 and 9, therefore the winding table will be the same. The connecting table is as follows:

Start of Coil No.	To Bar No.	End of Coil No.	To Bar No.
1	23	1a	9
2	25	2a	11
3	1	3a	13
4	3	4a	15
5	5	5a	17
6	7	6a	19
7	9	7a	21
8	11	8a	23
9	13	9a	25
10	15	10a	1
11	17	11a	3
12	19	12a	5
13	21	13a	7

From the above connecting table it will be seen that the end of Section 1 is connected to the beginning of Section 1a or, in other words, the two sections of a coil, which were in parallel with one another in Fig. 8 are now connected in series.

As was explained in the previous article, the number of turns per coil will be directly proportional to the voltage. In Fig. 8, assume that there are 20 turns per coil with 2 wires in parallel. By reconnecting as in Fig. 10, there will be 40 turns per coil, using one wire. From this it will be seen that while there are 13 coils in each winding Figs. 8 and 10, one has twice as many turns per coil as the other. This fact makes it possible to operate Fig. 10 on a 240-volt circuit.

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HELPING TO WIN THE WAR

The Colonial Power & Light Company and the Claremont Power Company are doing everything possible to release able men for military service.

Wherever possible, crippled men have been given the preference and work has been found to suit them. At the power house in Cavendish one of the load dispatchers is a man with only one arm. It is found that he is able to perform his duties fully as well as though he had both arms. In the power house in Claremont, it is found that a lame man makes an efficient operator.

Both of these companies have taken the employment of women into consideration. One is acting as load dispatcher in Cavendish and another is employed reading meters in Claremont and Springfield. Both have given complete satisfaction, and the companies no longer fear employing them on the grounds of inefficiency.

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PUBLIC UTILITY RATES

Over six months ago when it became apparent that increases in rates, being granted by the state public service commissions, would in themselves not enable public utility companies to continue their operations, and after this fact had been recognized by the authorities at Washington, who appreciated their vital importance for the prosecution of the war, the War Finance Corporation bill was drafted to meet this emergency. It now develops, after the final passage of the Act, that the various amendments to the bill, as interpreted by the Directors of the Corporation, render it ineffectual as far as meeting an emergency situation is concerned. O. B. Wilcox, of the firm of Bonbright & Company, in a recent letter says:

"It is apparent that the continued and increasing efficiency, and, consequently, the solvency of the public utilities of the country, are essential to the prosecution of the war. The inability of the utilities to meet their maturities and to respond by expansion to the unusual industrial demands for motive power and transportation is not due to anything inherent in that industry, but is due to two conditions altogether resulting from the war, namely:

(a) Increases in all the elements entering into the costs of operation, including materials, labor and capital, with the possibility of further increases which may outrun the obtainable increases in rates.

(b) The government financial operations monopolizing to a large extent the activities and resources of bankers and making large demands upon the investment funds of the country.

These two conditions are war conditions, brought about entirely by the war and must be considered and treated in relation to the war.

The assumption by the government, or an agency co-operating with the government, of the war risks incident to public utility operation and finance, assuring the banks and the investing public of the recognition of the essential character of public utilities and the intention of the nation to preserve both their efficiency and their solvency, should, by reestablishing confidence in sound public utility securities, open the investment funds of the country to much of the necessary public utility financing. * * * * * * * * * The President has said that "it is essential that these utilities should be maintained at their maximum efficiency and that everything reasonably possible should be done with that end in view." The bankruptcy of public utilities, otherwise solvent, but unable through conditions solely resulting from the war to finance their maturities and maintain their efficiency, would be a national disaster because it would seriously impair the ability of the country to prosecute the war. Of course, increases in public utility rates for service commensurate to the increased costs of operation are necessary as an incident to any solution of the present conditions."

CONSERVATION OF POWER AND LIGHT

By Charles E. Stuart

Chief of Power and Light Division, United States Fuel Administration

General plans have been laid out for the conservation of light and power by the Bureau of Conservation of the United States Fuel Administration, of which P. B. Noyes is Director, and these plans will be carried out by the Power and Light Division. They will be developed under the following subdivisions:

1. Elimination of uneconomical isolated plants.
2. The application of the Skip-stop to railways and the regulation of car heating and lighting.
3. Economy in utilization of power and light in factories.
4. Utilization of excess water power and interconnection of power systems.
5. Limiting the production of power to the most efficient plants available.

A brief statement with respect to each of these subdivisions is developed below.

The plans will be carried out through the cooperation of the following:

First.	A force of engineers organized and stationed with the Fuel Administration at Washington.
Second.	The engineering department of the United States Geological Survey.
Third.	The power division of the Council of National Defense.
Fourth.	A state fuel engineer attached to the office of the State Fuel Administrator, to supervise the activities in his state.
Fifth.	The public service commissions and State regulatory bodies.
Sixth.	The chambers of commerce, and similar representative business bodies.
Seventh.	Volunteer engineers located throughout the country.

The following gives the scope of the subdivisions:

Elimination of Uneconomical Isolated Plants

The individualistic way in which fuel is now consumed in cities is not efficient. A ton of coal burned in a large central station will produce at least four times as much electric power as if burned in the average small plant, and if centralized burning could be introduced to a greater extent, the amount of fuel required could be largely reduced without reducing in any way the ultimate production of light and power.

It is frequently the case that in buildings where electric plants are located and where exhaust steam is utilized in the heating of the building and in furnishing hot-water requirements, such buildings can adopt central-station service without a loss of money and at a saving in fuel.

As a rule it may be stated that where no extensive heating system is operated in conjunction with the generating plant, such a plant can purchase power at a great fuel saving and with a possible reduction in power cost. In other cases it would be more economical, from the viewpoint of fuel saving, to utilize central-station service in conjunction with isolated electric plants.

It is the duty of the Fuel Administration to devise means for securing a curtailment in the use of fuel in ways which will impose a minimum of hardship. It is believed that there are many plants, not only in New York, but throughout the entire country, which could, at least temporarily, shut down their own electrical machinery and purchase power from others at a financial advantage to both parties and with a considerable saving in fuel.

The Fuel Administration believes that if even a comparatively small proportion of the plants throughout the country which could save fuel in this way at a profit to themselves would do so, it would prove a tremendous help in meeting the fuel situation with which the country is confronted, and in winning the war.

While it may appear that the interests of the central station are being benefitted to a large degree, such is not of necessity the case. In some cases, central stations may be shut down. In any event any connection between a central station and a building or a manufacturing plant that is affected, will, of necessity, be for the period of the war only or through the period where the coal situation is critical. The machinery of the isolated plant can be readily preserved through this period of necessity. Under these circumstances the heavy expense attendant upon the making of the connection by the central station may completely or even more than offset any profit which could be expected of such a load through a short period.

The application of the "Skip-stop" to Railways and the Regulation of Car Heating and Lighting

One of the most promising methods by which we are securing economy in the use of fuel throughout the country, is by the introduction of the "skip-stop" system on the electric railways of the various cities.

With the present practice of having cars stop on signal at any street corner, there are usually from 12 to 14 stopping points per mile. With the skip-stop system, properly applied, these are reduced to not more than 8 per mile in the business districts, 6 per mile in residence districts, or 4 per mile in the open country. With the number of stopping points decreased in this way, a saving of from 10 to 15 percent. can ordinarily be effected in the power (and hence in the fuel) required, while at the same time the average speed of the cars in increased (without any increase in the maximum speed) and the service thus improved. Since this measure secures economy in fuel not only without handicapping the service, but with an actual improvement, it is obviously an extremely desirable type of conservation measure.

Our plan is to secure the adoption of the system by voluntary cooperation between the railway companies and the various municipal authorities or state commissions and to bring about this cooperation through the Federal fuel administrators for the several States. These administrators are all men of influence in their communities and so far we have found in every case that a request from the State administrator to the proper authorities was all that was necessary to secure permission for the introduction of the system as a conservation measure during the war. With permission thus provided for, the railway companies have all been glad to adopt the plan.

Through our efforts, through the independent efforts of various local administrators, or through the efforts of certain railway companies themselves, the skip-stop system has been adopted, or is about to be adopted as a coal conservation measure in Detroit, Washington, Baltimore, Brooklyn, Cincinnati, Columbus, Dayton, Toledo, Indianapolis, Evanston

(Ind.), South Bend, Newark (and the other cities of New Jersey), New Haven (and all the other cities of Connecticut), and in Okland, Berkeley, and Alameda, California.

The Connecticut Company has reported a saving in fuel of 10 percent. for its New Haven lines; and reports indicate saving in the other places at rates varying from 3,600 tons per year in Columbus to 2,100 tons per year in Detroit.

Various schemes for reducing car heating have been contemplated but as yet no definite plans have been formulated.

Economy in Utilization of Power and Light in Factories

The United States Fuel Administration is requesting, as a means of accomplishing power and light conservation in manufacturing and industrial establishments, the appointment, by the management, of a shop committee, composed of those best suited for the purpose and in size or number suitable to the size of the plant, one member of this committee to act as its chairman. The committee to be active with, and have charge of all details in the operation of the plant, that would in any way contribute to economy in fuel or that which fuel is used to produce and report weekly to the management or head of the plant.

It is also suggested that this committee be changed from time to time, so that the spirit and interest in this work may be maintained.

It is not the purpose arbitrarily to outline in detail the method for doing this work, rather to suggest in a general way, leaving the details and adoption of the plan in the hands of the manufacturers interested, as we realize that conditions in different plants and character of manufacture, as well as organization, will have a bearing on the size, character, and details of the committee, which must be suited to the particular case under consideration.

As a typical illustration of possible waste and opportunity for conservation, we suggest the following items:

1. Lights being unnecessarily burned.
2. Lamps of too high candle power.
3. The elimination of carbon lamps in favor of mazda lamps where practicable.
4. The elimination of arc lamps and substitution of nitrogen filled lamps which are from two to three times as efficient.
5. The restricted use of sunlight due to dirty windows.
6. Operation of motors when machinery is idle.
7. Excessive sparking, heating or erratic speed of motors.
8. Improper alignment of shafting.
9. Grouping of machines so as to operate motors or engines as nearly loaded as possible.
10. Staggering of operations so as to maintain as flat a load curve as possible.
11. Slipping belts.
12. Dry bearings.
13. Overheated or underheated parts of plant.
14. Excessive drafts due to lack of proper protection about openings of doors, windows, elevator and stair case areas.
15. The reduction of elevator service or the application of a skip-stop to elevator service.
16. The testing out of power circuits for relationship of capacity to load carried.
17. The paralleling of power circuits.

We also suggest that the work of this committee be conducted in such a manner as to provide records of savings, which could be incorporated in reports and information desired from time to time as to the progress of this work.

The War Industries Board and the United States Fuel Administration are laying particular stress on the assistance that can be rendered by industries in economizing in the use of fuel and power.

For the purpose of recognition of the individual service and interest of the members of committees, the Government will designate and identify them with a button or badge which will be furnished by the United States Fuel Administration.

The endeavor to bring about conservation by the above means is well under way in several sections of the country. Reports which have come in show savings in fuel ranging from 10 to 34 percent.

Utilization of Excess Water Power and Interconnection of Power Systems

A method of fuel conservation which promises a certain amount of immediate relief and at the same time opens up a field with almost limitless possibilities for future development is the interconnection of the present power systems of the country, and the consequent utilization of considerable excess water power which is at present available.

In many parts of the country duplicate transmission systems exist, serving practically the same territory. An interconnection between these systems for the mutual exchange of energy, would, in many cases, result in marked economies. In other cases, the lines of a power company which derives all, or nearly all, its energy from water power, may extend very close to the lines of another company which uses coal to a large extent for the generating of power. Since no company is so fortunate as to be operating with a 100 percent. load factor, there are necessarily times during light load, when the water-power company is forced to allow unproductive water to flow over its dam. At such a time a great saving in fuel would be effected were the two companies tied together and the load on the steam station transferred in part, or entirely to the water-power plant. Numerous hydroelectric companies have for a long time been carrying out this idea within their own systems, where the bulk of their power is derived from water and at the same time they maintain a steam reserve to carry their load during low water periods.

In some cases these system-interconnections would involve a considerable expenditure of both time and money, in which event they would not be subject to immediate aggressive action by the Administration but would be held in abeyance as possibilities for future consideration and developments. In a great many instances, however, very considerable savings can be effected with a minimum of delay and expense, and it is along these lines that the first efforts will be most energetically directed.

Limiting the Production of Power to the Most Efficient Plants Available

We have been able to locate nearly 500 instances throughout the country where there exists, in one form or another, a duplication of power production and supply. In other words, there are communities where two or more central stations are furnishing electrical energy with systems paralleling one another.

In certain instances the results of such a condition are not serious and in many cases probably unavoidable. Our investigations so far, however, have proved that a very large percentage of these situations offer an opportunity for large fuel conservation.

We find very often that an arrangement can be made at little or no expense whereby paralleling systems might be connected and the entire load supplied from the more economical station. In some cases, possibly, the combined load of both systems would be greater than could be handled by the more economical station. In such cases, as much load as possible should be carried by the station having the highest efficiency and the remainder taken by the other.

In general, as regards the program outlined above, other important measures of conservation will be effected.

First. By the closing of plants or the consolidation of plants there will be rendered available skilled men who are vitally needed in the many war industries of this country. Provisions are now completed in obtaining profitable work suitable to their ability.

Second. In many parts of the country there exists at the present time a power shortage. The interconnection of systems, the diversity factor of these systems considered, will render available additional quantities of power. The Council of National Defense is examining all communities where there is a surplus of power, having in mind the possible establishment in such communities of industries.

It may be stated that the conservation efforts of the Fuel Administration along the above lines are being directed so as to best serve the interests of all with a minimum of inconvenience and cost and with the object of making the coal supply that is available go as far as possible, so as to prevent the necessity of further drastic measures such as were necessary in January

It will be patent to every reader that in the face of a great potential shortage it would be criminal for the Fuel Administration to neglect obvious means of fuel saving such as outlined above and equally criminal for the individual plant owner to refuse or defer cooperation which may have as a direct result a loss in production of war materials or which may jeopardize the health of many families through shortage in coal supply. The administration believes it should not be necessary to resort to the issuing of orders for the adoption of these conservation measures but is relying, as in the past, upon voluntary action by those concerned and does not wish to enforce the measures where the saving in fuel would result in hardship to the owners not commensurate with the benefit derived by the public.

In this spirit, the Fuel Administration invites cooperation, whether the question be one of interconnection, of operation of plants at maximum efficiency, or of temporary closing down of plants. It invites suggestions and criticism of a constructive nature from all sources.

WANTED 4000 MEN FOR Y. M. C. A. WORK IN FRANCE

General Pershing has called on the Y. M. C. A. to send him 4,000 men for service with the Army in France. Of these 4,000, New York must furnish 1,000.

The Y. M. C. A. has been recognized by the President of the United States as a necessary and coordinate part of the American military establishment, and of the greatest value usefulness to our Army organization.

Its task is:

1. To keep our fighting men physically and morally fit.
2. To supply them with comforts, and to keep their minds and bodies active and clean.
3. To steer them straight and to be their friends, counsellors, and helpers.
4. In one crowd, to maintain their morale at 100 percent.

On the morale of the fighting men depends the victory. Napoleon said: "In war the morale is to the physical as 3 to 1."

The job of the Y. M. C. A. is to maintain morale. It is a big job, and requires men of big hearts and clear minds to do it. Men with experience in handling other men, are the type required—men whose judgment is mature, and whose actions are guided by sober second thought rather than by the impetuosity of youth. They must have character themselves, and they must be over the draft age; that is, past 31 years.

To have an influence over young men, a man must be tactful, must be firm, and 'on the level' in all his acts. He must think quick but think straight. He must have sympathy with the other fellow's point of view. This requirers patience and a cool temper. He must be able to do well the simple things of every day life, so as to show and help the other fellow to do them.

These are the kind of men General Pershing wants the Y. M. C. A. to send him.

Men who have succeeded in organizing and managing other men—such as department chiefs, sales managers, office managers.

Men who are successful in running departments in department stores, grocery stores, cigar stores, notion stores, and men who are successful as salesmen in such stores.

Men who can box and teach others to box; who can wrestle, and are good amateur atheletes, men who can play clean games of baseball, basket ball, foot ball, with professional and amateur.

Men who can write letters, such as good business correspondents and personal correspondents.

Men who can play on musical instruments, such as the piano, the guitar and the banjo, violin, etc., and who can sing and lead others in singing. A great historian of the Civil War said that "Music and writing home helped keep the soldiers well."

As these men must be over draft age, here is the chance for thousands of able-bodied men of from 31 to 50 years to volunteer in the biggest thing in all history, and see and have a part of the world war against the Hun.

To the men accepted, the Y. M. C. A. makes these guarantees:

1. A uniform and a kit.
2. Free transportation over-seas and back.
3. Expenses at the rate of $65 to $75 and an allowance for family when necessary.
4. Special war risk on insurance defrayed by the association.

SHELLAC

Shellac, says R. A. Lyon, in *Coal Age*, is one of the most valuable varnishes in use about electrical shops. It has the advantage of being a splendid insulator. It dries rapidly and it can be made almost any color desired. Shellac may be made by dissolving about 5 lb. of shellac gum in one gallon of 96 percent. proof alcohol. This composition gives a rather thick mixture, which is desirable for painting coils, for insulation and like services, but it is too thick to use as a varnish, for which use it should be thinned.

In buying shellac gum, or resin, it is desirable to purchase a good grade. Frequently the shellac resin is adulterated with ordinary rosin, which is much cheaper and inferior in every way. The rosin adulteration can frequently be detected by crushing the mixture—the odor and feel of the rosin will then be apparent.

For coloring shellac varnish (which is to be used in insulating) black, one of the well-known makes of black, air drying, alcohol finishing varnishes should be used. It should be mixed into the clear shellac mixture to an extent that may be determined by experiment. Lamp-black, which is finely divided carbon and hence a good conductor, should not be used in coloring shellac to be used for electrical purposes.

PUBLIC SERVICE COMMISSION'S POWER EXTENDED

The Supreme Court of Missouri has declared in a decision that the Public Service Commission has power to increase rates of public service corporations above the contract rates when the commission after investigation finds that such an increase is necessary for a reasonable income.

IRON COMMUTATORS

By B. G. Lamme

During the past two years frequent inquiries have been made as to why iron is not used instead of copper in the construction of commutators. Obviously this question is inspired by rumors and statements that German manufacturers are using iron in commutators, due to the scarcity of copper since the outbreak of the war. Apparently also it has been assumed, in some instances, that the present use of copper is more or less of a fad and that other metals, such as iron, could be used if desired. In this article, which appeared in a recent issue of The Electric Journal, the chief engineer of the Westinghouse Electric & Mfg. Co. undertakes to prove that the use of iron for commutators would not be an advance in the art but a big step backward.

In the course of the development of commutating machinery various metals have been tried out in commutators, all the way from pure copper, both hard and soft, through various alloys and brasses, cast copper of various purities aluminum, wrought iron, clear down to cast iron. All such materials have received consideration at some time or other and have been given fairly conclusive tests. Experience has shown that all of them could be used in commutators if one is willing to pay the price, this price being in the first cost of apparatus, in maintenance or in less satisfactory operating characteristics, or a combination of all. Under the stress of war conditions it may be necessary to pay any price, and apparently this is the condition which has confronted German manufacturers. In consequence, materials and constructions are used simply as a matter of necessity which, however, may not conform to conditions of even reasonably good design.

The use of copper in modern commutators is a matter of development and not simply a fad. In fact, most of the early commutating machines used other metals in their commutators, which would now be considered quite unsuitable. Cast copper and various brasses and bronzes were used quite extensively, with more or less bad results. Pure copper was considered too expensive for general use and it was only after very considerable development that the conclusion was reached that its apparent higher first cost was more than neutralized by improved maintenance and operation. Even after pure copper had come into general use for commutator construction, it was not known, or understood, why it was so superior to other metals.

About twenty-seven years ago the writer made extended tests on the use of iron in street railway commutators. The machines soon developed "high mica" and the commutators gradually blackened, the contact surfaces blistered and sparkling gradually increased until the commutating conditions became practically impossible from the operating standpoint. These conditions repeated themselves in every test until finally this construction was given up as impracticable. The difficulty was blamed largely upon high mica, as it was assumed that in some way, the metal wore below the mica, thus causing bad brush contacts, with resultant burning and blackening. It was not recognized that the converse was really the case and that the high mica was the result of burning rather than the cause. In all machines of those days there was more or less tendency for the commutators to "wear" considerably, and it was not recognized that such was not true mechanical wear, but that it was the result of burning away the contact surfaces.

A little later, the writer made quite complete tests on the use of aluminum on street railway motor commutators. This matrial worked better than iron, in the sense that burning and blackening and high mica did not appear as quickly as with the iron. However, like the iron commutator, there was no tendency to polish, but the commutator soon assumed a dull appearance which gradually changed to a blackened and burnt condition.

Bronzes and brasses were tried on similar railway commutators, and while these gave better results than the aluminum or iron, yet they developed high mica much more quickly than the copper commutators. With such evidence at hand, the use of forged or drawn copper for commutator bars was a natural conclusion. However, even with the best copper obtainable, there was some tendency toward blackening and burning of the commutators, generally accompanied by high mica and the difficulty was blamed primarily on the mica. It was assumed that the copper bars did not wear as rapidly upon the carbon brush as was the case with other metals. At the same time it was recognized that when the machine was operated without current none of these metals seemed to wear unduly. It was only when considerable current was carried that the wear was excessive. At that time, the real explanation of this difficulty was not fully appreciated.

Later investigations on collector rings and commutators, developed the fact that whenever a current is carried between a stationary brush contact and a moving surface, there is a tendency to burn away either the brush contact face or the moving surface, depending upon the direction of the current and upon the current density. It was found that this burning action, which is somewhat similar to that occuring in an arc, was to some extent a function of the exact loss. This was indicated partly by the fact that the burning was a function of both the brush contact drop and the current density. A given current, for instance, might produce very little burning as long as the contact drop was quite low; whereas, if for any reason such contact drop increased materially noticeable burning would begin. If the current was from the brush to the commutator or collector, the brush contact surface would tend to burn away more than the opposing surface. If, on the contrary, the current was from the collector or commutator to the brush, then the collector surfaces would tend to burn and, in some cases, deposit the burnt material on the brush face.

When carbon brushes are used, there is usually a considerable contact drop due, apparently, to the nature of the materials in the brush itself. This drop, in many cases, is in the nature of one volt for each contact and it is fairly constant over quite a wide range of current. In nconsequence, the contact loss varies nearly in proportion to the current and not as the square of the current. Due to this very considerable loss with carbon brushes, there is a tendency to burn away the brush surface and to burn and blister the commutator or collector surfaces with which the brush is in contact. This tendency to burn is dependent upon the actual current density in the brush (including local or short-circuit currents), but the resultant burning is largely a function of the material in the commutator or collector face. sA the brush cannot make perfect contact with the metallic surface to which it is opposed, there are minute arcs at the contact and these evidently burn away the surfaces. However, the real burning action is dependent upon the inability of the surface to conduct away heat rapidly, for if the heat developed in the surface film is not conducted away with sufficient rapidity, then such surface is liable to be blistered or burned locally, even though moving with respect to the brush. Such burning or blistering naturally roughens the contact surface and increases the contact drop and thus tends to increase the arcing and burning action. Thus, if there is any burning action it tends to grow worse, cumulatively. This burning away of the surface leaves the metal surface of the commutator slightly lower than the mica, unless the latter wears mechanically at the same rate that the commutator metal burns away. As this is not usually the cast, high mica soon develops, simply by the action of burning away of the metal. Thus high mica is a result of the trouble, rather than the cause. However, as even a very gradual burning away will eventually leave the mica above the surface, modern practice has tended toward undercutting of the mica, so that even with a slight burning tendency the brush still maintains contact with the metal, thus preventing accentuation of the trouble.

As mentioned before, this burning action is a function of the contact voltage, the current density and the non-burning or non-blistering qualities of the metal constituting the commutator. It is in this latter feature that copper has proven so superior to other metals. Extended experience shows that the heat conducting qualities of pure copper are so good compared with most other metals or alloys that the burning or blistering action of the current under a brush is very small, except for high current densities. Anything which tends to decrease the heat conducting properties of the commutator metal, tends to increase burning action. This has been very clearly demonstrated in elaborate tests of carbon brushes on collector rings, etc., where questions of commutation did not come in to disturb the conclusions. Such tests have been made covering copper, bronzes and alloys of various sorts, wrought iron, cast iron, etc. In practically all cases, with high current densities, the burning and blistering action appears to be dependent upon the ability to conduct the heat away from the contact surface. By such conduction the local heating of the contact film of metal is kept at a low point which results in reduced fusion of the metal, and with very good heat conducting materials the fusion of the metal may be so minute that the polishing action of the brush keeps the surface in a smooth glossy condition.

It is an interesting fact that the electrical conductivities of the metals and their mixtures and alloys, bear a fairly close relation to their heat conductivities. Experience shows that very little impurity in copper will reduce its electrical conductivity to possibly one-third or one-quarter, and its heat conductivity will be decreased nearly in proportion. Most of the alloys of copper have a very low conductivity compared with copper itself, while wrought iron is worse than most of the copper alloys in this regard. The series of tests above referred to indicated quite clearly that the burning tendency varied very much as the electrical resistance of the material, that is, with the heat resistance. Wrought iron, having from eight to ten times the resistance of copper, would burn or blister and get rough at very much lower current densities than copper commutators or rings. Even some of the alloys which appeared to be good for collector rings, showed bistering effects at very much lower limiting current densities than copper. Consequently, it developed that the limiting carrying capacty of different metals in commutators and collector rings varied roughly with the heat conducting qualities, and thus copper proved to be superior to any of its alloys or any other available material. According to this line of reasoning, silver should be better than copper, but ths is not an available metal. The above also explains why alloys of copper in which other elements have been introduced for the purpose of hardening, etc., usually do not have the ultimate carrying capacity found in copper. Aluminum has fairly good heat conductivity, if pure, but it is so easily oxidized and the resistance of the oxidized surface arises so rapidly, that presumably this fact neutralizes any possible gain otherwise. Experience on actual commutators showed that aluminum did not take a polish, even under moderate current densites and, in fact, it acted very much like some of the higher resistance metals used in the tests.

It should be evident from the above that, when materials of higher heat resistance, that is, wth poorer heat conductivity than copper, are used in commutators, the operatng current densities should be reduced accordingly. Thus, it may be possible to use iron or steel for commutator bars, provided the brush current densities are reduced sufficiently. In very small machines, this might mean only an increase in the dimensions of the commutator and brushholders. In larger machines, however, any material modification in the proportion of the commutator may lead to radical changes in the machine as a whole, so that the total cost would be materially higher than in the copper commutator machine. This depends entirely upon how much sacrifice is to be made in operating conditions and maintenance. If these are to be kept at the same high standard as on present copper commutator machines, then it is questionable whether the iron commutator would prove to be practical under any conditions. The same conditions hold true, to a certain extent, with certain alloys instead of copper in the commutator. As such alloys, as a rule, cost nearly as much as copper itself, it should be obvious that any material increase in the dimensions of a commutator will soon balance any possible gain.

In larger machines one serious condition would be liable to be encountered with other than copper commutators. At present these machines are built for quite high peripheral speeds of the commutators, and construction difficulties are encountred which would make any increase in their length or diameter very objectionable. Consequently, serious modifications in the general construction of the machine, and possibly in the general construction of the machine, and possibly in its speed conditions, are liable to be necessitated. In fact, in many cases the whole design of the machine is predicated on the commutator construction. In such cases the use of a poorer material in the commutator would undoubtedly be a backward step in the development.

It is thus obvious, that the use of iron in commutators, while possibly practicable under the urge of necessity, is not in the direction of an advance in the art. In fact, it is a big step backward. It should be assumed naturally that if, in the past thirty years of development in commutating machinery, iron commutators have not come to the front, it is for very good reasons, and the preceding is simply an attempt to bring out some of the foremost reasons.

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POWER PLANT EFFICIENCY

The United States Fuel Administration has announced the appointment of Henderson W. Knott to manage the field force of engineers and inspectors which is at work among the power plants of the country, carrying out a campaign of instruction and inspection designed to bring the use of fuel for the production of power to the highest possible efficiency and economy. Mr. Knott has been the general manager of the Morgan Crucible Company of New York City.

The appointment of Mr. Knott is a part of the plan, originated by David Moffat Myers, advisory fuel engineer of the Fuel Administration, to have each of the 250,000 steam plants in the United States visited by a competent man who can make suggestions and report in connection with the questionnaire originated by Mr. Myers, working with committees from the four great engineering societies. This work will naturally require a large number of inspector devoting their time to travelling among the steam plants.

This field force will be organized by states in order to give it greater force and efficiency. Many of the state heads who work directly under the State Fuel Administrators have already been appointed and Mr. Knott, co-operating with Mr. Myers, will complete the list of state appointees. Mr. Knott will, at an early date, visit the states already organized to study the work being done by the men in the field, and to speed up the inspection program.

THE TRADE IN PRINT

What The Industry is Doing in a Literary Way

NOTICE TO READER

When you finish reading this magazine cut this out, paste it on the front cover; place a 1-cent stamp on this notice, hand same to any postal employee and it will be placed in the hands of our soldiers or sailors at the front. No wrapping—No address.

A. S. BURLESON,
Postmaster General.

"The New Era in Street Lighting" is the title of a 36-page book recently published by the Holophane Glass Company, 340 Madison Avenue, New York. It describes and illustrates the results of recent scientific research, and shows how these results have been practically applied to street lighting. This book should prove of special value at the present time, because it explains what is meant by conservation in street lighting and shows how to effect marked economies, such as being able to reduce the energy consumption by one half and obtain illumination equally as effective as was formerly possible.

This is the first book ever published giving a complete resume of the recent progress in street lighting practice and its publishers have spared no effort to make it most comprehensive. A limited quantity of these books are available for distribution to engineers and city officials and may be obtained by addressing the Holophane company, in their official capacity.

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Archer & Baldwin, Inc., New York City, has distributed booklet No. 55, listing electrical and steam machinery and equipment. In this list are included many attractive bargains in motors, both alternating and direct current condensers, motor generator sets, rotary converters, transformers, water tube boilers, etc.

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"The Potentiometer System of Pyrometry and Temperature Control" is the title of a 60-page, 8 x 10½ in. catalog, published by the Leeds & Northrup Co., of Philadelphia to describe a system of pyrometry and temperature control in which the potentiometer method is employed for measuring the electromotive force of thermocouples. A known electromotive force is included in the circuit with the thermocouple and by varying the known eletromotive force, the current can be varied until a galvanometer, also in the circuit, indicates that no current is flowing. When this has been done, the thermocouple electromotive force is, of course, equal to the known electromotive force. Due to the fact that no current flows at the moment of measurement, changes in the resistances of lead wires, thermocouples, galvanometers, etc., are eliminated and do not affect the result. By making the lead wires of the same material as the thermocouple, the "cold junction" of the latter is brought back to the instrument where its effects can be compensated for automatically.

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Bailey Meter Company, Boston, Mass., recently issued its bulletin No. 41, entitled "How to Save Coal." This pamphlet covers boiler room efficiency in a most instructive way in a language that all can understand. Boiler capacity, boiler efficiency, combustion, air supply, best condition of fuel bed, air as a fuel, evaporation per pound of air, how to measure the air, are all discussed in a thorough manner. Steam flow recorder, air flow recorder, the effect of coal, dirty tubes and leaky baffles, and temperature of gases are all discussed in their influence on boiler room economies, and the manner in which the co-ordination of records by means of the Bailey flow meter permits of efficiency of operation at all times.

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The Cutler-Hammer Mfg. Co., of Milwaukee and New York has just issued a 6--page (8½ x 11 in.) folder, illustrated and describing C-H Sectional Battery Charging Equipment for industrial electric trucks. This type of battery charging equipment has been extensively used in both public and private garages for charging the batteries of pleasure and commercial vehicles. During the past two years it has been widely adapted for charging industrial trucks, tractors, battery locomotives, battery driven chairs, and starting and lighting batteries.

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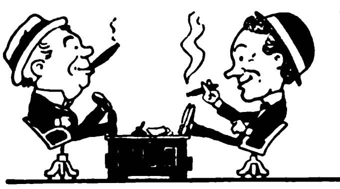
NEW MOTOR BOOKS

Laird & Lee, Inc., Chicago, announce that they have now in press the 1918-1919 edition of "The Modern Motor Car," by Harold P. Manly. It will be issued in one compact volume of 536 pages, large 12mo, with 225 illustrations from detail drawings and photographs and a 24-page alphabetical index, durably bound in flexible keratol, with round corners and colored edges. The revisions and additions bring this standard work up to the very minute, making it a complete, practical and handy reference cyclopedia on all matters connected with the care, repair and upkeep of every type of automobile, old and new.

The same firm have also in hand for immediate publication: "The Farm Tractor—Its Care and Repair," by Wallace B. Blood. This will be uniform in style and size with "The Modern Motor Car," and at the same price, $2.00, postpaid.



Did You Know That-

BITS OF GOSSIP FROM THE TRADE

Commonwealth Edison Company, Chicago, now carries on its roll of honor the names of 1040 employees engaged in various branches of Government service.

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Edison Storage Battery Co., of Orange, N. J., has opened a sales office at 740 Land Title Bldg., Philadelphia, Pa. J. A. Hurst, sales engineer of the Edison Storage Battery Co., is in attendance.

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Edison Storage Battery Supply Company has moved its New Orleans office from 201 Baronne Street to larger and more commodious quarters in the Maison Blanche Building, Room 911. D. B. Mugan is district sales manager.

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General Devices & Fittings Company, Chicago, recently opened an office in New York in the Vanderbilt Concourse building, 52 Vanderbilt avenue. I. W. Gross, who was formerly technical adviser to the Interborough Rapid Transit Company, is in charge of the new office.

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Delta Electric Company, Marion, Ind., manufacturer of electric lighting devices and specialties, announces the opening of a branch establishment at 686 Mission street, San Francisco, Cal. O. E. Yates, western sales manager for the company, has been placed in charge of the branch.

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Electric Storage Battery Company, with general offices and works located at Philadelphia, Pa., has issued Bulletin 169, superseding Bulletin 150, which deals with its oil-switch batteries. This bulletin is well illustrated and gives electrical descriptions, showing the application of the storage batteries to switching apparatus.

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Mid-West Engine Company, Indianapolis, Ind., a recent consolidation of the Lyons-Atlas Engine Company of Indianapolis and the Hill Pump Company of Anderson, Ind., is planning to greatly increase the capacity of its plant. Additional plant extensions will be made and new equipment installed, including some important electric installations, and for this purpose over $1,000,000 has been appropriated.

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The Holtzer-Cabot Electric Company, Roxbury, Boston, Mass., announces that its business in motors, dynamos, motor generators, etc., previously conducted by the James Goldmark Company, 83 Warren street, will in the future be handled from the New York office of the company located at 101 Park avenue, with Douglas Cairns in charge.

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Westinghouse Elec. & Mfg. Co. announces that its Picnic Committee has voted not to have the annual picnic this year. The products of a half-day's work, which would not be turned out if the picnic were held, will be looked on by the company as a contribution from the employees here to the boys over there.

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Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., announces that it is forced to withdraw the prices quoted in its "Handbook of Hoisting Machinery." Until such time as material and labor costs become more stable, this company must discontinue its practice of publishing a standard price list on electric hoists.

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Emerson Motor Prices Advanced. On June 20, advanced prices on Emerson motors and motor applications became effective. The advance was equivalent to about 5 percent. of former prices, varying according to the application of new discounts to bulletin lists. The higher prices now in effect have been made necessary by continued increases in the cost of labor and material entering into the production of Emerson products.

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D. C. and Wm. B. Jackson, engineers, announce that on account of two members of the firm having gone into the National Service, and the third member expecting to do so as soon as practicable, they will close their offices and suspend business for the further duration of the war, as soon as the various pieces of work with which they are now occupied can be completed. They expect to resume business after the conclusion of the war.

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Westinghouse Electric & Mfg. Co. announces a change in representation in its western district, with headquarters at Indianapolis, Indiana. Prescott C. Ritchie has been appointed district representative to succeed H. S. Johnson, whose resignation becomes effective June 30. Mr. Ritchie has had a considerable amount of experience in the automobile industry, having been in charge of headquarters' inquiry work, for the western district, in the main offices of the company for some years past. Before that he was connected with the Thomas B. Jeffrey Company at Kenosha, Wisconsin.

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Interborough Rapid Transit Co. has made formal application to the War Finance Corporation in Washington for a loan of $37,700,000 for three years. It is proposed to secure this loan with $39,489,000 of first and refunding mortgage 5 percent. bonds of the company which are now held in the treasury, permission for the issuance of which already has been granted to the company by the Public Service Commission. At the time the Public Service Commission granted this permission to the corporation several months ago it stipulated that the bonds should not be sold at less than 93½. Had the bonds been immediately put out that price could have been realized, but, as a matter of patriotism, the management held up the offering because it would have conflicted with the first offering of Liberty Loan 3½ percent. bonds. The feeling was that after the Liberty Loan campaign was over the market would be such as to permit sale of these bonds at no less than the figure mentioned. The situation in the investment markets, however, changed decidedly in the meantime and this prevented the sale of bonds by any corporation except at prohibitively low prices.

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PURELY PERSONAL

Samuel Kahn, general manager of the Western States Gas & Electric Company, has been elected president of the Pacific Coast Section of the National Electric Light Association.

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J. F. Owens, vice-president and general manager of the Oklahoma Gas & Electric Company, recently addressed the Drumright Rotary Club.

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Terrell Croft, 33 Amherst Avenue, University City, Mo., technical author, instructor and consulting engineer, has been called to Washington by the Educational Committee of the War Department, of which C. R. Dooley is director. Croft has been placed in charge of the work of standardizing the electrical courses of training for enlisted men, and has been granted leave of absence by the Luminous Unit Company of St. Louis, with whom he was associated as their chief engineer.

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William A. Magee, formerly mayor of Pittsburgh, Pa., has been appointed a member of the Public Service Commission of Pennsylvania.

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J. R. de Lamar was elected a member of the board of directors of the National Conduit & Cable Company, of New York City, at a recent meeting.

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W. A. Layman, president of the Wagner Electric Manufacturing Company, St. Louis, Mo., has been chosen to serve on the board of directors of Washington University.

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C. G. Tarkington, formerly with the Chicago district office of the Westinghouse Elec. & Mfg. Co., is now in charge of the Washington office of the Mechanical Appliance Co., Milwaukee, Wis.

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F. W. T. Smith, formerly with the Westinghouse Elec. & Mfg. Co. at East Pittsburgh and later city electrician of Cleveland, Ohio, is now in the sales department of the Elliott Electrical Company of Cleveland.

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C. T. Maynard, electrical engineer of the Vermont Marble Company, Proctor, Vermont, has resigned to become electrical engineer of the Rumford Falls Power Company, Rumford, Maine.

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F. S. Tallmadge, formerly with the Northwestern Electric Equipment Company, St. Paul, Minn., has been promoted to the rank of first lieutenant in the Engineers and is now stationed at Camp Jackson, South Carolina.

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E. P. Dillon, manager of both the railway and power divisions in the New York district office of the Westinghouse Electric & Mfg. Company, has resigned to become general manager of The Research Corporation, with headquarters in New York City.

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Charles E. Howe, consulting engineer of Macon, Ga., and for many years identified with the water power development in Georgia, was recently commissioned a major in charge of the public utilities at Camp McClellan, near Anniston, Ala.

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Prof. P. B. Woodworth has resigned as dean of Lewis Institute and is now district education director in the War Department. His office is located at Room 1212 Tribune Building, Chicago. This district includes Wisconsin, Illinois, Indiana, Michigan and Ohio.

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G. O. House, formerly superintendent of the Saint Paul Municipal Water Department, has been appointed manager of the Northern States Power Company, Saint Paul, Minn., succeeding P. T. Glidden, deceased.

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Dr. **Chas. W. Burrows,** associate physicist of the National Bureau of Standards in charge of the Magnetic Section of that institution, has resigned and will take up the work of commercial research and consultation, with laboratories, equipped for research on problems involving magnetic materials and apparatus, located at Grasmere, Borough of Richmond, New York City. Dr. Burrows has rather unusual qualifications for the work he is about to undertake. In 1905 he received the degree of doctor of philosophy from the University of Michigan. Since then he has been a member of the scientific staff of the National Bureau of Standards at Washington, D. C. During this period he has reduced practical magnetic testing to an exact science. The Burrows magnetic permeameter is the standard method for commercial as well as for precise magnetic measurements in this country. His greatest achievement has been in the discovery and development of the science of magnetic analysis.

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Clarence Shelden, who suffered a stroke of paralysis in August, 1916, while acting as general superintendent of the New York & Queens Electric Light & Power Co., has so far recovered as to be able to resume professional work with New York office of the General Electric Company.

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A. P. Bender, of the transformer division of the power sales department of the Westinghouse Electric & Mfg. Company, at East Pittsburgh, after July 1st will be connected with the electrical section, finished materials division of the War Industries Board at Washington.

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Edward Briggs, of the Chicago office of H. M. Byllesby & Company, has joined the 161st Depot Brigade, Barracks 334 West, Camp Grant, Illinois. John Burmeister, also of the Chicago office of the company, has enlisted in Government service and is located at Camp Wheeler, Macon, Ga. C. W. Paessler of the same office has enlisted in the navy.

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T. E. Keating, manager of the turbine section of the power sales department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., was recently commissioned a lieutenant, senior grade, United States Navy. He has been assigned to the United States Navy Steam Engineering School at Stevens Institute as instructor to the junior engineering officers in modern turbine and condenser practice.

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Howell VanBlarcom, assistant manager of the power sales department of the Westinghouse Electric & Mfg. Company, at East Pittsburgh, will be connected after July 1 with the power and lighting division of the Fuel Administration at Washington.

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W. A. Haines has been appointed district representative at Detroit of the Automobile Equipment Department of the Westinghouse Electric & Mfg. Co. Among the automobile manufacturers of the Detroit district, Mr. Haines is well known through his service for some years as assistant district manager of that department of the Westinghouse company.

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P. B. Findley, technical editor in the Department of Publicity, Westinghouse Electric & Mfg. Co., has resigned from that position to enter the training school at the University of Pittsburgh where he will take a special course in radio work, with the Signal Corps. Before going to the Westinghouse Electric company, Mr. Findley was editor of the Electrical Age, in which position he made a large number of friends in the electrical field who will wish him success in his military work.

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A. B. Cole has been appointed assistant to manager, Department of Publicity, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., to succeed M. C. Turpin, who has accepted a position in the Ordnance Department at Washington, D. C. Mr. Cole will have charge of the editorial work, including the preparation of literature, and supplying information to the press.

John G. Wood, Anderson, Ind., formerly general manager of the Remy Electric division of the United Motors Corporation, has been appointed president and general manager of the Mid-West Engine Company, a consolidation of the Lyons-Atlas Engine Company, of Indianapolis and the Hill Pump Company, of Anderson, Ind. The new company will specialize in turbine engines needed in large quantities by the United States Fleet Corporation.

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Arthur H. Young, director of the American Museum of Safety since January 1, 1917, has resigned to take charge of the employee relations department of the International Harvester Company. He will take up his new duties immediately. Although giving up the actual direction of the museum's work, Mr. Young will continue to be closely concerned with its affairs, for he has been elected to the vice-presidency, succeeding the late Dr. Frederick R. Hutton. In recognition of Mr. Young's accomplishments as chief safety expert of the Federal Government, the museum has just awarded him the Louis Livingston Seaman medal.

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F. A. Mansfield has resigned from the Westinghouse Elec. & Mfg. Co. to become manager of the Pittsburgh office of the Mechanical Appliances Company of Milwaukee, a new company which has recently opened offices in Detroit, Chicago, Minneapolis, Cincinnati, Cleveland, Washington, and now enters Pittsburgh. This company manufactures motors and generators of limited sizes. Mr. Mansfield is well known in the electrical industry, having been connected with the export and industrial department of the Westinghouse company for many years. Prior to his resignation, he had been employed on Government work.

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On July 1, 670 officers and employees of H. M. Byllesby & Company and affiliated companies were engaged in the military service of the United States or Allies. This represents 13.8% of all male employes of the organization. There are now 4 gold stars in the flag.

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ASSOCIATIONS AND SOCIETIES

Chemists from all parts of the country are planning to go to New York City to attend the various conventions to be held by chemical and technical organizations in Grand Central Palace during the week of September 23. Co-incident with these meetings will be held the fourth national exposition of chemical industries which promises to be the largest and most complete exposition of these industries ever held. In order to show the strides made by the chemists of America it will be necessary to use four floors of the building.

The exposition is a war-time necessity and regarding it as such each exhibitor is planning his exhibit so that it will be of the greatest benefit to the country through the men who visit it, all of whom are bent upon a serious purpose—that of producing war materials in large quantities, and constantly increasing this production till the war has been won by the United States and its allies.

Papers covering practically every phase of chemistry and a discussion of steps that will need to be taken after the war, will be presented by leading experts in each branch. Pressing chemical problems concerning many of the chief articles of domestic and foreign commerce will be taken up during the convention, and it is expected these discussions will have an important bearing on the future manufacture of materials that have been scarce and high-priced ever since the curtailment of American commerce with Germany and other European countries. In order to fill the demands of chemicals, hundreds of factories have sprung up in various parts of the country, and while doing a large business, it is pointed out by experts that there is a lack of preparaton to meet new conditions which are bound to follow at the close of the war.

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J. B. WHITEHEAD GETS LONGSTRETH MEDAL

The Franklin Institute through the action of its Committee on Science and the Arts has awarded the Edward Longstreth Medal for Merit to Major J. B. Whitehead for his paper on "The Electric Strength of Air and Methods of Measuring High Voltage," appearing in the April 1917 issue of the *Journal of the Franklin Institute*.

In awarding this medal, the Committee adopted the following resolution:

Resolved, That the Edward Longstreth Medal of Merit be awarded to Dr. J. B. Whitehead for his paper entitled "The Electric Strength of Air and Methods of Measuring High Voltage" appearing in the April 1917 issue of the *Journal of the Franklin Institute*, a clear exposition of the underlying principles of the phenomenon of the electric corona at high potentials, a resume of the present methods of high-tension electrical measurement, and a full description of a new and noteworthy instrument—the Corona Voltmeter, invented by the writer—and its application to important problems in modern electrical engineering.

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ELECTRICAL CONTRACTORS CANCEL OUTING—DEVOTE MONEY TO W. S. S.

Under the chairmanship of Frederick W. Lord, of the Lord Electric Company, the Electrical Contractors Committee of the Pioneer Division of the War Savings Committee of Greater New York is fast approaching the goal set for it. As a result of the efforts in behalf of the war savings movement put forth by Mr. Lord, the electrical contractors, engineers, electrical inspectors, and maintenance men now are completely organized and have pledged to systematically buy War Savings Stamps.

Agencies for the sale of stamps are maintained by nearly all the firms in the trade.

The contractors, in addition to having their employees enlisted in the war savings campaign, are also after all their customers, and not an opportunity is overlooked by them to dispose of stamps.

That the electrical contractors' employees are in the war savings movement is borne out by the fact that they have cancelled their annual outing this year, and by their decision to work on that day and to devote the proceeds of the day's pay to the purpose of War Savings and Thrift Stamps.

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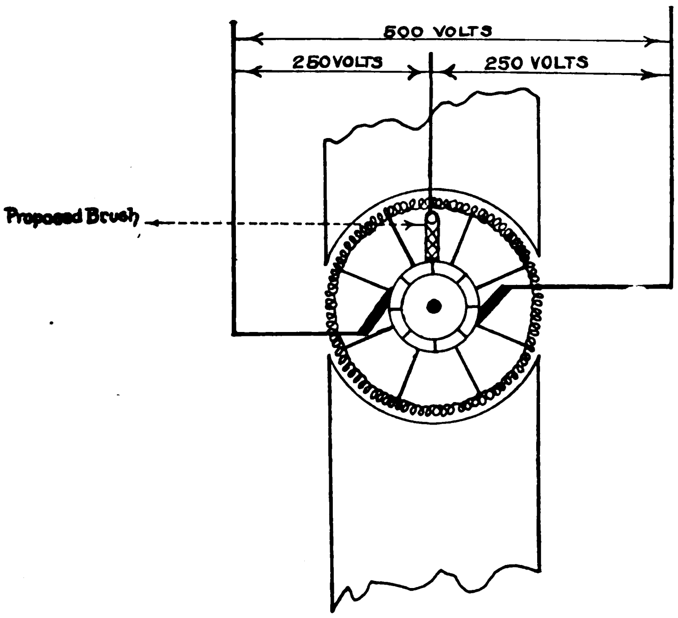
Antomotive Electric Association held its third semi-annual meeting at Lake Placid Club, Essex County, New York, July 10-12. The attendance was the largest of any meeting held thus far, every member company being well represented. Consideration was given to the question of extending the membership. The association approved the report of the Standardization Committee, B. M. Leece, chairman, and favorable comment was made in regard to the extent and quality of standardization work accomplished by the S. A. E. electrical equipment division at the Dayton meeting. The Legal and Patent Committee submitted a progress report. A standardized contract form was completed and recommended for use by the variosu member companies. In connection with the contract form, uniform service policies were also outlined. Business sessions were completed late Friday but many of the members and their wives remained at the club over Saturday and Sunday.

NUTS FOR THE KNOWING ONES

QUERIES AND ANSWERS IN TECHNICS

Can a 500-volt, two-wire, 8-pole, 8-brush, direct-current generator be changed to a 3-wire generator that will deliver 250 volts between the neutral, and either of the outside legs, and 500 volts between the two outside legs?

I propose changing it in the following manner but am not



sure of the results. By placing an auxiliary brush as per dotted line will I get the desired results, or will some one suggest another or better method?

I am at present using a balancing set that is a constant source of trouble and would like very much to do away with it if possible.

F. P. Miller, Abbeville, La.

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In the April issue of ELECTRICAL ENGINEERING F. E. Austin, of Hanover, N. H., gives a method for constructing a small transformer. Would Mr. Austin consider giving method of computation in detail?

F. Fehrenkamp, Kenedy, Texas.

In designing a transformer, as in designing other electrical devices, different requirements of operative conditions will necessitate different methods in design.

A brief outline applying to the design of a transformer will be presented herewith, based upon the so-called fundamental equation of the transformer which is:

$$E_p = \frac{AN2\pi fB}{\sqrt{2}\ 10^8}$$; in which E_p denotes the alternating pressure, expressed in volts, applied to the primary coil terminals; A denotes the area, expressed in square inches, of the cross-section of the iron core of the transformer; N denotes the number of turns in the primary windings; $2\pi = 2 \times 3.1416$; f denotes the frequency of the applied pressure, in cycles per second, and B denotes the number of magnetic lines of force set up in the iron core per square inch of cross-section.

It will now be assumed that the applied pressure is 110 volts, and its frequency is 60 cycles per second. The assumption of these two values leaves three unknowns, denoted by A, N, and B.

It is necessary to have some knowledge of the amount of magnetic flux, or magnetic lines of force that can be set up in the iron core. This depends upon the permeability or the conductivity of the iron used, for magnetic flux.

Ordinary iron, which is employed in the construction of transformer cores, has the ability of conducting about 80,000 lines of force per square inch in section.

Suppose the assumption is made that the iron to be used will conduct 75,000 lines per square inch. Of course it is necessary to ascertain by actual test the permeability of any particular grade of iron used; as the permeability varies according to the quality of the iron.

According to the assumptions made, the data may be assembled as follows:

$E_p = 110$ volts.
$A = 1$ square inch.
$f = 60$ cycles.
$B = 75{,}000$ lines per square inch.
$\sqrt{2} = 1.414$.
$2\pi = 6.28$.

This leaves the only unknown to be N, the number of turns on the primary coils.

Solving the fundamental equation for N gives:

$$N = \frac{E_p \times \sqrt{2} \times 10^8}{A\ 2\pi f\ B}$$, and substituting the assumed numerical value gives:

$$N = \frac{110 \times 1.414 \times 10^8}{1 \times 6.28 \times 60 \times 75{,}000} = 550 \text{ turns.}$$

For continuous service the assumption of 75,000 lines per square inch is probably somewhat excessive; but for intermittent service it would be safe.

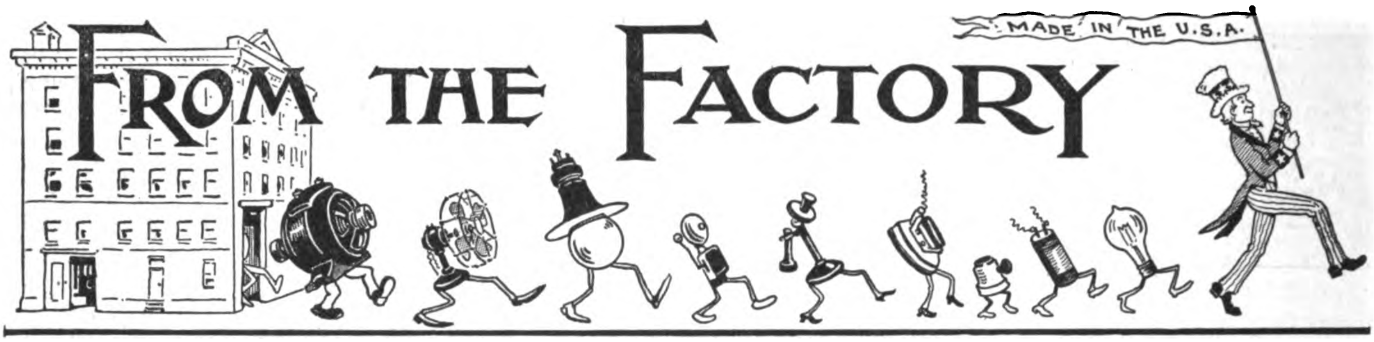
If the output of the transformer is to be, say, 120 watts, the input will need to be in excess of this. If the efficiency of the transformer is assumed to be 50 percent., the input will be 240 watts for an output of 120 watts. If the input is 240 watts and the applied pressure is 110 volts, the current must at least be $\frac{240}{110} = 2.2$ amperes. The primary wire must be large enough to carry 2½ amperes. No. 25 B. & S. gauge will be proper.

If the efficiency of the transformer is 50 percent. there will need to be twice as many turns per volt on the secondary as on the primary. That is, if the secondary pressure were to be 110 volts, there should be 1100 turns on the secondary. If 550 turns are wound on the secondary, the secondary pressure would be only 55 volts.

If No. 25 B. & S. gauge is to be used on the primary, sufficient space must be allowed, which determines the length of the iron core. If the primary is wound on in two coils, and two layers per coil, since the overall diameter of double cotton wound magnet wire is 0.026 inch the winding space will need to be $137 \times 0.026 = 3\frac{1}{2}$ inches; or allowing for some spacings between turns, a distance of say 4 inches must be allowed. To allow for a form or spool to hold the winding a length of core of say 6 inches should be allowed. The two limbs or legs of the core should be separated at least 2 inches. This fixes the length of the complete core as 20 inches, and of course determines the weight since the volume of the core is 20 cubic inches.

Since the core is built up of thin plates, it should be noted that the core section means the actual section of iron; not the section of built-up plates.

F. E. Austin, Hanover, N. H.



Short Stories About Electrical Goods Offered By Manufacturers

CROUSE-HINDS CONDULETS

Two new types of condulets are announced by the Crouse-Hinds Co., of Syracuse, N. Y. One cut shows a single gang FS condulet with switch installed and shows the protective cover at one side.

Condulets. Crouse-Hind Co., Syracuse, N. Y.

The other cut shows a two-gang FS condulet with a two-gang protective cover mounted. The catalog number of the single gang cover is DS-108, while the two-gang is DS-1082. Both of these condulets are designed to meet a need that has been pressing for several years.

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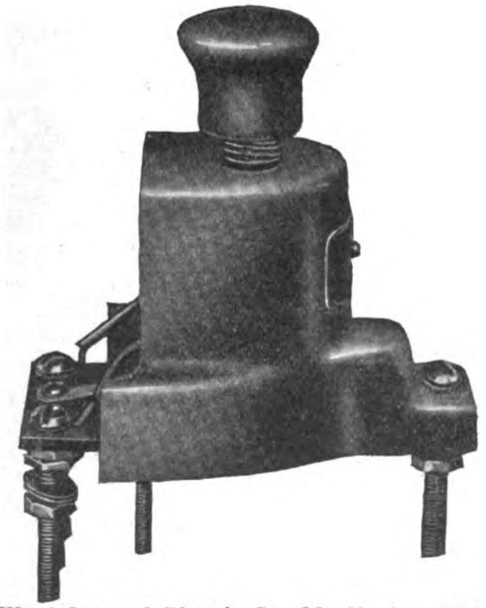
CUT-OUT FOR FARM LIGHTING SYSTEMS

Farm-lighting systems are said to be automatically controlled by the reserve current cut-out, made by the Ward Leonard Electric Co., Mt. Vernon, N. Y. This device will close the circuit when the generator voltage is about 40 volts, and will automatically open it when the charging current is reduced to zero and the battery voltage is higher than the generator. It is especially adapted for use with a gas-engine-driven dynamo set of 1200 watts or less, and is made in standard sizes for 40 volts and 30 amp. Combining reserve cut-out with the start-stop and ignition switch, protection is obtained against the damage usually caused when switches are closed at the wrong time.



Ward Leonard Electric Co., Mt. Vernon, N. Y.

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"ARROW E" SURFACE SWITCHES

The binding post is one of the most important features of a snap switch. This is particularly true in old work where the wires are apt to be short. The binding post on a new type of Arrow E switches is formed with a flange, which, with the head of the binding screw makes a natural channel for the wire. The wire, coming through the poreclain, feeds automatically into the binding post and under the head of the binding screw, because it can't go anywhere else. It is even necessary to loop the wire. A single twist brings it under a retaining lug, so that when the binding screw is tightened the wire stays in place.

The convenience of this binding post makes it very much easier for the wireman in ordinary installation, and the sure contact with short wires makes it a most desirable switch for confined spaces. Any wireman will tell you he would rather wire up an Arrow E Snap Switch than any other switch on the market.

The indicating dial on Arrow E snap switches lies in between the cover and the cover lining. There is no open hole from the outside into the switch mechanism. It is just as much sealed up as a non-indicating switch. No moisture, dirt or dust can get through. This indicator being independent of the mechanism, it puts no additional burden on the spring, and these switches are consequently just as long lived as non-indicating switches.

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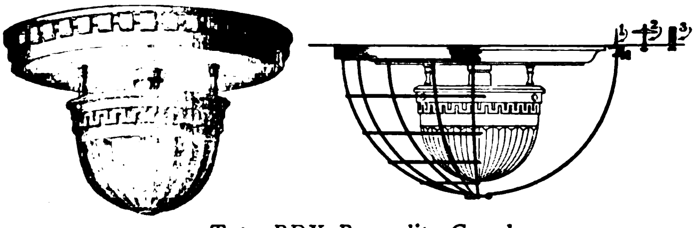
PROTECTIVE GUARD *for* LIGHTING UNITS

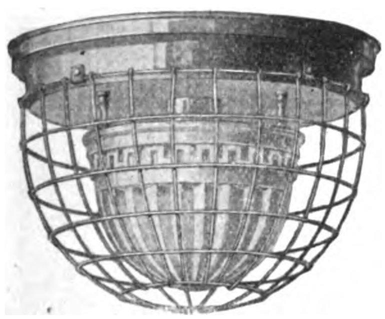
The Luminous Unit Co., of St. Louis, Missouri, has developed recently a guard of new design. In the Type BD unit, the guard is integral with the remainder of the fixture; but the new guard, which is designated Type BDX, may be installed in combination with any of a number of Brascolites of different designs. Or it can be used to protect any other



Type BDX Brascolite Guard

lighting unit which can be contained within it.

As shown in Fig. 2, the Type BDX guard is supported by an angle-iron ring which is drilled with four holes to provide for fastening to the ceiling. The ring is entirely independent, mechanically, of the lighting unit which is to be protected. Therefore, when strains are imposed on the guard, they are not transmitted to the lighting unit. The hemispherical wire cage is held to the ring with four knurled-head set-screws. These permit the easy removal or replacement of the guard to provide for cleaning and lamp renewal. The guard proper is made of mild steel wire, electrically welded at the junctions. Screws of any of three different types can be used for supporting the guard ring to the ceiling. As shown at 1 (Fg. 2) wood screws are supplied when it is



Type D Brascolite, Luminous Unit Co., St. Louis, Mo.

specified that the ring is to be mounted on a wood or a plastered wood-lath ceiling. When it is specified that the ceiling is of metal-lath or hollow tile, toggle bolts as indicated at 2 are supplied. Expansion bolts will be shipped when it is specified that the ring is to be installed on a concrete, stone or glazed brick ceiling. The guards are made regularly in four different sizes of the following outside diameters: 13, 18, 21, 25 in. They can be used respectively with bowls of the following outside diameters: 10¼ or 11 in., 14, 15 or 16 in., 18 or 19 in., 22 or 23 in. The Brascolites for which these guards can be used are the Types, AD, WD, NB, FE and IB.

OVERLOAD CIRCUIT-BREAKERS

A new type of circuit breakers, differing from other makes by the fact that magnetic blowouts are used and that the current is carried on solid copper rolling contacts instead of the usual laminated contacts, is being manufactured by the Allen-Bradley Company, 495 Clinton Street, Milwaukee, Wis. The operation of these breakers is on the same general principle as other standard overload breakers. The manufacturer claims that this apparatus is particularly well adapted to the protection of electric motor circuits and for installation on panels with motor control. The breaker is made in both the single-pole and two-pole types. The plain overload breakers will carry their rated capacity continuously and can be set to trip at 100 percent. above and 50 percent. below rated capacity. These breakers are for direct-current service.

FARM-LIGHTING PLANT

A farm-lighting unit complete with battery and self-starter generating 110 volts direct current and which has 660 watts capacity is being manufactured by the Unilectric Corporation, 235 Mount Elliott Avenue, Detroit, Mich. Motors up to ½ hp. can be operated and at the same time 300 watts can be used for illumination. A 4-cycle motor is equipped with a Dixie magneto and a storage battery automatically charged. Fuses, complicated switches and belts are said to be eliminated.

Constant voltage is maintained at all times under varying loads by an electric throttle governor. All operating parts of the valves and cams are well oiled and incased in dust and waterproof compartments. The plant is started and stopped by the push of a button located at any convenient point.

SUCCESSFUL BURNER FOR FUEL OIL

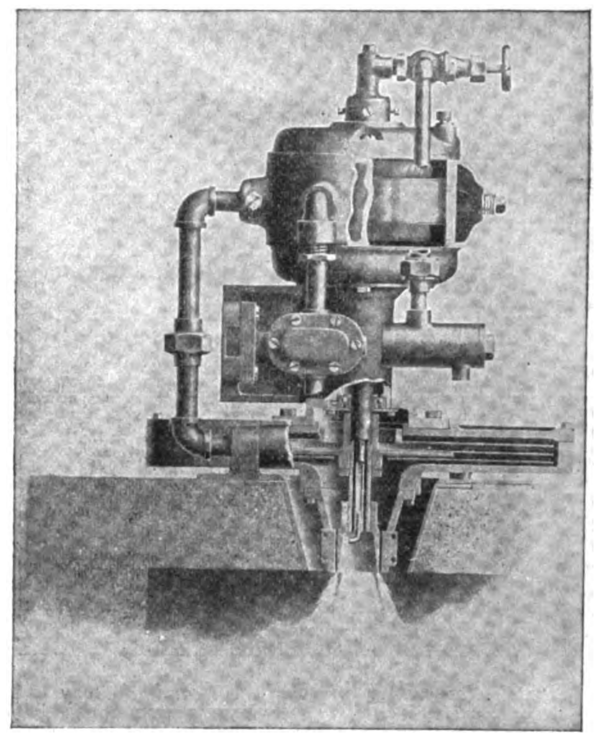
In order to prevent a recurrence of the fuel conditions of the past winter, much study is being given to the fuel situation.

One of the suggested means for relief is the more extensive use of fuel oil, particularly in those sections of the country where it can be easily and cheaply obtained.

The use of this fuel has many advantages, such as simplicity in handling, convenience, efficiency, and in many localities it is cheaper than coal.

That fuel oil has not had a wider use, has been due largely to the types of burners which have been developed, many of which have not been practical for general use.

To be successful, such a device must be simple. Complicated machinery, driving pumps, air blowers, and gear boxes form a complex problem, with high initial cost and heavy expense for upkeep. For all practical applications the



Sectional View of Ray Oil Burners operated by Westinghouse Motor.

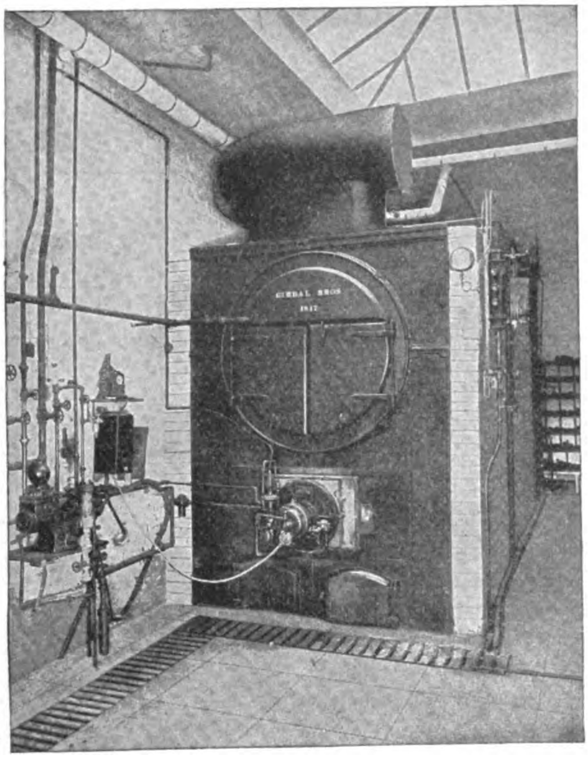
burner should require no adjustments after installation, and should operate over long periods of time without attention. When properly installed a successful burner carries a very low fire hazard.

To burn fuel oil, it must be perfectly atomized, and at the same time sufficient air must be introduced to get through combustion. Several methods have been used. Steam and air atomization, while successful, are not entirely satisfactory for a number of reasons, chief of which is the waste of oil, which cannot be countenanced, particularly under present conditions. Air atomization requires too much complicated machinery to obtain the desired results. Steam is not always available and is only feasible for high-pressure work. Therefore, in order to make the burning of fuel oil both popular and profitable, the need has been for a mechanical atomizing burner with high efficiency, low upkeep and small initial cost.

W. S. Ray, of San Francisco, has devised a method of atomizing oil in an open cup, lying horizontally, driven at 3450 revolutions per minutes, and then forcing air at high velocity around the cup and in a direction away from the cup. In this method he not only introduces sufficient air for proper compression but also enough to direct the fire into the fire-box. Naturally, the air leaving the blower would be turning in the same direction as the atomizer, causing the fire to be unsteady, and having a tendency to throw oil on all sides of the fire-box, but this the inventor overcomes by inserting guide vanes in a nozzle surrounding the atomizer, which direct the air from a revolving motion to a straight path.

This method has been found to give perfect combustion to the oil, and the inventor has developed a burner to utilize it with as little complication as possible.

So necessary is the oil burner to the institution in which it is used, wherever it may be installed, that no excuse will be accepted for its being out of commission at any time.



Installation with 150 hp. boiler in candy factory.

Therefore, it must be constructed of the best material, and all parts must be easily interchanged and of well-known standards.

The Ray Oil Burner has standardized with a Westinghouse totally enclosed motor. The hollow shaft of this motor has been extended to permit the worm gear to be fastened to the center of the shaft, and the blower and atomizer are attached to the end opposite the motor. This permits the centering fo the bearing on the shaft. A Hess Bright ball bearing is used at each side of the worm gear. This worm gear is encased in a housing which is constructed with an oil well at the base. This gives the two bearings a splash feed which is positive and removes the danger of either under-oiling or of over-oiling.

The totally enclosed motor jacket is specially cast with a hollow frame so as to completely encase the motor and allow the fuel oil to continually pass around the motor. This lengthens the life of the motor by keeping it cool at all times, and at the same time, warms the oil somewhat before it is introduced for combustion. This also permits the use of the burner in a boiler room with a temperature so high that an ordinary open motor would overheat and burn out.

With the exception of domestic stoves, fuel oil as low as 14 gravity can be burned successfully without smoke, soot or dirt, in all types of fire boxes, where high heat is needed. In California, with coal at $8 per ton, and fuel oil at $1.50 per barrel of 42 gal., a saving of approximately 50% over coal may be obtained with this burner, on the basis that coal has 14,000 B.t.u. per pound, as against oil at 18,500 B.t.u. per pound, and assuming that the coal is perfectly fired. Usually at least 25% of the heat units are not obtained from the coal on account of imperfect firing which causes incomplete combustion.

In addition to this saving in the cost of fuel, there is an additional saving in the cost of attendance. To burn coal requires attendants constantly on the job 24 hours per day, whereas one man can supervise a large number of oil burners. This feature is well worth consideration, not only from a monetary standpoint, but also from the standpoint of the labor supply, which has been greatly depleted by war conditions.

The Ray oil burner is very flexible in its application and can be used in anything from a hot-air furnace in a private residence to a 500 hp. boiler installation.

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WIRELESS TELEGRAPH BUZZER

The electrical buzzer is a most valuable instrument in wireless work. Early in the development of radio communication, the electrical buzzer was employed for testing the sensitiveness of the filings coherer, making certain that the receiving set was ready to respond if a transmitting station should happen to be working. And to this day the buzzer has remained an important adjunct to radio work.

As in the case of other apparatus, the buzzer has undergone marked changes from the crude form employed on bell circuits. The aim has been to obtain a greater rate of vibration from the armature, so that the interruptions would be of a higher order. This has called for delicate adjustments and good contacts, so that the present radio buzzer bears about the same resemblance to the conventional buzzer that an automobile bears to a wheelbarrow.

Typical of present day radio buzzers is one designed by Louis G. Pacent of New York. It is fitted with lock nut levers for permanently locking the adjustments after the proper pitch or note has been obtained. No tools are required. The base is of composition, while the black-enameled brass case is fastened on by a bayonet socket arrangement. This buzzer which is necessary for exciting radio oscillating circuits for measurement work and detector tests, has been approved by the U. S. Navy. It can be adjusted to give a tone of 500 cycles of 1,000 sparks per second, simulating the signals of most modern transmitters.

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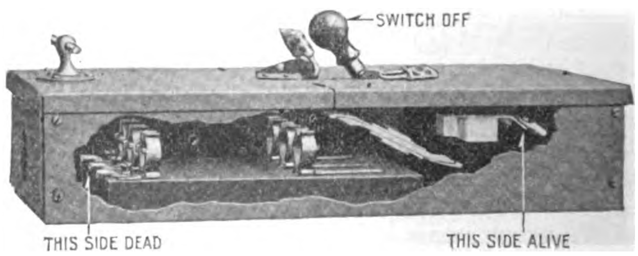
SAFETY SWITCH

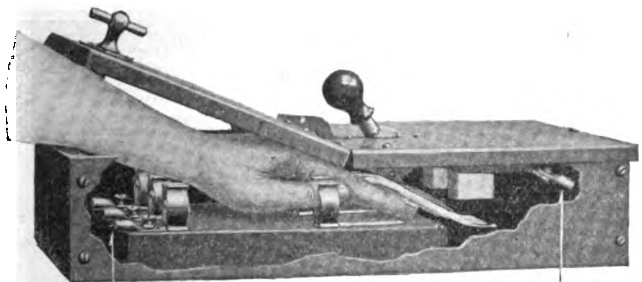
In many steel mills, factories, mills, and similar industries where most of the workmen have little knowledge of electricity, it is desirable to use switches having no live parts exposed or accessible in the ordinary operation of the switches or when replacing fuses.

This is fully accomplished in the Krantz Auto-Lock Switch, marketed by the Westinghouse Electric & Mfg. Co.,



Krantz auto-lock switch, locked in open position.

which is intended for use on main circuits or wherever an ordinary knife switch is applied. The switching parts and fuses are enclosed in a steel box, the cover of which is in two parts, one being screwed on to form a permanent covering for that end of the box containing the switch, and the other part being hinged so as to swing back and permit the renewal of fuses, which are located in this portion of the box. An ingenious latching mechanism makes it impossible to open the cover without first throwing the switch to the "off" posi-



Shows how it is impossible to touch live parts.

tion and rendering all fuses and other accessible parts dead. Thus fuses may be replaced at any time with absolute safety. As long as the door of the case is open, the switch contacts can not be closed.

By using a padlock, the switch handle can be locked in the "off" position, making it impossible for any one to close the switch, except the person holding the key to the padlock. By using another padlock, the cover may be locked shut, so that the fuses cannot be tampered with. Either of these padlocks can be used independently of the other, so that the switch cover can be locked shut with the switch either "on" or "off," or the switch can be locked in the "off" position with the cover either locked or open.

Contact is made by means of a laminated spring copper brush, double ended with auxiliary arcing contacts at each end. The outer leaves of the brush are bronze to provide additional spring pressure.

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COIN HANDLING MACHINES

Much labor is saved daily at the offices of the Detroit United Railways by automatic coin handling machines. A bank of machines made by the Sattley Coin Handling Machine Company of Detroit, Mich., handle an average of 200,000 coins each day.

The machines, operated by Westinghouse 1-3 hp. motors, receive the miscellaneous coins in the hoppers at the top. Without further attention, battered and badly worn pieces are thrown out and the remaining coins are sorted into their respective denominations. These are accurately counted and properly wrapped in rolls of any desired amounts. Thus a great deal of time is saved and the element of error is reduced to a minimum.

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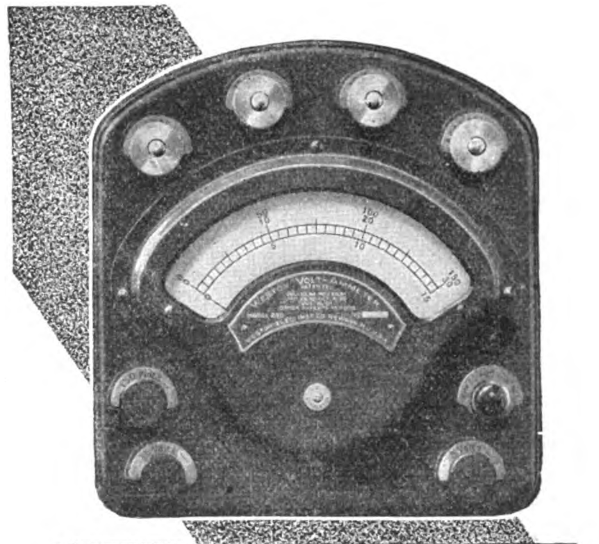

Electrical Engineering

Treating of the Theory and Practice of Electrical Generation and Transmission, and the Utilization of Electrical Energy.

Frank A. Lent, New York

Vol. 52 **SEPTEMBER, 1918** **No. 3**

ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

By H. A. Hornor

(Concluded from page 22, August issue)

Various Types of Ships

Under normal business conditions, ship designs naturally differed in many respects. The prime mover of such changes was the insatiable spirit of competition. However, it has been possible to group vessels into certain classes, as well as to subdivide them for specific registration. In the various large classes the electrical installation as a whole has its modifications in extent and character. This particular subject has been treated in rather full detail in a paper presented at the Panama-Pacific Convention of the American Institute of Electrical Engineers, San Francisco, California, September 16, 1915. It will suffice to make excerpts from this paper to indicate briefly the practice and to these will be added an approximation of the cost of each installation.

Launches and Yachts.

For the amateur yachtsman there are complete outfits manufactured which may be purchased for a moderate amount oi money. The extent and character of such installations depends entirely upon the luxury desired by the owner. Naturally there are installations which are most elaborate and costly. On the other hand the small steam, or gasoline, motor launch may be conveniently equipped with a one kilowatt, direct-connected generating set wound for a standard voltage. In this manner standard lamps, fittings, and searchlights may be used.

Tugboats, Fireboats, etc.

The equipment of a seagoing tug usually consists oi two 10-kw., 110-volt generating sets; one 18-inch searchlight; and approximately 120 incandescent lamps. The type and style of fixtures does not differ greatly from that used on larger merchant ships. A specially small steam-tight fixture is sometimes provided. This installation would cost about $4,000.

Dredges

The merchant type dredge carries about 120 lights, one or two searchilghts, a couple of 10 kw. generating sets. A special diverging lens may be fitted on the searchlight so as to divide the beam, lighting both banks of a stream and keeping the center dark so as not to interfere with the regular traffic. This type of installation costs a little more than the seagoing tug, because of the size of vessel and approximates $4,200.

Ferryboats

The usual type of single-decked ferryboat that plies the Delaware River between Philadelphia and Camden carries about 225 incandescent lamps and two generating sets at 110 volts. One of these sets is large for the night load and one small for the day load. Special switching devices are arranged automatically to cut in and out the proper running lights as the captain locks and unlocks his steering wheel. Such an installation costs approximately $3,800.

River Excursion Steamers

There are two types, one for day trips only and one for night trips. The former are not so elaborately furnished, or as extensively lighted, as the latter.

Day boats carry about 300 or 400 lights, one 18-inch searchlight and a couple of 35-kw. generators. Their installation costs approximately $5,000 to $6,000. The night boats carry a 100 to 200 kw. generating plant, from 900 to 1200 lamps, and a large searchlight. The decorative features usually require special lighting fixtures of expensive design. The cost of the installation is difficult to determine. Some installations in the past cost as much as $25,000 to $30,000.

Freight Vessels, Colliers and Oil Tankers

Moderate size vessels of this type, 5,000 to 6,000 tons carrying capacity, carry about 150 fixtures, two 10-kw. generating sets and one 18-inch searchlight. The installation costs about $8,500.

Coastwise Passengers and Freight Vessels

The electrical installation in this type of vessel may become more extensive as it is customary to carry an electrician aboard. For a fair sized vessel there would be provided about 150 to 200 kw. capacity about 1700 to 1800 lights, two searchlights, and numerous small motors both for the galley appliances, the machine shop tools, and for artificial ventilation. All the important signalling systems calculated to insure the safety of passengers, or give them comfort, are installed. Wireless telegraph is required by law; so also is a complete auxiliary lighting system for the passageways and principal living rooms. This latter may be separately energized, and may be supplied either from a storage battery or a gasoline motor-generator outfit. This latter equipment has not been eagerly sought after by careful owners. The cost of such an installation varies between $25,000 and $30,000.

Conclusion

The activities of man are restricted to the present, but his thoughts are permitted to rehearse the past or speculate upon the future. As "time and the hour runs through the roughest day" may exact an account of some special action done at some precise time, yet in the comprehensive view of the present emerges from the past as similtaneously it enters into the future. For a broad view of the development of the electrical applications to marine progress it will be well to briefly summarize what has been done in all time.

The Past

W. D. Forbes in a short article reviewing twenty years of "Changes and Advances in Marine Auxiliaries" published in the April, 1917 issue of *Marine Engineering* has this to record of electricity.

"During the period named the introduction of electric light aboard ship has contributed more to the safety and comfort of all hands than any single advance. Electric generators and their motive power units are now thoroughly reliable, and it, of course, follows that the electric motors are equally dependable.

Also satisfactory storage batteries are now obtainable, adding greatly to the comfort of those in charge. The continuous rotary motion in moving machinery is self-evidently a condition which would make for smooth running and lasting qualities in driving ship auxiliaries. The first of these was the electric motor and when coupled to a fan, and the plant was in proper balance, there was no vibration and but little noise."

This speaks well for a past performance.

Present Tendencies

The lighting system advances in direct ratio with the development of the electric lighting unit. There is apparent an effort to put aside the old practical methods of "spotting" incandescent lamps and substitute exact calculations based upon the investigations of the illuminating engineer. This tendency will no doubt lead to further improvements in the type of fixture and the methods of handling light.

As to the power auxiliaries, Mr. Forbes in the above quotation shows that rotary motion either by steam turbines or electric motors holds the attention of marine engineers. This is further subscribed to from the English viewpoint by C. R. Bruce in an article published in the annual number of *Shipbuilders* for May, 1917. He says:

"The driving of auxiliaries on board a vessel by steam turbines or rotary steam engines presents a number of advantages. Alternative proposals have been made from time to time in the direction of driving the various engine-room auxiliaries by electric motors supplied with current from a central generating station, and the proposition has undoubtedly attractive features. The difference in weight and space occupied by auxiliaries on the rotary principle, whether steam or electric, is striking, and the merchant service cannot long remain uninfluenced by this development. Imported auxiliaries to which the rotary principle has been applied are the feed pumps, the ventilating and forced-draft fan, and the main circulating pumps."

For the propulsion of the vessel the combination of the high speed steam turbine with double or single mechanical reduction gear has the preference over all other suggested methods. On this subject Mr. Bruce says:

"Whether the mechanical gearing will fulfill all expectations remains to be seen. According to present indications, it would seem that the advent of the geared turbine means that the reciprocating engine is doomed for powers above say, 3,000 horsepower for single screw and 6,000 horsepower for twin screw ships. Electrical propulsion is favoraly reported upon in America, where it is at present being installed on certain war vessels. It is in the heavier classes of naval work that the field for electric propulsion seems most promising, on account of interchangeability and the great range of speeds over which good economy can be maintained. In this particular respect the electrical system is superior to all other methods of marine propulsion. In the merchant service, however, such considerations are of little importance. Still, one cannot say how far the development of the passenger liner may go and it may be that in such vessels will be found opportunities for the application of electrical propulsion. Powers may be demanded in the future beyond the scope of the geared turbine, and the electrical system would seem to possess all the essentials for the development of the highest powers."

Mr. Bruce gives tables showing the progress in marine machinery for cargo steamers from 1877 to 1916. It is interesting to note that this type of vessel increased in length from 314 ft. to 503 ft., in speed from 11.25 knots to 14.25 knots, in indicated horsepower from 775 to 7000 shaft horsepower, from one tandem compound steam engine to two Brown-Curtiss steam turbines and that the fuel consumption was reduced from about 2.5 lb. per horsepower to .85 lb. per horsepower.

Trend of the Future

The creative imagination has full play in the broad vista of electrical invention. There are many improvements of a practical nature which the past developments in this branch of applied science promises to fulfill in the future. For matters of safety vessels now carry auxiliary lighting outfits whose source of energy is not derived from that which propels the vessel. Indubitably the future holds out some method of generating electricity economically other than the use of steam or oil. As soon as such a method is discovered the auxiliary supply will not be required. In the nature of advances the methods now used for distributing energy especially for lighting purposes will be superseded either by economical portable electric unit or a system of lighting not requiring the flow of current along a conductor.

Final Word

From the opinions quoted previously the future seems very bright for an enlarged and progressive employment of electricity for the propulsion of vessels. It is believed that the day for electric propulsion is now dawning. Practical advance in the design of oil engines of large power direct-connected to electric generators is in line with the progress of ship design in that vessels of the future will be high speed, high power, and of large displacement. The question always arises is there a limit? When all ships are driven by an electric couple will this be the ultima thule? The answer is negative. Even if the point of improvement is reached wherein the vessel may obtain her fuel from the liquid in which she travels, there will be found only the asymptotes of the hyperbola of future invention. In the course of natural events the high speed vessel will doubtless be largely promoted for the peoples of the earth, now drawn nearer and nearer to each other by the mysterious signals of the air, who will demand a closer physical communication for their welfare and prosperity. As fantastic as it may seem in this day when a business man opens his morning paper in the ferry boat and complacently avails himself of the security of arriving in a few brief minutes on the other side of the river so will the time come when the mighty forces of science will safely transport a like business man from New York to London in time to execute his business and return home for supper.

INDUCTIVE EFFECTS OF ALTERNATING CURRENTS

The operation of trunk line railroads in recent years by means of alternating currents has not been hailed with joy by the telegraph and telephone companies whose lines happened to be within the sphere of influence of the railroad power circuits. From the day the first train ran there has been trouble on the intelligence lines, due to inductive effects. How these inductive effects are produced and what means have been adopted to overcome them are told in this article, which was presented by H. S. Warren in a paper read before a recent meeting of the Philadelphia Branch of the American Institute of Electrical Engineers.

Introduction

Telephone and telegraph companies in the conduct of their business not only have to maintain their lines and service against ordinary forms of interruption, such as lightning disturbances, mechanical failures, etc., to which all overhead electrical lines are inherently subject, but also, they have to see to it that their lines are protected against the interference by electric power lines. Such interference may be due to actual or threatened physical contact between wires of the two systems, to passage of current from one system to the other by leakage, or to the class of disturbances known as "inductive."

One important kind of inductive disturbances on telephone and telegraph lines is that arising from installations of alternating current railroad electrification, such installations being principally employed in connection with trunk line railroads carrying heavy traffic.

In approaching the subject of interference to communication systems by such electrificed railroads, it seems desirable first to consider some aspects of the general subject of inductive interference from power lines, of which interference from electrified railroads is a special case. In this general discussion of the subject it will be convenient to borrow freely from the work of the Joint Committee on Inductive Interference in California.

Historical

The induction of voltages in an electric circuit by current changes in a parallel circuit was discovered by Faraday in 1831. The property of self induction of an electric circuit was discovered by Joseph Henry at about the same time. The phenomenon of induced electrostatic charges was known already through various experiments. In 1838 Henry, in the course of his researches, observed that a current was induced in an electric circuit when a Leyden jar was discharged through a parallel circuit. This seems to be the first case on record of electric induction between circuits.

Since the time of Faraday and Henry a stupendous amount of electrical research and experimentation has been conducted and as a result of this and of brilliant theoretical work by Maxwell and others, the fundamental laws of electrostatics and electrodynamics has been very fully worked out. The general equations expressing the laws of induction are, however, not suitable for us in the solution of practical problems. On account of the large number of factors involved, many of which cannot readily be evaluated, it is generally necessary in specfic cases to resort to simplifying assumptions and approximations.

As to what actually happens when a voltage is set up in an electric circuit by induction we know very little. It is well to bear in mind that we do not even know what voltage really is, or current, or electricity. We use these terms merely to express certain phenomena and relations found by observation, whereby we are able to derive results of much practical value.

Characteristics Affecting Disturbances. Telephonic currents consist of numerous component simple currents varying in frequency from about 200 to 4000 or more periods per second. The signaling currents employed on telegraph lines are also complex, but their most important components are of less than 300 periods per second.

Power circuits are commonly of either 25 or 60 periods per second but, in addition to the fundamental periodicity, harmonics are usually present to a greater or less extent and it is due almost wholly to the harmonics which come within the range of the most important voice wave components, that noise is produced in telephone circuits by induction. By care in designing electric power machinery, so as to reduce the proportion of such harmonics, it is probably feasible to avoid much of the noise disturbance to telephone circuits which otherwise would result. Thus a small expense in eliminating this trouble at its source may obviate a much larger expense later.

Abnormal Conditions. It is important to recognize that the inductive effects of power circuits are liable to be greatly magnified at times of abnormal conditions. The violent changes which occur in the electric and magnetic fields surrounding a power circuit, when one of its conductors breaks or becomes grounded, set up in neighboring communication circuits surges which may represent relatively large amounts of power. A parallel which, under normal operating conditions, causes no disturbance may produce very serious interference under abnormal conditions.

Balanced and Residual Voltages and Currents. In analyzing inductive phenomena it is advantageous to classify power circuit voltages and currents under two general heads: (1) Balanced voltages and currents, that is, those which are balanced or symmetrical with reference to the earth; (2) residual voltages and currents, that is, those which are wholly unbalanced with reference to the earth. The circuit of the residual voltages and currents is comprised of the metallic circuit conductors as a group, constituting one side, and the earth (including earthed conductors), constituting the other side.

At every instant the algebraic sum of the balanced currents, and likewise of the balanced voltages, is zero. Hence, at any instant the algebraic sum of the currents in the line conductors is the residual current and, similarly, the algebraic sum of the voltages to earth of the line conductors is the residual voltage. For example, in an ordinary railway circuit, consisting of overhead trolley wire and grounded rail return, all the voltage and current are residual.

There is no definite relation between these two classes of voltages and currents and entirely different means usually have to be taken in counteracting their respective induction effects. In general, the residuals cause more inductive disturbance than the balanced components as the residuals are all in phase and their effects are cumulatice, whereas the induction from the balanced voltages and currents in one conductor is partially neutralized by the induction from balanced components in each other conductor of the circuit. Also the residuals usually contain a larger proportion of harmonics than the balanced components and this is another reason why they are likely to cause more disturbance, particularly to telephone circuits.

Causes and Preventive Measures for Residuals. As residual voltages and currents are largely responsible for inductive interference, it is of great importance in the prevention of such interference that they be suppressed or reduced by all reasonable means available.

Star-connected, three-phase, transformer banks with the neutral grounded will set up triple harmonic residuals due to variation of permeability of the iron from varying magnetic density and may also cause residuals by reason of inequalities of the transformer impedances. In general, the most effective measure against this triple harmonic effect is the use of a delta-connected secondary or tertiary winding, thus providing a shunt path for the triple harmonic currents. The magnetic density also should be kept as low as practicable. Residuals due to inequalities of impedances in transformer banks can, of course, be eliminated by equalizing these impedances.

Another condition which may produce large residuals is the use of generators with star-connected armature windings. When such a generator with its neutral grounded is connected to a power line, either directly or by autotransformers, residuals are set up in the line. When such a generator, with its neutral not grounded, is connected to the line through standard transformers, residuals will be impressed on the line if the transformer bank is connected star-star, the line side neutral grounded, and the station side neutral connected to the generator neutral.

Grounding of transformer or generator windings at any points not normally at zero potential, unbalances an electrically connected circuit and thereby causes residual voltages and currents.

Another important cause of residuals, which however may not be so obvious, is the unbalance of a power circuit due to in quality of the capacitances to ground of its several conductors. If the three line conductors of a three-phase circuit are carried throughout in the same relative positions, that is, if the circuit is not transposed, the capacitances to ground will be unequal and a part of what would otherwise be balanced voltage and current becomes residual. These inequalities may be overcome by transposing the power circuits throughout their entire length. To make such transposition effective with respect to interference to telephone circuits it is necessary that the power circuits be transposed at intervals which are short in comparison with the wave lengths of the higher harmonics present. The frequency of transpositions depends somewhat, however, on the inherent unbalance of the conductor configuration. As an indication of the number of transpositions required for a reasonable degree of balance to ground, it may be said that parallels of 6 to 12 miles the latter applying to a triangular configuration, are usually adequate.

It is evident that the symmetry of a line which has been thoroughly transposed may be destroyed by connecting to it branches or taps which unbalance the capacitances to earth of the line conductors. Of course, if such a tap is grounded, the residuals resulting may be very large.

At times of accident, when a power circuit is in an abnormal conditions, residuals of relatively enormous values are liable to be created. These set up correspondingly large induced voltages in parallel communication circuits. This emphasizes the importance of high grade construction and maintenance of power lines involved in parellels so as to minimize the frequency of such occurrences.

Unbalance of Communication Circuits. Not only are there these two kinds of disturbing voltages and currents on power circuits, namely, balanced and residual, but each of these components may set up, in a neighboring metallic communication circuit, two different effects; (1) an induced voltage betwen the two conductors of the communication circuit, which directly tends to cause currents through the signaling instruments; (2) an induced voltage between the conductors of the communication circuit and ground, which by reason of unbalances in the communication circuit indirectly causes currents through the signaling instruments. Theoretically, assuming a telephone circuit and all its connected apparatus absolutely symmetrical, electrically, with respect to earth and always so maintained, voltages induced equally in the two sides of such a circuit would not cause noise in the telephone. In practice it is not possible to attain absolute symmetry although in well constructed and well maintained telephone circuits the degree of balance is very high indeed. The telephone is, however, such a very sensitive instrument that no attainable degree of balance can avoid noise when relatively very high voltages are induced between the telephone wires and ground, as is done in many cases by parallel power circuits. It is therefore essential that induced voltages to ground be limited to values which are permissible on communication circuits so maintained.

Transpositions Within Parallels. Interference by induction from balanced currents and voltages can most readily be prevented by means of a coordinated system of transpositions applied to both power and communication circuits within the limits of parallels, the term "parallel" being understood to mean the region within which the two classes of line are in sufficiently close proximity for inductive disturbances to be set up in the communication circuits by the power circuits. It is to be noted that transpositions for this purpose to be applied to power circuits within the limits of parallels, are quite distinct from the transpositions previously referred to as being necessary throughout the entire length of a power circuit in order to equalize the capacitances to ground of the several conductors.

Principal Factors in Determining Interference. Before leaving this general part of the subject I will enumerate the principal factors which determine the amount of induction and whether it is sufficient to constitute interference.

1. *The length of the parallel.*

Other things being equal, the longer the parallel, the greater the induced voltage.

2. *The separation of the two classes of lines.*

In general, other things being equal, the less the separation of the power line and communication line, the greater the induced voltage.

3. *Configuration of the power line.*

The investigations of the Joint Committee on Inductive Interference show that the configuration of the power line has an important bearing on inductive effects, the relative merits of different configurations varying with the separation of the power and communication lines, the spacing of the power conductors, and the relative importance of balanced voltages and currents. While it is not possible to draw a simple general rule for determining the most advantageous configuration the differences in particular cases are marked and deserve special attention as oftentimes substantial benefit can be secured in this way at small additional cost. This is particularly true of multiple circuit lines, the resultant induction depending largely on the relative poling of the power circuits.

4. *The magnitudes and fundamental frequency of the normal operating voltages and currents of the power circuits.*

The effect of electric induction, of course, is proportional to the voltage of the power line, and of magnetic induction to the current on the power circuit.

5. *The magnitudes of residual voltages and currents.*

It has already been explained that residual voltages and currents are a principal cause of inductive interference. Hence while the amount of residuals on metallic circuits is usually small as compared to the balanced components, the inductive effects of the former are liable to preponderate.

6. *The wave shapes of both balanced and residual voltages and currents, involving the magnitudes and frequencies of all harmonics.*

The effect of wave shape on interference, to telephone circuits particularly, is exceedingly important. Wave shapes in practice on different power systems are found to have extremely wide variations. An unfavorable wave shape, *i. e.*, one having a large proportion of high harmonics, may produce a hundred times as much noise as a pure sinusoidal wave of fundamental frequency.

7. *The unbalances of the communication circuits, their magnitude, character and location.*

Such unbalances are caused by inequalities in resistance, inductive, insulation or capacitance to ground. The last mentioned quantity is balanced approximately by transposing the conductors. The other elements enumerated require proper design, construction and maintenance of these lines, where in open wire or in cable, together with their connected apparatus.

8. *Terminal apparatus of the communication circuits and the distance of such apparatus from the parallel.*

The senitiveness of the terminal apparatus is, of course, an important factor in determining the allowable amount of induced voltage. Also if the parallel is at a considerable distance from their terminal of the communication circuit, the induced voltages and currents may become considerably attenuated before reaching the receiving instruments.

9. *The voltages and currents of the power circuits under abnormal conditions.*

It has already been stated that the voltages and currents of power circuits under abnormal conditions, which are liable to be largely residual in character, produce the most severe inductive effects. The values of these quantities under abnormal conditions, in relation to corresponding values under normal conditions, vary a great deal on different power systems.

10. *The number of parallels which may effect cumulatively the same communication circuit.*

In many cases the same communication circuit, especially if it be on a long trunk line, may be involved in a considerable number of different parallels. In such cases the induction contributed by each parallel must be sufficiently restricted so that the cumulative results from all will not produce disturbances which cannot be endured.

11. *The importance and character of use of the communication circuit.*

It is obvious that the more important circuits, on which interference is most serious, should be afforded a higher degree of immunity from disturbance than circuits of less importance. also, of course, the character of the communication circuit as, for example, whether it is a telephone or telegraph circuit, is of fundamental importance in considering the question of inductive interference.

12. *The volume of transmission on the communication circuit.*

In case of a long distance telephone circuit, where the volume of transmission is small, a less amount of extraneously induced current will interfere with receiving than on circuits of less length where there is a large volume of transmission.

13. *The relative cost of preventing interference.*

While in all cases means should be employed which will allow adequate communication service to be given, still it is not expected that complete freedom from inductive disturbances can be attained. Any induced voltage, no matter how small, will generally cause some impairment of service. The amount of induced voltage which it is justifiable to allow, depends to some extent on the difficulty and expense involved in further reducing such voltage. After the foreign voltage has been reduced to an amount which can, if necessary, be tolerated, it becomes simply a problem of balancing the value of further improvement against its cost.

It will be seen that the number of elements affecting inductive interference is quite large. Moreover, some of these elements, as for example, the wave shapes of the lower circuit voltages and currnts, are not ordinarily known, and have induction-producing values varying enormously in different cases. Hence the difficulty of formulating any simple method of determining in advance whether a given construction will or will not produce interference.

The foregoing discussion, while general in its application, is in many respects concerned with reduction from power transmission lines. We will next consider specifically some of the inductive effects of alternating current railroad installations.

Alternating-Current Railroad Electrification

The reasons why alternating-current railroad electrifications cause large disturbances to neighboring communication lines, principally by electromagnetic induction will now, I think, be apparent when it is considered that, (1) the railroad trolley road circuit, from its nature and use, is more subject to abnormal conditions, such as short circuits, than ordinary power transmission lines.

Classes of Interference. Some of the different ways in which disturbances due to alternating current electrified railroads manifest themselves in the telephone and telegraph plant, may be classified as follows:

1. *Interference with operation.*
   a. Interruption of service
   b. False bell ringing
   c. Noise
   d. Interference with telegraph signals
2. *Physical injury to plant.*
   a. Fire hazard
   b. Magnetization of loading coils
3. *Hazard to employees and to telephone using public.*
   a. Electric shock
   b. Acoustic shock

These various disturbances may be of a most serious mature and telephone and telegraph companies are unable by themselves to cope with the problem of protecting their lines and service against them. In order to make this more clear, we will review briefly some of the fundamental characteristics of telephone service and point out some of the distinctive features of the plant required to make this service possible.

The Telephone System. The fundamental electrical problem of telephony is three-fold:

1. The production of an electrical wave which is a faithful copy of the spoken word.

2. The transfer of this wave without appreciable delay over distances which may amount to hundreds or thousands of miles, without excessive change of form by distortion, without the accession of foreign disturbances, and without undue loss of intensity.

3. The production at the receiver of an audible sound wave which is an adequate counterpart of the electrical wave and, therefore, of the original spoken word.

As speech is carried on telephonically by means of an extremely small amount of energy, it is necessary that a large part of the telephone plant be of a sensitive and delicate construction. This includes the subscribers' sets where occur the delicate transformations from air wave to electrical wave and *vice versa.*

These substation instruments cannot be located at central offices where they would be under the immediate supervision of a trained staff but they must be placed in the subscriber's office, factory, home or wherever they will be most available and convenient for his instant use. There are now over ten million telephone stations in the Bell System. These sensitive nerve ends of the telephone system are distributed throughout the entire country in every conceivable variety of location.

In addition to the delicate substation apparatus, each telephone conversation requires the exclusive use of a connecting circuit. Even though the circuit be hundreds of miles in length it cannot be used for any other telephonic purpose. This exclusive circuit must be low in resistance, capacity and leakage so as not unduly to attenuate the telephone wave. It must be so transposed, balanced, and protected that so far as possible it will not pick up electrical disturbances from earth currents telegraph lines or other telephone circuits or itself constitute a source of disturbance to the latter. The network of telephoen circuits now comprises more than twenty-two million miles of wire.

In addition to meeting the above basic requirements, the telephone system, in order to realize its potentialities as a utility of the greatest benefit to the public, must include facilities such that at any time on request of a subscriber connections can be made between any two points, without delay or other inconvenience, and the charges for the service must be as low as possible. At present about thirty-two million such telephone connections are made per day in the Bell System.

Prompt, efficient and economical service on the existing scale requires that an immense number of separate circuits be brought together into common central offices and provided with every device and attendance which will facilitate traffic over the system. It requires, for example, that hundreds of wires be crowded into cables, the latest types of which have 2400 conductors within a sheath whose outside diameter is 2⅝ inches. It requires great congestion of wires and apparatus in switchboards in order that many thousands of lines may be brought within reach of a single operator. It requires elaborate and reliable signaling arrangements to economize time and circuits. It requires uniformity in plant and methods throughout the entire system so as to make possible prompt connection between any two points. While it has been found practicable to devise means for transmitting the required signaling currents over the telephone plant safely, the danger of fires from the currents and voltages employed for signaling has been avoided only by the exercise of extreme care, although these currents and voltages are very small compared with the currents and voltages on power lines.

From this brief consideration of the telephone problem, showing that a large portion of the telephone system is inherently of a delicate nature and susceptible to interference, it is clear that telephone apparatus and circuits would be destroyed if but a small fraction of the powerful currents and voltages used by other electric utilities were permitted to enter into the telephone system.

Values of Induced Voltage. In studying the inductive effects of electrified railroads, it has been found advisable to determine approximately the amount of induced voltage in a communication circuit, per mile, per 100 amperes in the trolley, for different horizontal separations between the trolley and the communication circuit, and with different percentages of the trolley current in the rails. For example, it has been determined that, with 60 percent., rail current (that is, 40 percent. of the trolley current return flowing in the earth as stray current), the induced voltages per mile, per 100 amperes in the trolley, are in general about 10 volts, 5 volts and 1 volt, at 50 feet, 300 feet and 4000 feet separation, respectively. Thus at 50 feet separation, with 1000 amperes in the trolley, a ten mile exposure would result in 1000 volts induced. These are maximum figures in that they are based on the assumption that power is supplied in one direction only. It should be understood that the induction varies considerably in different cases since the induced voltages are affected by all the various conditions which go to determine the course that the stray current takes. Some parallelisms may extend more than ten miles and at times of short-circuit the current may amount to many thousands of amperes, and, in such cases, the induction is liable to be correspondingly more severe unless preventive measures are taken.

The specific effects of these induced voltages will now be touched upon briefly.

Interruption of Service. Induced voltages may be high enough to operate the telephone protective devices and, if the current across the protector is sufficient, the line will become permanently grounded and the telephone service interrupted until the protector is restored to normal condition. If the protector is located in a central office, the time required to make repairs is relatively short, but if it is at a subscriber's premises, considerable time may be required for a repair man to reach the station. In cases where the operation of the protector does not actually ground the lines, it may lower the insulation resistance sufficiently to make the line noisy.

It may also sometimes happen that foreign voltage of a value below that required to break down the protector spark gap will yet be sufficient to puncture the insulation of the wiring at some point.

False Bell Ringing. Voltages of about 8, 20 and 200 volts, depending somewhat on the prevailing earth potentials, are sufficient to ring ordinary grounded bells, standard biased bells, and (by breaking down protector spark gaps) metallic circuit bells, respectively.

An accidental trolley ground on a 25-cycle single-phase electrification through a thickly settled community may ring scores or even hundreds of subscribers' bells, some of which may be located a mile or more from the railroad. Such false bell ringing is apt to be a source of serious complaint by subscribers, and is particularly annoying when it occurs at an unseasonable hour as, for example, 5 o'clock in the morning.

Noise. In order to appreciate the effect of small currents in producing noise in telephone circuits, it must be considered that a very small fraction of a microwatt of power at voice current frequencies will produce an audible sound in a telephone receiver and a few microwatts are sufficient for a telephone conversation in a quiet place. When the current in the telephone receiver caused by induction from outside circuits is large enough to produce an audible sound, it has an important effect on the efficiency of the circuit for transmitting speech, particularly when the circuit is used for talking over long connections so that the energy of the voice currents approaches the minimum which will give a satisfactory conversation. An extraneous sound which is scarcely more than audible to an untrained ear and might be thought to be of negligible consequence, has in reality, the effect of impairing a telephone circuit by a large percentage, or otherwise expressed, of destroying a material part of the circuit's value for service purposes.

The interfering effect of foreign current of a given magnitude depends very greatly, however, upon the frequency. The maximum effect is for current having a frequency of about 1100 cycles per second. At lower frequencies the effect falls off rapidly and at 25 cycles is probably only about two-thousandth as great as at 1100 cycles. This fact explains why the inductive interference to telephone circuits from 25-cycle railway systems is not predominantly noise. Twenty-five cycle current normally have relatively very small components in the telephone-frequency range and the effect of these high-frequency components is damped out much more rapidly than that of the fundamental by separation of telephone and railroad circuits. Noise from such railways is, however, present to some extent, and is liable to become serious under any conditions which produce a bad wave shape in the power circuit.

Interference with Telegraph Signals. At 25 cycles an induced current of one-milliampere is liable, under some conditions, to interfere with ordinary Morse transmission, while rapid telegraph systems, printers, etc., are more or less impaired by extraneous currents of any value.

Fire Hazard. The use of heavy insulating coverings for wires in telephone switchboards is impossible on account of the necessity of bringing many lines within a limited space. It is not feasible to employ for this purpose such insulation as is considered good practice for electric light and power wires. Thus it is unavoidable that the dielectric strength of the telephone wiring be relative low.

Investigations of the fire hazard due to foreign voltages impressed on telephone lines indicate that voltages of 200, or even less when backed by considerable power as in the case of induced currents from alternating current railways create a distant fire hazard.

Although the fire hazard brought about by railroad electrification is due chiefly to the higher voltages induced at times of short circuits on the railroad, it is possible that the repeated electrical stresses of lower voltage, due to normal railroad operation tend to decrease the dielectric strength of the insulation and thereby facilitate breakdown.

Magnetization of Loading Coils. Loading coils in very large numbers are now employed in both open wire and cable telephone circuits. These coils are liable to be permanently magnetized by any induced currents which are materially in excess of telegraph currents. While they are magnetized there is a considerabel loss of transmission efficiency and it is ordinarily impossible to demagnetize them without removing them from the circuits. Moreover large currents through the loading coils may permanently reduce the permeability of the iron cores and make them unsuitable for use on long toll cable circuits.

Electric Shock. At times of short circuits on the railroad and sometimes during switching operations, electrical surges may be set up in the telephone circuits, which are of sufficient intensity to produce electrical shocks to persons at the telephone or working on the circuits at the time. While it is improbable that such shocks will be the cause of serious personal injuries, even minor shocks are objectionable and constitute a basis of complaint as the public expects telephone instruments to be perfectly safe at all times.

Acoustic Shocks. Inductive surges such as are capable of producing electric shocks to persons are also liable to cause loud noises in the telephone receivers which may result in acoustic shocks to persons using the telephone at such times. Even the relatively slight clicks which sometimes occur due to battery interruptions may be very annoying to telephone users and acoustic shocks sometimes caused by induced voltages may be much more severe.

Investigations and Experiments. Since 1905, when first notified of the intention to install single phase electrification on a section of the New York, New Haven and Hartford Railroad the American Telephone and Telegraph Company had done a large amount of work on plans, tests, experiments and studies of various kinds, most of it in conjunction with representatives of railroads and the electrical manufacturing companies, all with the general object of finding means for protecting the telephone and telegraph lines and service against interference from electrification installations. A considerable amount of work has been done in connection with various electrification projects which have not been installed, some of these projects having been abandoned, at least in so far as the specific plans under consideration are concerned, while in other cases the matter is being held in abeyance, awaiting more favorable conditions for undertaking construction.

Means for Preventing Interference from Alternating Current Railway Electrifications

There are various means which have been proposed, some applicable to the railway system and some applicable to the affected communication systems, for preventing or reducing inductive interference. Some of these means have not been found successful or advantageous in practice while others have proved beneficial in varying degrees. It will be of interest to consider briefly some of these proposals.

Separation. The most effective means is to avoid the parallel, wherever practicable, by keeping the communication circuits and electrified railroads sufficiently separated. With the extension of electric traction, and the constantly increasing importance and efficiency of communication circuits, the avoidance of parallels will be increasingly important. However, this first rule for preventing interference, is unfortunately, not one which can be generally adopted in practise. Railroads and communication circuits must serve the same communities and it is necessary that the connecting routes of each be reasonably straight and direct. The field of influence of an alternating-current railroad which uses the running rails as a part of its circuit extends out to a great distance on both sides of the railroad. This makes effective separation from such electrified railroads much more difficult than separation from most other kinds of power transmission circuits.

Neutralizing Transformers. Where communication circuits are subject, under normal operating conditions of the railroad, to induced voltages sufficient to interfere with telegraph service, neutralizing transformers can be resorted to and if properly designed and connected into the disturbed circuits, such transformers will effect neutralization of a large part of the induced voltage. The transformers are provided with a plurality of windings, some of which, called primaries, are inserted in certain of the affected conductors which are grounded at or beyond the limits of the parallel, while the remaining, or secondary windings are connected serially into other of the conductors in which the induced voltages are to be neutralized. Under favorable conditions the remaining, non-neutralized voltage, is only 5 to 10 per cent. of the total induced voltage.

For a more complete description and discussion of neutralizing transformers reference is made to an article by Thomas Shaw in the *Electric Journal,* November, 1914.

Neutralizing transformers, however, have serious disadvantages from the telephone company's standpoint. The primary circuits, of which there are ordinarily from one-third to one-half the number of secondary circuits, are practically lost for telegraph purposes although they can be used for telephoning, at somewhat reduced efficiency. The secondary circuits are also reduced somewhat in telephonic transmission efficiency, but not so much so as the primaries.

Neutralizing transformers have served a useful purpose in the early stages of alternating current railroad electrification where means of restricting the railroad's field of inductive influence were not employed. They continue to have a limited field of usefulness, particularly in making endurable moderate amounts of induced voltages which remain after preventive methods have been applied at the source of disturbance, but they leave the general problem of interference unsolved. They are not applicable to subscribers' lines nor have they been found effective in neutralizing the higher harmonics which cause noise.

Drainage Coils. Drainage coils, bridged across a telephone line, with their mid-points connected to ground, provide a low impedance path for currents induced between wires and ground and thus tend to reduce the voltage. Such coils must be exceedingly well balanced or they will themselves constitute a source of unbalance and thus augment noise. Moreover, they increase the susceptibility to noise resulting from irregularities in series resistance or impedance of the telephone circuits. Also they impair telephonic transmission efficiency.

If telegraph service or direct-current signaling is employed on circuits equipped with drainage coils it is necessary to place condensers in series with the coils. The effect of this apparatus on telegraph service is distinctly detrimental.

Drainage coils have not proved to be adapted for general use on commercial systems but are helpful on private telephone circuits of power transmission companies for reducing high electrostatic charges when such private circuits are carried close to high-voltage wires.

Sectionalization of Telephone Circuit. An affected telephone circuit may be sectionalized by cutting in repeating coils at one or more points. This may be advantageous in certain cases of exposed rural lines where by placing a repeating coil at each end of a parallel it is possible to change to a metallic circuit through the parallel. It is also sometimes useful on private telephone circuits of power transmission companies as it makes possible the insulation of the telephone sets from the exposed telephone wires. On commercial telephone systems the usefulness of this method is very limited as it introduces large transmission losses, precludes the use of telegraph and brings in difficulties in connection with line signaling.

Shielding Conductor. A copper conductor used as a shield may be strung near the disturbed communnication wires and grounded at the ends of the parallel. With a conductor of suitable impedance, the current carried by the conductor will have a neutralizing effect on the induced voltages in the near-by communication wires. The action is similar to that of neutralizing transformers but less effective. In case of an aerial cable the cable sheath itself can be so used instead of a spearate copper conductor. The benefits derivable from this method however, are very limited.

With a view to increasing the neutralizing action of such a conductor, it has been suggested that a part of the railway current could be diverted into it. The quantitative relations involved are such, however, that great difficulties stand in the way of successful application of this scheme on a commercial scale.

Resonant Circuits. Combinations of coils and condensers, adjusted to be resonant at the distributing frequency and connected so as to reduce the disturbing current in the receiving instruments, have been employed to some extent. These afford considerable benefit for low-speed telegraph service such as ordinary hand sending. For higher-speed operation, the benefit obtainable in this way becomes rapidly less. Many modern telegraph systems operate at speeds approaching 25 dots per second which makes it impossible to differentiate in this way between the signaling and disturbing currents.

Similar methods have been suggested for reducing noise but are not usually applicable because the harmonics which cause noise are within range of frequencies required to give good telephonic quality.

Balance and Insulation of Telephone Circuits. It is advantageous to construct and maintain telephone circuits exposed to induction with a high degree of balance and insulation. This includes an adequate transposition system. In all cases of inductive disturbance care should be exercised that these features of the affected lines are properly attended to.

Use of Relay Sets. On direct telephone lines the bell is bridged between the two metallic conductors. On two-party selective lines one bell is connected between each side of the circuit and ground. On four-party semi-selective lines two bells are connected between each side of the circuit and ground. On four-party lines, with full selective ringing, the bells are not connected to ground except at times when an operator is ringing on the line and at such times the connection of the bell to ground is established by means of relays. On all these classes of lines both sides of the circuit are grounded at the central office.

It will thus be seen that an induced voltage between the circuit conductors and ground might ring all grounded bells, but under normal circumstances would not ring bells on a direct line or at stations equipped with relay sets. However, if the induced voltage is high enough to operate the telephone protectors, a path to ground is established through the protector, and bells on direct lines or bells at relay stations may be falsely rung.

Biasing Bells. In regions where the induced voltages are not too high, false bell ringing can be obviated by biasing the bells that is, by stiffening the control springs so that increased voltage is required to ring the bells. Obviously, there are very positive limitations to what can be accomplished in this manner.

Measures Applicable to Railroads. The foregoing measures for obviating inductive interference are of a palliative nature and assume a condition of the electrification which produces large inductive effects. Another class of measures for avoiding interference looks to the source of the disturbances, the electrical system of the railroad, and seeks to avoid the conditions which produce large induction. This latter class has, in general, the advantage of benefiting, not one affected circuit only, but all communication circuits within the area affected .

Double Trolley. One radical and probably effective method of preventing inductive interference from single-phase railroads would be the use of a double-trolley circuit completely insulated from ground, thus avoiding the use of the running rails as a part of the railway circuit. This method, however, is distinctly unpopular with railway men, mainly for operating reasons, on account of the complexity of the overhead construction particularly in yards, and at sidings and crossovers. Purely from the cost standpoint this method might have advantages in certain cases, where the conditions of exposure are severe and other methods of restricting the earth currents are expensive to apply.

Frequent Power Supply Stations. One of the most important methods of interference-prevention is the provision of a sufficient number of substations to supply power to the trolley-rail circuit at frequent intervals. If the substations are near enough together, the amount of stray current and the average length of path of such current can be made small. It is particulraly desirable that all sections of electrified railroad which are involved in parallels be supplied with power from both directions rather than by stub end feed.

Sectionalization of Trolley System. Considerable advantage may be gained by sectionalizing the trolley, thus decreasing the length of the earth current path as well as reducing the amount of power supplied to a short circuit. However, as each separate section of trolley requires an independent power supply sufficient for its maximum demand, the total transformer capacity required for a given length of electrified road is much increased by any considerable use of trolley sectionalization. Notwithstanding this objection a limited amount of sectionalizing may be used to advantage where the exposure is severe.

Opposing Polarities. On railroad lines having two tracks it is possible to connect two trolleys for opposing polarities, so that the current flowing in the rails and earth is not the difference in the currents of the two trolleys. An instance of this method applied to a direct current railroad is afforded by the City and South London Railway in England which has been so operated for 20 years. As applied to alternating current railroads of 11,000 volts, this method is considered to have serious operating disadvantages in respect to cross-overs between tracks, and for this reason this plan, which was studied in connection with the revision of the Woodlawn-Stamford electrification of the New Haven Railroad in 1912, was not adopted.

Balancing Transformers. This method, which is now employed on the main line electrification of the New Haven Railroad, is of much benefit in reducing stray currents, particularly where power is supplied from both directions. Its use, however, involves a combined transmission-distribution circuit, tied together by the balancing auto-transformers, whereas the general practise in such matters seems to tend toward a separate transmission line supplying power to the trolley-track circuit through standard transformers.

Booster Transformers. Another important method of controlling railroad currents is by the use of booster-transformers placed at frequent intervals along the electrified section. These transformers have a substantially even ratio of transformation, the primary winding being inserted serially in the trolley and the secondary winding inserted serially in the track circuit. In this way the track current is required to be substantially equal to the trolley current at points where the transformers are located. By placing the transformers near together the leakage of current into the earth between transformers is made small.

A modification of this plan is to install a feeder electrically connected to the rails at intervals, and insert the secondaries of the booster-transformers in series with this feeder. In this way the current is confined to the feeder instead of the rails. The London, Brighton and South Coast Railway embodies an installation of this type. This arrangement is somewhat more effective perhaps than trolley-track transformers but it involves considerable additional expense for the feeder, which must be of high conductivity. One advantage of the feeder-booster, over the track-booster arrangement, is that successful operation of the former is not so dependent on high grade maintenance of the track bonding.

Specific Electrifications

Having now considered various means which are available, or at least, worthy of being considered, for avoiding or reducing inductive interference to communication systems by alternating current electrified railroads, we may now direct our attention to some specific electrification installations and see what has actually been done to prevent such interference and with what degree of success. In so doing I will confine my remarks to the salient features of four single-phase installations: (1) New York, New Haven & Hartford Railroad, Woodlawn to Stamford; (2) New York, New Haven & Hartford Railroad, New Canaan Branch; (3) Norfolk and Western Railroad, Bluefield to Vivian, W. Va.; (4) Pennsylvania Railroad, Broad Street, to Paoli, Pa.

Woodlawn-Stamford. The original electric installation of the New York, New Haven and Hartford Railroad Company between Woodlawn, N. Y., and Stamford, Conn., began operation, in part, in the summer of 1907. This is a section of four-track railroad, about 21 miles in length, and all power was supplied by a generating station at Cos Cob about three miles west of Stamford. To move a train at Woodlawn, the current passed for 18 miles over the trolley wires and paralleling feeders from Cos Cob to the locomotive, the remainder of the circuits from locomotive to Cos Cob, being the running rails and earth. The telephone company's New York-Boston subway is, throughout this section, situated at varying separation averaging about 2000 feet from the railroad, a sufficient distance so that the inductive effect of the trolley current would have been largely neutralized by the inductive effect of the rail current, had these two currents been equal. However, due to the long rail path, a large part of the current left the rail and spread into the earth, where its effect in neutralizing the corresponding part of the trolley current was negligible.

After full electric passenger service between Woodlawn and Stamford was inaugurated, the induced 25-cycle voltage on circuits in the New Haven subway, at normal rush hour periods, was as much as 170 volts. On the Shore Line, one of the telephone company's open wire routes between New York and Boston, the corresponding induced voltage was about 300, the higher voltage on the Shore Line being principally accounted for by about a mile and a half of exposure near Greenwich, where the average separation was only about 100 feet The open wire Shore Line circuits were also affected by noise, which was most intense during periods of train acceleration, the pitch of the noise varying with the speed of the train. The subway circuits being in metal-sheathed, underground cable, and not having any section of very close parallelism, were not made noisy. The Midland Line, another open wire route between New York and Boston, about four miles away from the railroad at the nearest parallel section, sustained corresponding induction of about 40 volts.

Wires of the Western Union Telegraph Company, which were carried on poles located on the railroad right of way, were subjected to much higher voltages. These wires, except a few which were equipped with nenutralizing transformers and continued in use by the railroad company, were removed to a new pole line which was built a number of miles away.

The conditions as to induction continued substantially as outlined above for a period of four or five years.

Early in 1911 the railroad company made known its intention to extend the electrification to include the Harlem River branch and the New York, Westchester and Boston Railroad. The former is a six-track line used principally for freight, extending about 12 miles from its junction with the main line, near New Rochelle, to the Harlem River. The New York, Westchester and Boston Railroad, which is partly four-track and partly two-track, was constructed principally for suburban service and extends from West Farms at 176th Street, where it forms a junction with the Harlem River branch, to White Plains, a distance of 16 miles. A branch six miles north of West Farms taps the main line of the New Haven Railroad just east of New Rochelle. These two new lines involved the direct connection, to the western end of the previously electrified section, of additional electrified line to the extent of about 200 miles of single track railroad. Moreover, it was planned that, after the Harlem River branch was electrified, freight trains, as well as passenger trains, on the entire system west of Stamford should be operated electrically.

This proposed large extension of the electrification, with its resulting increase in load, caused considerable apprehension to us of the telephone company. Our estimates of induced voltages under the new conditions, based on the railroad company's estimates as to future train loads, indicated over 1500 volts on the Shore Line and nearly 1000 volts on the subway. These values correspond to maximum normal railroad loads and the induction would have been still greater at times of abnormal conditions. Voltages of this magnitude are far beyond the endurable limit for the telephone company and the matter was taken up by the companies with a view to determining what could be done to ameliorate the situation.

In January 1912, a joint committee of engineers, comprising a representative each of the New Haven Railroad Company, the Western Union Telegraph Company, and the telephone company, was formed to study this question. Several different plans for modifying the railroad distribution system were laid before this committee. After six meetings during the ensuing three months, a plan was decided upon and a sub-committee of engineers was designated to work out the details.

This new distribution system involved quite a comprehensive change in the original installation. It was cut over on January 15, 1914 and has been found to bring about a great improvement with respect to induction.

Besides an additional power supply station at West Farms, which in itself effects a considerable improvement, the new distribution system includes the use of 17 balancing autotransformers of 2000 kv-a. capacity each. These are distributed along the line, in such locations as are most advantageous for supplying power to the trolley circuit, so as to minimize the length of path of current through the rails.

As full accounts of this distribution system have been published I will not undertake an extended description of it here.

The same system has since been used by the railroad company in extending the electrification from Stamford to New Haven.

At present, the induced voltages on the through circuits in the subway seldom exceed 30 volts under normal conditions of railroad operation.

The principal interference now incurred (apart from that due to the New Canaan branch which is discussed elsewhere) is in connection with railroad short circuits in the vicinity of Stamford. Within the section from 2 miles west of Stamford to 5 miles east of Stamford, local subscribers' lines and trunk lines have been affected by false ringing, false flashing of line signals, and grounding of protectors, on about twenty different occasions in the past three years, an average of twenty lines being affected on each occasion. It is of interest to note that these troubles are localized within this seven-mile section of the sixty-mile electrification from Woodlawn to New Haven, and also that it is at aprroximately the middle of this seven-mile section that the New Canaan branch, referred to immediately below, joins the Main Line.

New Canaan Branch. In 1907 the New Canaan branch of the New Haven Railroad, which previously had been operated at 500 volts d. c., was reconstructed and its trolley connected directly to the 11,000-volt trolley on the main line near Stamford.

This branch is about six miles long, single track, and the traffic is light so that under normal conditions of operation no interference with telephone or telegraph lines was produced. However, the telephone circuits have been subjected to a great deal of interference from this branch, due to short circuits. Owing to the conditions of power supply, the short circuit current at New Canaan is about 2500 amperes or ten times the maximum load current. At points nearer the main line the short circuit is even greater.

The inductive effects of the New Canaan branch were augmented by the large proportion of earth current, due to the relatively high impedance of the single track. Momentarily voltages as high apparently as 1000 were imposed on trunks between New Canaan and other places and voltages up to 500 on many telephone circuits in the New Canaan exchange. These induced voltages operated protectors, permanently grounded and put out of service many telephone lines and subjected operators to severe acoustic shocks. Due to the recurrence of these surges, the operators in the New Canaan office became so afraid of shocks that the operating efficiency was seriously impaired.

In 1913, after several unusually severe surges from short circuits had been experienced, the matter of finding some means to overcome this interference, which had already been under consideration by the telephone and railroad companies, was taken up with renewed energy. Various plans were proposed and an extended series of experimental tests and measurements were made, as a result of which, means were finally agreed upon as follows: 1. To keep the rails well bonded. 2. To insert a current-limiting reactance in the trolley, near its junction with the main line trolley, so as to restrict the short circuit current. 3. To install 12 series booster track-trolley transformers at intervals of about 1-2 mile. 4. Readjust the circuit-breaker, at the junction with the main line, for instantaneous operation.

From the tests and from experience with six booster transformers, it is believed that the above mentioned measures will be effective in preventing this interference although the full installation of transformers and the current limiting reactance has not yet been completed.

It is of interest to note that the balancing transformer plan although generally giving good results on the main line of the New Haven Railroad, does not afford an effective means for preventing inductive interference under such conditions as exist on the New Canaan branch.

Norfolk and Western Railroad Electrification. This electrified section is between Bluefield and Vivian, West Virginia, a distance of approximately 28 miles. The railroad is double track with numerous yards and sidings and includes some heavy grades. The power house for supplying power to the electrified section is located at Bluestone, about 10.8 miles west of Bluefield. Power is transmitted by duplicate single phase transmission lines at 44,000 volts to five substations, the distances between which, respectively, beginning at Bluefield, are 8.2, 4.6, 6.6 and 4.8 miles. At these substations the voltage is stepped down to 11,000 for delivery to the trolley-track circuit which is electrically continuous throughout from Bluefield to Vivian.

The original plans for this electrification were taken up with the telephone company who proposed some modifications for the better protection of the paralleling communication circuits. The plans as modified include 23 series booster trolley-track transformers, the average spacings of which are, east of the power house, about a mile and a half, and west of the power house about a mile. Each transformer is 100 kv-a. continuous rating and 400 kv-a for 2 1-2 minutes.

One telephone line paralleling this road has several exposures of about 500 feet separation from the railroad and there are also local circuits of the Bluefield Telephone Company in proximity to the railroad. No trouble has been reported from induction under normal railroad conditions. At times when the electrification wires are down noise has been experienced on some of the above mentioned circuits. Also a telephone trunk circuit which crosses the railroad underground is sometimes thrown out of service when the railroad circuit is in trouble, by reason of the copper block protectors at the crossing becoming grounded. Some trouble has been sustained from corrosion of lead cable sheaths at underground crossings of the railroad in Bluefield but it has not been established whether or not this is due to electrolysis by the alternating railroad currents.

Broad Street—Paoli. Plans for electrifying the Pennsylvania Railroad's four-track main line from Broad Street to Paoli were announced early in 1913. The question of interference with the telephone company's lines was taken up with the engineers representing the railroad company and several plans looking to the prevention of interference were considered. As a result of the best information then available it was decided in 1914 to install series booster trolley-track transformers for the purpose of confining the current to the rails.

The power for this electrification is conveyed by a 44,000-volt 25-cycle transmission line to three substations, one each at West Philadelphia, Bryn Mawr and Paoli, and from these substations supplied to the trolley-track circuit at 11,000 volts. Sixteen pairs of trolley-track transformers, each transformer equipping two tracks and having a continuous rating of 80 kv-a. and 600 kv-a. for one minute, are provided, the spacing between transformers being about one mile.

The regular operation of electric passenger trains between Broad Street and Paoli was begun during the latter part of September, 1915. Extended induction tests were made on the section east of Bryn Mawr in April, 1915 and on the entire line in the following August. Further induction tests were made in the summer of 1916.

In July, 1916, the railroad company commenced operating synchronous condensers at Radnor and it has been found that, with these condensers in use, the booster transformers are greatly overloaded at times of short-circuit. This results in the transformer iron becoming heavily saturated and the magnetizing current, consisting largely of the third harmonic, which under these conditions reaches very high values, necessarily flows through the ground. The current wave is badly distorted as a result of this overloading and the induced voltages during short-circuits may actually be higher with the booster-transformers than without them; in fact, it has been found preferable to remove the booster-transformers east of Bryn Mawr, and only those from Bryn Mawr west are now regularly in service.

With all booster transformers in service the maximum induced voltages, (peak values)*, during normal operation are about 10 for subscribers' lines and 25 for trunk lines; at times of short circuit, calculations based upon experimental data show that the maximum voltages may exceed 1000 on subscribers' lines and 1200 on trunk lines. With all booster transformers cut out, the corresponding figures are, for normal operation, 50 volts for subscribers' lines and 125 volts for trunks and, at times of short circuit, 225 volts for subscribers' lines and 900 volts for trunks. These figures assume two condensers in service.

This section of railroad follows through a highly developed suburban area where disturbances on telephone lines are extremely undesirable. Unfortunately, a considerable number of cases of bell ringing due to short-circuits on the railroad circuit have been experienced. Not all short-circuits cause bell ringing however.

During the first three months of electric operation, namely, October, November and December, 1915, the number of short-circuits causing bell ringing averaged 10 per month and the bell ringing troubles over 2000 per month. During the following seven months the average number of short circuits causing bell ringing, fell to 4.5 per month and the bell ringing troubles from 735 in January to 57 in July. Since July, 1916, the number of short-circuits per month which caused bell ringing have been further reduced and during the year 1917 averaged about 1.5 per month.

The improvement in the bell ringing situation after January 1916 and up to August 1916, was due partly to changes in the railway control circuits and in the operating arrangement of circuit breakers, and partly to the substitution of relay sets for standard party line bells, at subscribers' stations within the regions of heaviest inductive disturbances, and the biasing of bells within the areas of less disturbances. The work required changes in subscribers' apparatus at about 3000 stations.

The synchronous condensers installed in the latter part of July, 1916, increased the maximum voltages impressed on the telephone circuits at times of short-circuit on the railroad, so that while the actual number of short-circuits causing bell ringing has been reduced since that date, the average number of bell ringing troubles per month has increased. From August 1916 to December 1917 inclusive, there were 22 short circuits causing bell ringing and 1589 bell ringing troubles, an average of 72; whereas for the five months' period preceding the installation of the synchronous condensers, there were 20 short circuits causing bell ringing, and 356 bell ringing troubles, an average of

*On account of the wave shape distortion described above it was found advantageous here to measure peak voltages rather than effective voltages and all values of voltage mentioned in this discussion of the Paoli electrification are peak values.

18, or one-quarter of the corresponding average number in the later period. During the year 1917, 45 percent. of the bells rung were on direct lines and not grounded.

The high induced voltages causing bell ringing have been experienced over the entire electrified portion of the Main Line except within about three miles of Broad Street. It is fortunate that the region of high induced voltages does not extend to Broad Street, otherwise, owing to the density of telephone development within that district the trouble would be exceedingly difficult to cope with.

In a small percentage of cases where bells are rung the induced voltages are sufficient to leave the telephone lines grounded through the protectors, thus interrupting service.

Methods of signaling on call circuit trunks involving use of the ground have had to be abandoned.

Noise tests made on ten trunks which parallel the electrification indicate that the reduced currents from the railroad cause a small amount of noise but not enough to constitute interference with service on these comparatively short lines. However, I may mention the fact that in the construction of the new Philadelphia-Reading toll cable, in which the requirements as to freedom from noise are more exacting than in the case of the shorter Main Line trunks, the liability of noise, together with other features of interference, was considered a sufficient reason for changing to a different route in order to avoid exposure to the electrified section of the railroad. The route adopted involves charges of $1000 a year more than the route exposed to the electrification, which otherwise would have been followed.

None of the telephone company's circuits affected by the electrification is now used for telegraphy, hence there has been no intereference with this type of service. It is expected, however, that telegraph service over the paralleling toll circuits will be required later and to give this service it will be necessary, unless there is some new development, to employ neutralizing transformers with their attendant disadvantages and limitations.

The high voltages induced on the telephone lines at times of short-circuits, also, in the opinion of the telephone company, constitute a considerable fire hazard, although it is fortunately true that no fires have as yet been caused. All terminating trunks at the three directly exposed offices west of Bryn Mawr have been provided with carbon block and heat coil protection. As these trunks are in underground cable, they would not require these protective devices except for the induced voltages. As an additional precaution against fire the telephone company has maintained a special force of night watchmen at several central offices throughout this area where regularly there are no inside men at night, thereby incurring an expense of about $18,000 per year. As a still further precaution, trunks to certain offices west of Malvern were for a time provided with repeating coils at Malvern, but it has recently been necessary to phantom these circuits, which has required the removal of the repeating coils.

A large number of the trunks affected by induction from this electrification are equipped with loading coils. Tests on these coils show that more than 20 percent. of them are magnetized to a greater or less extent but it has not yet been determined whether this trouble has been brought about wholly or in part by induced currents from the railroad circuits or whether it is due to other causes.

Within the area of high induced potentials, telephone subscribers and employees are exposed to the possibility of electric shocks at times of short circuit on the railroad. Fortunately, however, no troubles from such shocks have yet transpired.

Telephone operators and users are also exposed to the possibility of acoustic shocks at times of surges from short circuits, although no serious acoustic shocks, due to this electrification, have been reported.

It will be seen from the foregoing that, notwithstanding all that has been done by the railroad company and the telephone company to reduce interference, here still remain, at times of short circuits, certain hazards of fire and shocks, bell ringing trouble, and other latent interference as described. While this impending interference has not, with the exception of bell ringing, actually materialized into trouble, nevertheless the possibility of such trouble is continually present and the conditions can by no means be regarded as satisfactory.

Looking to further improvement in the situation a number of plans which involve changes in the distribution system of the railroad, have been worked out. The plan which, on the whole, seems entitled to the most favorable regard, involves the installation of additional power supply transformers at Radnor and at a point 16 1-2 miles from Broad Street, and also includes the sectionalizing of the trolley at both these points. This plan further requires the moving of the Berwyn-Malvern aerial telephone cable to a more remote location. By the adoption of this plan it is estimated that the maximum induced voltage at times of short-circuits would be brought down to 250. This would largely reduce, but not wholly avoid, the fire and shock hazards, bell ringing on direct lines, and the other evils involving the operation of protectors. The cost of carrying out this plan, including labor and material only, has been estimated at $140,000.

Another plan, involving more extensive changes in the power supply and distribution system to avoid wholly the interference and hazard, would require a much larger expenditure and perhaps would not be warranted by the existing situation.

A different plan would be to install sufficient additional booster-transformers so that they would not become overloaded at times of short circuits. This would probably require placing the boosters one-third to one-half mile apart and would cost from $85,000 to $150,000. This plan has not been worked out in detail, as the railroad company objects to the introduction of insulating joints in the trolley wires at such frequent intervals.

Conclusion

It may be said in conclusion that means are now known whereby alternating railway currents can be kept sufficiently within control, except under abnormal conditions, to prevent substantial interference to neighboring communication lines, although the application of such means to the extent necessary to produce satisfactory results may involve considerable expense.

Even under abnormal conditions the interference can be greatly reduced by the application of suitable measures, but in some cases there still remains the problem of obtaining a sufficient reduction of interference without incurring a cost which the railroad companies consider excessive.

It is important in each electrification project that the railroad company and the communication companies affected cooperate in determining what interference-preventive measures shall be adopted. Each electrification requires a special study, as the best measures to employ may be quite different in different cases.

I wish to take this opportunity to testify to the broad-minded and cordial manner in which the railroad companies and electrical manufacturers concerned have cooperated with us in searching for a satisfactory solution of this problem, a work which, it is probably unnecessary to add, is still in progress.

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CONTRACTORS' MOTOR-DRIVEN COMPRESSORS

A portable compressor outfit, that can be readily hauled to the job, put immediately to work, and promptly removed when wanted elsewhere, forms therefore, a very valuable addition to the contractor's plant, has just been brought out.

It is electrically operated and is therefore especially adapted for city work where current is available at all places, and it is more conveniently and easily handled than corresponding steam, gasoline or oil operated types. It consists of a 10 x 12 type E. R. Ingersoll-Rand compressor driven by a 50 hp. Westinghouse motor. It has a capacity of 300 cu. ft. of air per minute at 100 lb. pressure.

ELEMENTS *of* ILLUMINATING ENGINEERING

In this article which, like the preceding ones on this subject have been published by courtesy of the General Electric Review, Ward Harrison takes up the reason for the use of reflectors and other lighting accessories. He discusses the properties of the several sorts of materials employed for this purpose, and the approved methods of employing these accessories so as to get such illumination as the lamp is capable of giving both where and how it is needed.

Reflectors and Enclosing Glassware

The light from a bare incandescent lamp is distributed in a manner such that under most conditions it cannot be employed effectively without the use of reflectors or enclosing glassware. Such accessories should not only redirect into useful angles light which would otherwise be ineffective, but should serve the additional purposes of modifying the brilliancy of the light source and diffusing the light to produce a soft and pleasing illumination.

Three systems of lighting are commonly employed. They have been referred to as direct, indirect, and semi-indirect. In the so-called direct-lighting system, the unit distributes the light downward into the room; in the indirect system all of the light is thrown upon the ceiling and thence reflected into the room; in the semi-indirect system, a greater part of the light is thrown upon the ceiling but some of it passes through the bowl and directly into the room.

In the units for these systems various reflecting surfaces and transmitting media are used, and a knowledge of the action of such surfaces and media in the utilization of light is necessary to a proper selection.

A ray of light unless meeting interference will travel along a straight line indefinitely. Such interference may be in the nature of absorption by the medium through which it passes or by the object upon which it impinges. This is noticed when a beam of light passes through the smoky atmosphere, through a piece of smoked glass, or meets a black opaque body. In these cases, a part of practically all of the light loses its identity and is converted into heat. A second torm of intereference is termed refraction. Refraction is a bending of the ray of light due to its passing from one medium to another of greater or less density as for example from air to water or from air to glass. A very common instance of refraction is the apparent bending of a fish line at the point where it enters the water; as a matter of fact, the line is straight but the light rays coming from that part of the line which is under the water are refracted when they pass from water into air. A third form of interference with the progress of a ray of light in a straight line is reflection of the ray by a surface. A fourth form of interference is diffusion, which is the breaking up of the beam and spreading of its rays in all directions by the medium through which is passes or by the surface upon which it falls. By controlling these four methods of interference—absorption, refraction, reflection, and diffusion, we are able to make the light from any source do very largely as we desire.

Polished-metal and Mirrored-glass Reflectors

The simplest form of reflection is that which takes place when a ray of light strikes a polished-metal surface. As indicated in sketch A, Fig. 1, a ray of light having a direction **Sa** on striking a polished-metal surface is reflected off in the direction **ab**, so that the **Y** (called the angle of reflection) is equal to the angle **X** (called the angle of incidence) and practically no light is reflected in other directions. This is called regular reflection. It will be seen, therefore, that it is possible to redirect light traveling in a given direction into any other desired direction by means of such a surface properly placed. When we consider that the schoolboy by means of a pocket mirror or piece of polished metal can take the beam of sunlight that comes in at the window and redirect it with remarkable accuracy to any place in the room, the general principle involved is seen to be simple. While all polished-metal surfaces reflect light in the manner described, they do not reflect it in like amounts. For instance, if two beams of 100 lumens each fall respectively on a polished-silver surface and on a polished-aluminum surface, the silver will reflect approximately 88 lumens and the aluminum about 62 lumens. In other words, the silver surface will absorb only 12 percent. of the light while the aluminum surface will absorb about 38 percent. All of the light falling on an opaque surface is either reflected or absorbed by that surface.

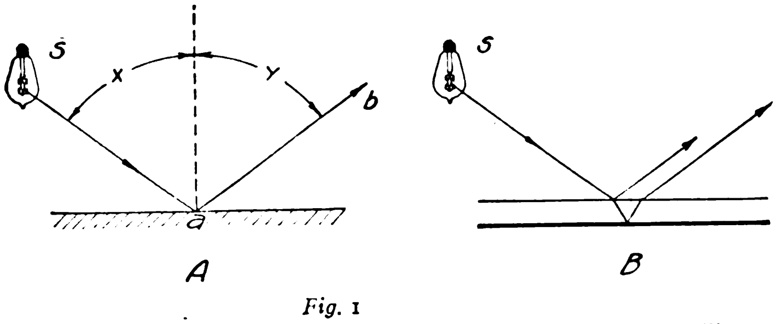

Fig. 1
B—Reflection from mirrored surface
A—Reflection from polished surface

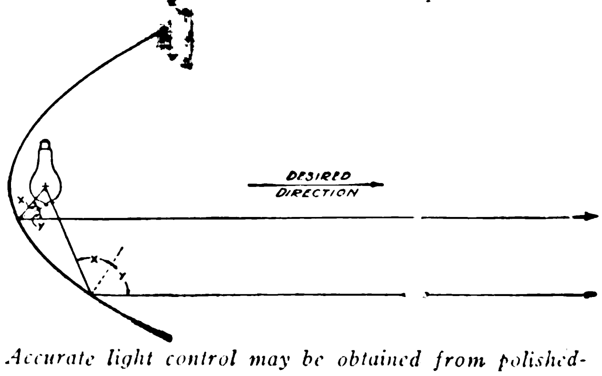

Fig. 2. Accurate light control may be obtained from polished-metal or mirrored surfaces

Similar to the reflection characteristics of polished metal are those of mirrored glass. Fig. 1, B, shows the path of a ray of light striking the surface of a commercial type of mirror with silvering on the back of the glass. A small part of the light is at once reflected by the polished surface of the glass without passing through to the silvered backing; the remainder passes through the glass to the silver, from which it is reflected through the glass again and out along a line parallel to the ray reflected from the glass surface. The fact that most of the light has to pass through the glass both to and from the reflecting surface makes the silvered mirror, from a laboratory standpoint, a less efficient reflecting surface than the polished silver itself. For instance, if 100 lumens strike a mirror the reflections and absorptions are of the following order for magnitude: 10 are reflected by the exposed surface of the glass, 10 are lost by being absorbed by the glass, leaving a total of about 175 lumens which are reflected by the silvered surface; the loss in the glass depends, of course, on the quality of the glass. The deterioration of a polished-metal reflecting surface in service is, however, a factor which often more than offsets its higher initial efficiency.

To obtain a desired distribution from a polished-metal or a mirrored surface, it is necessary that the contour of the reflector at each point be such that it makes equal angles with the incident ray at that point and the desired direction of light. For example, where parallel rays of light are desired,

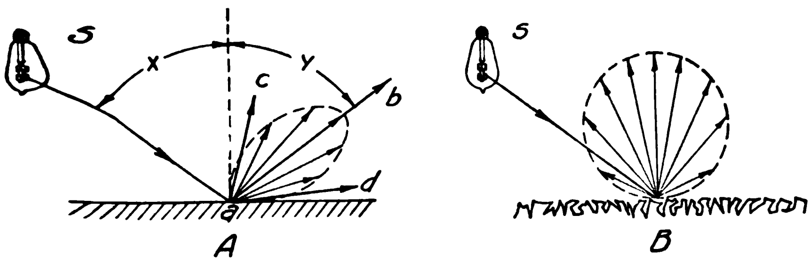

Fig. 3
A—Reflection from semi-mat surface
B—Reflection from rough mat surface

as in the case of automobile headlights, the cross-section of the reflector will have to be of the nature of that shown in Fig. 2, namely, a parabola. A hemispherical reflector, on the other hand, placed above the lamp with its center coinciding with the light source, will not concentrate the light at all but will nearly double the candle-power at each angle in the lower hemisphere, since each ray that strikes the reflector is reflected back along the same line through the source, and into the lower hemisphere. Mirrored reflectors have a disadvantage that they throw brilliant images of the filament, or striations, on the surfaces illuminated. In practice, these striations are often eliminated by corrugating the reflector or frosting the lamp, with, however, some loss in the control of the light.

Since polished-metal and mirrored surfaces follow definitely the law of regular reflection, these surfaces are used in reflectors where the aim is to obtain definite and accurate control of the direction of the light. The automobile headlight and the floodlighting units are the most familiar applications of polished-metal reflectors for accurate light control. Mirrored glass is also widely used for both direct and indirect lighting units.

Dull-finished or Semi-mat Reflectors

A dull-finished or semi-mat surface can be considered as one which has many small polished surfaces making innumerable slight angles with the apparent contour. A surface coated with aluminum paint affords a good example. When a shaft of light strikes such a surface, the individual rays are reflected at slightly different angles, but all in the same general direction, as shown in Fig. 3, A. This is known as spread reflection. The spread of the reflected beam indicated by the angle between lines **ac** and **ad** is dependent upon the degrees of smoothness of the surface, the smoother the surface the narrower the angle. When the reflecting surface is viewed along the line **ba**, no distinct image of the light source is visible but only a bright spot of light.

The reflection characteristics of dull-finished or semi-mat surface reflectors are similar to those of reflectors having polished surfaces, with the exception that the light is redirected with less accuracy. The efficiency of dull-finished reflectors in the deep-bowl shape, for example, unless they are carefully designed, is likely to be reduced somewhat owing to cross-reflection from one side to the other and consequent absorption of the light—a condition which is not so likely to obtain in a polished reflector of the same shape. The aluminumized-steel reflector is the only commercial semi-mat reflector in general use. A form commonly employed is shown in Fig. 4.

Rough Mat-surface Reflectors

If a mat surface is so rough that it has absolutely no sheen, as, for example, the surface of blotting paper, and a beam of light strikes it, as indicated in Fig. 3, B, the light is likely to go down into one of the pockets and be reflected back and forth so that when it comes out the rays are sent in all directions. The result is that the whole surface appears equally as bright from one direction as from another, that is, just

Fig. 4. Typical aluminumized-steel reflector

the same as it would if it were luminous from being heated to incandescence. In other words, the candle-power per square inch of apparent area is uniform. Under these conditions, the candle-power is a maximum in a direction perpendicular to the surface, for the surface has the greatest apparent area when viewed from this direction. When the measurement is made from any other direction the apparent area is less, and since the candle-power per square inch of apparent area is constant, the candle-power is less. White blotting paper is one of the best examples of the diffusing type of reflecting surface; a good sample will reflect about 80 percent. of the light which strikes it.

Since light which falls upon a rough surface is reflected in all directions, it follows that the shape of reflectors using such a surface has little effect on the resulting distribution of light. In Fig. 5, **S** represents a light source at the mouth of a rough-surface reflector **aaa**. The light distribution is the same when the reflector has the cross section **aaa**, **bbb** or **ccc**, for when the reflector is viewed from below, it simply appears as a white disk. However, if a contour such as **bbb** or **ccc** is used rather than **aaa**, there will result a needless absorption of light due to cross reflection of light between the inside surfaces, and the light from **S** would, therefore, be utilized to better advantage with the shape **aaa**.

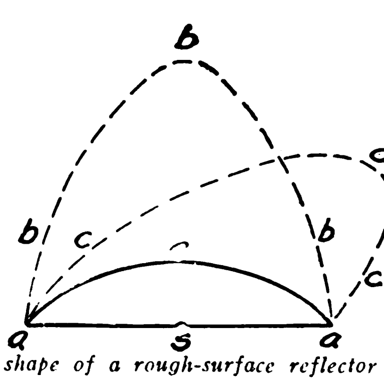

Fig. 5. The shape of a rough-surface reflector has relatively little effect on distribution

Reflectors having a rough reflecting surface are difficult to keep clean and are therefore seldom used, since opal glass and porcelain enamel offer the same advantages without this handicap.

Prismatic Glassware

Prismatic glassware, as it is usually employed in lighting units, is made up of many small prisms which compose the entire body of the reflector. The principle involved is that of total reflection, which is illustrated in sketch A of Fig. 6. The sketch shows the path of a single light ray; the angles of the prism can be made such that when the light ray passes into it and strikes the back surface **bc** it is reflected to the

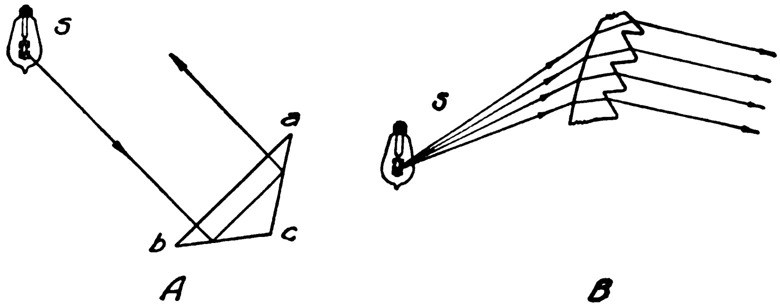

Fig. 6
B—Reflection by prisms
A—Reflection by prism

surface **ac** and out again as shown. It will be observed that, for all practical purposes, this reflection is the same as would be obtained from a polished-metal or mirrored surface; that is, each prism is the equivalent of a narrow strip of mirror. By tilting this strip longitudinally the direction of the reflected beam can be accurately controlled and by giving it the proper curvature the desired distribution of all the light falling on it can be obtained. The tops of the prisms are usually rounded slightly, which permits the transmission of a small percentage of the light and thus improves the appearance of the reflector. Prrismatic glassware of proper design does not produce striations.

Dust on the exterior of a prismatic reflector reduces the light in the upper direction only, but moisture and moist dirt in optical contact with the exterior surface affect the reflecting power of the prisms and reduce the light output both upward and downward.

A typical prismatic-glass reflector is shown in Fig. 7. So-called velvet-finish prismatic-glass reflectors are also available. These reflectors give a distribution similar to that of a semi-mat or dull-finished reflector, for, as will be discussed in a subsequent paragraph, the etching on the inside surface of the reflector gives spread characteristics to the reflected light.

Prismatic glassware is also used for refracting or changing the direction of light rays passing through. The prisms used in refractors are of different shape from those used in reflectors. The paths of light rays through four prisms of a refractor are indicated in Fig. 6, B. Refractors ae commonly used where a very broad distribution of light is desirable as in the case of street lighting.

Since with both prismatic reflectors and refractors the light is reflected by or passed through clear glass only, the absorp-

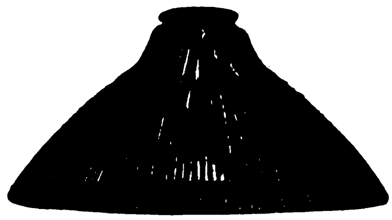

Fig. 7. Typical prismatic-glass reflector

tion is low and the efficiency of such glassware is of the highest order.

Opal-glass Reflectors

Opal glass finds considerable application in illumination practice both as a reflecting and a transmitting medium. In general, there are two types of opal glass, classed as dense and light. The properties of opal glass can be most readily understood if we regard it as common glass, in which fine white particles are, so to speak, held in suspension. When a ray of light strikes this surface, part of the light is reflected directly, as in the case of a polished-metal surface. The remainder of the light travels through the glass in straight lines until it strikes the white particles, or any minute air bubbles which may be present, whence it is dispersed in all

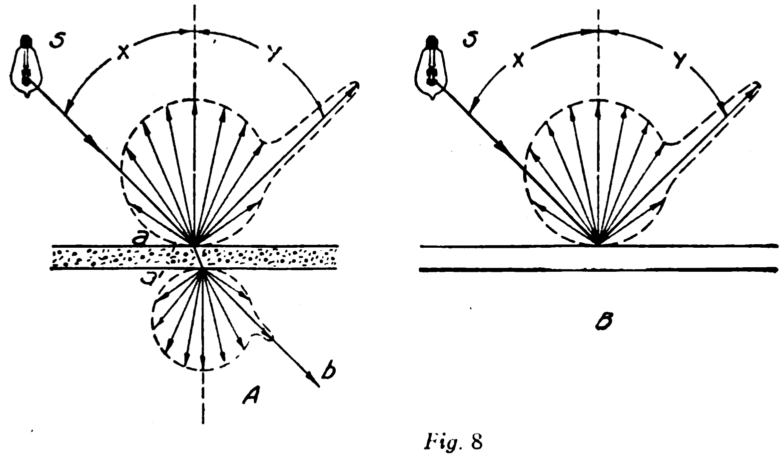

Fig. 8
A—Reflection and transmission by opal glass
B—Reflection from porcelain-enameled steel

directions, some of it being thrown back and reflected as shown in Fig. 8, A, and the remainder being transmitted through and out in all directions. If, by chance, any of the light passes through the glass and fails to strike any of the white particles, it goes out in a line parallel to the one along which it entered. Thus, if a lamp were enclosed in a ball of opal glass, through which on the average, say, one ray in a hundred cloud pass without striking any of the white particles, the filament outline would be visible if viewed from the proper direction; in the case of Sketch A of Fig. 8, this would be in the direction ba'.

The effectiveness of opal glass in redirecting light depends upon the number of white particles and their density in the glass. An opal glass which permits only about 10 percent. of the light striking it to pass through is classed as very dense; light opals may allow as much as 60 percent. to be transmitted. A totally enclosing opal-glass ball may, however, have an over-all output as high as 80 percent., for while only 60 percent. of the light coming directly from the lamp

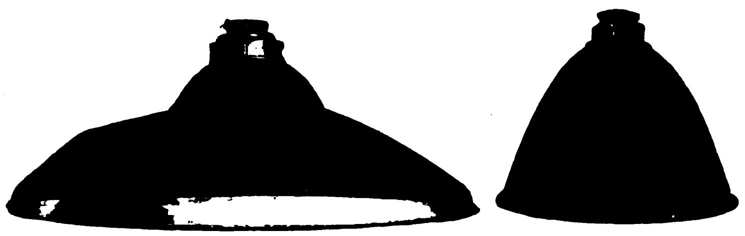

Fig. 9. Dome and bowl shaped porcelain-enameled steel reflectors

to a point on the surface may be transmitted, sufficient light may come to this point from the illuminated interior of the ball to bring the total transmission of the ball up to 80 percent. For a typical test piece of glass of the common commercial type, with 40 percent. transmission, about 10 percent. of the total is directly reflected, 10 percent. is absorbed by the glass and the other 40 percent. is reflected in all directions.

Dense opal glass need not necessarily be thick. A thin coating of a dense mixture may be "flashed" on a body work of clear glass of ordinary thickness and thus produce what is known as flashed opal. Tests have shown that such glass absorbs less light than ordinary opal glass of equal diffusing power and hence flashed opal is particularly adapted to use in enclosing units, where the lightest density which will hide the filament is desirable and where greater density will result in unnecessary absorption.

Two important advantages make opal glass a very desirable reflector material. These are: (1) its smooth surface minimixes the collection of dust and permits easy cleaning; and

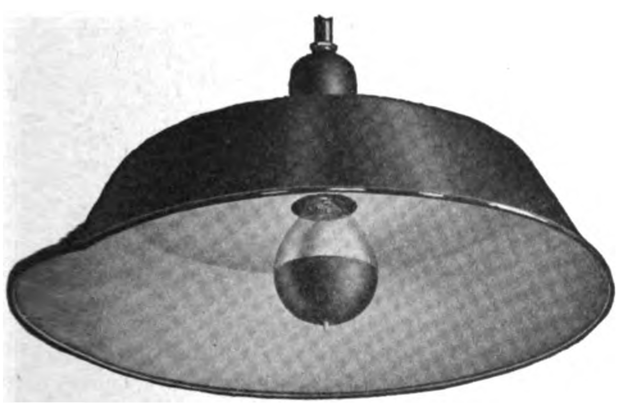

Fig. 10. Metal-cap diffusing unit

(2) the glass transmits a portion of the light, which renders the reflector luminous and thereby adds materially to its appearance. These two advantages are largely responsible for the wide use of opal glass for reflectors and reflecting equipment.

Opal glass is used for open reflectors, semi-enclosing units, for balls, stalactites, and other forms of enclosing diffusers, and for semi-indirect units. Due to the fact that the reflected light is diffused, the contour of the reflector is a less important factor than in the design of mirrored glass or prismatic reflectors, and is determined largely by the appearance desired. Lighting units using opal enclosing glassware are popular for use with Mazda C lamps because of the good diffusion obtained for a direct-lighting fixture and because of the variety of attractive designs which are available.

In the case of semi-indirect lighting, it should be remembered that one of the main advantages of this system is the possibility of reducing the brightness of the light source so that it is comparable with its surroundings, and care should, therefore, be taken in the selection of such units for offices, school rooms, and the like, to select a sufficiently dense glass.

Porcelain-enameled Reflectors

In the familiar enameled-metal reflector, the surface, so far as its optical characteristics are concerned, can be considered as a plate of opal glass in optical contact with a steel backing. This opal must be very dense so that as little light as possible will pass through, for all the light that penetrates to the steel backing is absorbed, and therefore wasted. Enamels vary considerably in efficiency and if of two reflectors one appears gray in comparison with the other, it is sure to be considerably lower in efficiency. Sketch B, Fig. 8,

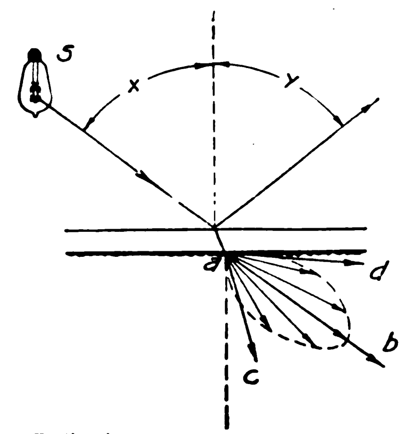

Fig. 11. Reflection and transmission by etched glass

shows the characteristic distribution of a porcelain-enameled surface on steel.

Porcelain-enameled reflectors find their principal use in industrial plants, where the advantages of efficiency, ruggedness, and permanency of reflecting surface are important.

Porcelain-enameled reflectors are commonly classified by shape as dome or bowl. These shapes are illustrated in Fig. 9. In general the dome reflectors are more desirable when used with bowl-frosted Mazda C lamps because of their higher efficiency and the larger apparent size of the light source. Other things being equal, the larger the diameter of the source, the less the glare, the softer the shadows, and the less the annoyance from glaring reflectors. In selecting any dome reflector, care should be exercised to see that its lower edge extends appreciably below the lamp filament.

A reflector which, while it employs porcelain enamel for its principal reflecting surface, also makes use of a polished-metal cap which is placed over the tip end of the lamp to redirect all the downward light upward against the porcelain-enameled surface whence it is thoroughly diffused and directed downward, is shown in Fig. 10. The light from this unit is characterized by freedom from glare, and the shadows are soft with gradually fading outlines. This unit finds its principal use in industrial plants where Mazda C lamps of 150 watts or larger are used and where reflections in polished surfaces would prove annoying if ordinary reflectors were employed.

Frosted-glass Reflectors and Globes

Frosted glass transmission characteristics may be likened to the reflection characteristics of a semi-mat surface. Fig.

11 shows the direction of a beam of light striking glass, the upper surface of which is smooth and the lower surface sand-blasted or roughed with acid etching. Some of the light is, of course, reflected from the glass as is shown in the figure, but most of it goes through the glass, and as the individual rays strike the rough surface they are partially dispersed. When the surface is viewed along the line **ba**, the light source is visible only as a bright spot. A familiar illustration is a frosted Mazda C lamp, in which only a bright spot, showing the presence of the filament, but no distinct outlines, is visible.

Etched glass should be used to give a spread transmission of light rather than as a good reflector. It is of little value except for enclosing units. Unless a frosted glass surface is of a very fine texture, it accumulates dirt rapidly and is difficult to clean. A recent tendency in illuminating engineering has been to make use of strippled or pebbled glass which has the diffusing characteristics of sand-blasted glass without the same difficulty of cleaning. Glasses of this character are especially valuable where it is desired to transmit light without greatly changing its direction.

THE ALIEN ENEMY ACT

At the request of A. M. Palmer, Custodian of Alien Enemy Property, we publish below a statement concerning the purposes of the Alien Enemy Act. It goes without saying that this Act is so important in its bearing on the electrical industry that a careful reading of it, and compliance with its requirements, will be of real service at this time to both the electrical industry and the country.

There are two ways of making war against an enemy. One by force of arms; the other by force of economic pressure.

When a nation wages economic war it brings to bear upon the enemy every force it can muster to stop his supply of food, money and munitions and thereby make him weak and impoverished.

The day the United States entered the war, there was in this country millions upon millions of dollars belonging tc Germans. It was invested in mines, factories, banks, steamships, farms and plantations. Its total amount might run into billions. We had no way of estimating then. But we did know that it was German gold that was colonizing industries here in America and that it was good American money that was being shipped back to Berlin in the form of earnings to enrich the German nation, to fill its war chests, to help complete its great plan for a world control of commerce and industry.

When war was declared, the Army and Navy started to mobilize men and guns, the Shipping Board to build the fleet; the War Trade Board to cut all commercial relations with the enemy, and the Alien Property Custodian to gather into the Treasury of the United States every penny of German owned money that could be found. That is why the office of the Alien Property Custodian was created.

The duties of the Alien Property Custodian are exactly what the name implies, only in addition to the work of taking over and administering holdings of enemies, he has been given power by Congress to sell outright those properties belonging to the great industrial and corporation classes of Germany planted here in America.

In order to help, it is important to know just who is an "enemy" and what is enemy property.

Enemy property includes any and every kind of property, money, chattels, securities, lands, indebtedness, accounts receivable, eac., which belongs to an enemy. Even if the property is held in the name of another, by a dummy or in trust, if the real beneficial interest belongs to an enemy, it is enemy property.

An enemy under the Act is:

1. Any person regardless of citizenship or place of birth, which is within the boundaries of Germany, Austria-Hungary, or their allies, or within the territory actually occupied by their military or naval forces. A peaceful and law-abiding German or Austrian citizen residing in the United States is not an enemy; but an American citizen living in enemy territory is an enemy.

2. A person residing outside of the United States and doing business within the territory of enemy countries or their allies.

3. A corporation, if incorporated within the territory of enemies or their allies, or incorporated in any neutral country and doing business within the territory of enemies or their allies.

4. An official or agent of an enemy government or any subdivision thereof.

5. All natives, citizens, or subjects of Germany or Austria-Hungary interned by the War Department.

6. All citizens or subjects of Germany or Austria-Hungary resident outside of the United States who are: (a) wives of officers, officials or agents of Germany or Austria-Hungary, wherever resident; (b) wives of persons within the territory (including that occupied by military and naval forces) of Germany or Austria-Hungary; or (c) wives of persons resident outside the United States and doing business within enemy territory.

7. Citizens or subjects of Germany or Austra-Hungary who are prisoners of war or who have been or shall be interned by any nation associated with the United States in the war.

8. Citizens or subjects of Germany or Austria-Hungary who since April 6, 1917, have disseminated or shall hereafter disseminate propaganda to aid any enemy nation or to injure the cause of the United States, or who have assisted, or who shall assist in plotting against the United States or any nation associated with the United States in the war.

9. Citizens or subjects of Germany or Austria-Hungary who are included or who shall be included in the "Enemy Trading List" published by the War Trade Board.

10. Citizens or subjects of Germany or Apstria-Hungary who, at any time since August 4, 1914, have been resident within enemy territory.

Note: Numbers 2, 6, 8, 9 and 10 apply only to persons resident outside of the United States.

Three quarters of a billion dollars worth of property have been reported to the Alien Property Custodian at Washington to-day, but from our investigation throughout the country we know that there is much more not yet located. Here is where the citizens can render valuable assistance.

You can help the nation by mailing the Bureau of Investigation, Alien Property Custodian, Washingotn, D. C., reports or information of enemy owned property in your vicinity. You are shareholders in this great combination trust company, department store, and auction sale, now run by the government, and the larger you swell its holdings the more you will back up the Army and Navy now battling against the Hun.

A CALL FOR VOLUNTEERS

There is always need at the National War Savings headquarters for one more volunteer.

If you have a little time that you can give regularly, or now and then, call at 51 Chambers Street, New York, or telephone, and offer your services.

If you can form one or more societies you will be welcomed as an organizer.

If you can write a song or play, or have thought of a good illustration or a happy idea about War Savings, send it in.

EDITORIAL

WARTIME CHANGES

Coincident with the many sweeping changes that have come over our economic and social life since our entry into the great war, there have occurred many changes of a minor nature—minor in comparison with the larger social and economic changes of a revolutionary nature which have taken place within the last year —yet of immediate and great importance to the persons directly affected. Few are the persons and enterprises which have not been drawn into some part of this malestrom. Due to complex conditions which are unnecessary to recall here in detail, ELECTRICAL ENGINEERING, like the railroads, the telegraph and telephone companies, the shipping industry, and many diverse but essential wartime industries, has changed ownership. Within the last thirty days it has removed from its former headquarters in the Woolworth Building, New York, where it was published by the Wm. R. Gregory Company, to 258 Broadway, New York, where it will be published in future by Frank A. Lent.

The policy of ELECTRICAL ENGINEERING will not, however, change with change of ownership. As before, this journal will continue to concern itself with the design of electrical apparatus, and the transmission and utilization of electrical energy. It will continue to be a practical journal for the practical man, modified according to wartime requirements. In its pages will be found readable articles, short or long according to the nature of the subject, that will be found helpful by all who are earning their livelihood in the electrical industry, or who may happen to be interested in the manifold operations of this all-embracing industry merely as a diversion. Until the war is over and industries in general return to something that resembles their pre-war status, the fundamental purpose of ELECTRICAL ENGINEERING will be to publish articles that will help directly or indirectly to win the war. Regardless of any hardships it may be called upon to endure, the electrical industry, in common with all other industries, must continue patriotically to sacrifice itself for the cause of freedom. All industries are menaced alike by the Hun's conception of "kultur," and until this menace is removed all industry must alike forget its small needs and be prepared to respond to the needs of Government. Patriotically, therefore, regardless of ownership, ELECTRICAL ENGINEERING will continue for the duration of the war to be helpful in any way it can to aid the Government. It will not concern itself with politics. Whatever the Government asks that it do, that it will do promptly and ungrudgingly. Much of its space will be given to wartime activities that appear to bear only indirectly on the eletrical industry; but if need be even the electrical industry will have to forego something to which it is justly entitled should the wartime requirements of the Government in other fields demand that space be given to extraneous matter. Until the war is ended, then, our readers are asked to keep patience with us, and, in common with ourselves, to be content to make the best of a situation that demands the publication of many articles that would ordinarily be found in the pages of journals whose readers are more interested in economics, sociology, and things of that sort than they are in the production, transmission, and utilization of electrical energy.

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PICTURING NUMERICAL DATA

Those there be, and their numbers are on the increase, who claim that figures which indicate varying relationships between commensurables are best comprehended only when they are pictured by means of curves. Some people have an obsession for curves. They cannot keep track of their ordinary everyday expenses without referring them to rectangular co-ordinates. The continually increasing cost of living during the last four years apparently means little to them unless it is pictured by means of a curve that continually climbs upward. The reverse process of picturing the continually decreasing purchasing power of a dollar is depicted by a curve which continually climbs downward. In the ages before men thought of picturing such homely data by means of curves, people kept track of their expenditures and of the purchasing power of the dollar by means of mere figures. Their bank accounts told the whole story. By means of figures, for instance, they could tell whether costs were going up or coming down. Nowadays all chart advocates must have a curve or set of curves, colored to suit the local requirements of the tabulator, to tell the same story. By these folk curves are looked upon as a substance, instead of a shadow caused by a substance through the medium of a mental luminary. Curves plotted in this way are known as charts. Some charts are useful, but many others are superfluous and might readily be dispensed with. No chart dealing with objective things tells anything that is not already told in another way by the data from which it was plotted. At best charts are only another way of telling the same story that is already told by mere figures. Like the preceding sentence, it is mere repetition. To many engineers charts appear to be indispensable; but many bankers, merchants, and manufacturers seem to struggle along successfully without them.

There are several schools engaged in the pastime of picturing numerical data by means of charts. There is what might be called the realistic school, which shows by means of barometric charts how one variable, such as temperature, changes in relation to another variable, such as time. By means of what might be called apple pie charts, the realistic school shows what portion of a person's income is expended for rent, light, heat, culture, food, clothing, insurance (if there is any), and savings (if there are any). Again these charts tell nothing that mere figures themselves do not tell. It is merely a kindergarten way of telling the same story to persons who cannot seem to grasp the relationship between abstract figures. Such charts tell the story, to be sure, but they do not require the mental exercise that is required when one compares figures. One of the drawbacks to all forms of charts is that sometimes as much time and as much effort is involved in showing another person how to interpret the chart as would be involved in showing him how to compare the figures themselves. The various charting folk are not by any means united; they have severe family differences.

Another school, the impressionist school it might be called, deals with what are known as trend charts. Trend charts attempt to show what the ultimate relationship between variables will be should pre-existent conditions continue indefinitely. These charts merely indicate future possibilities. At best they are but approximations of actualities, and they often point to absurd conclusions. Another school shows by means of flat line horizontal "curves" how a number of different things are varying with respect to each other and with respect to time. These curves when subject to common sense treatment and interpretation are used by manufacturing and shipping interests to good purpose. Often they are made useless by the interjection of too many if and but factors by those who have a turn for complicating matters.

We hold no brief for or against the making of charts. Charts have but their uses, but there is no need of getting silly over them. Especially commendable are those charts which are utilized in electrical text books to picture the subjective phenomena attendant upon alternating current operation. The relationship between pressure and current in a circuit subject to inductive influences couldn't very well be comprehended by the average student without diagrammatic charts. But it is a far cry between picturing complex subjective relationships by means of charts that tend to elucidate the text, and becoming obsessed with the charting of simple objective relationships like the cost of living and the expansion or contraction of mercury in a bulb as time goes on. By all means let us have charts, but on matters objective it were well to hold fast to common sense and remember that charts after all are but the shadows of figures gone before.

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ESSENTIAL ENTERPRISES

Outside of the new manpower bill just enacted by Congress, the thing that concerns business men most to-day is the question as to what is really essential, what non-essential. One recently christened non-essential is the extension during the war of public utility lines that are not required for strictly war purposes. This recommendation, made last month by the Capital Issues Committee, is of great concern to all electric light and power companies. On this subject the committee's own words tell so plainly what is wanted and why it is wanted that further comment is superfluous. This is wartime, we are all soldiers, and the first, last, and only duty of a soldier is to do as he is told.

"If the men, money and material which the government needs are to be made available for essential war purposes," wrote the committee to the state commissions, "there must necessarily be a considerable degree of sacrifice on the part of individuals, communities and corporations in adjusting themselves to the substitutions and changed standards which the situation compels. Existing facilities must be made to serve in the place of new ones, regardless of temporary inconveniences and discomfort, unless the public health or paramount local economic necessity is involved. May we suggest to you that these considerations apply with marked force to the public utility situation. The extensions and betterments which public service corporations are accustomed to make in normal times, either on the initiative of their own or by direction of the regulating commissions under which they operate, should in our opinion be postponed until after the war, unless an immediate war purpose is served, and may we ask of you consideration of the propriety of deferring even the performance of contractual obligations arising from franchise or other local requirements, when no military or local economic necessity is served by such expenditures."

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ELECTRICITY AND THE SHIP

In this issue we publish the concluding chapter on the application of electricity to the building and navigating of ships. For the last twelvemonth this story has been carried forward as a serial in these columns. Beginning with the electrical equipment of a modern shipyard, it has told of the many diverse uses of electrical energy in maritime enterprises, from the planning of the yards in which the ships are built to the navigating of these ships by electrical means once they are afloat. Taking opportunity by the forelock, the author has contributed to the literature of ship building a series of articles that are as informing and entertaining as they are of direct practical value to the big army of ship building mechanics which is now making as naught the ravages of the Hun submarines during the last four years. If the artisans to whom this series of articles is addressed fail to profit by the compression of the author's experience of twenty years in the art of ship building into about one hundred pages of type, the fault will not lie with the author nor with us but with the artisans themselves. The author's many years of invaluable experience have been theirs almost for the asking. He has told his story with charming frankness and delightful lucidity. Unlike that part of the prayers for the departed which speaks of something which has gone before as "a tale that is told" this portion of the author's life work is not a tale that is told, but a readable story in print. There it is in type for those who would learn, even at this late day, the rudiments and the application in detail of an art that will play no small part in winning the war.

AMERICA'S ENERGY SUPPLY

Bs Charles P. Steinmetz

The gist of this article, which was originally presented at the 1918 convention of the A. I. E. E., is to demonstrate that the economical utilization of the country's energy supply requires generating electric power wherever hydraulic or fuel energy is available, and collecting the power electrically, just as it is distributed electrically.

The first section contains a short review of the country's energy supply in fuel and water power. Here it is shown that the total potential hydraulic energy of the country is about equal to the total utilized fuel energy.

The second section shows that the modern synchronous station is necessary for large hydraulic powers, but the solution of the problem of the economic development of the far more numerous smaller waterpowers is the adoption of the induction generator.

The third section considers the characteristics of the induction generator and the induction-generator station, and its method of operation, and discusses the condition of "dropping out of step of the induction generator" and its avoidance.

In the appendix the corresponding problem is pointed out with reference to fuel power, showing that many millions of kilowatts of potential power are wasted by burning fuel and thereby degrading its energy, that could be recovered by interposing simple steam turbine induction generators between the boiler and the steam heating systems, and collecting their power electrically.

Available Sources of Energy

THE only two sources of energy, which are so plentiful as to come into consideration in supplying our modern industrial civilization, are coal, including oil, natural gas, etc., and water power.

While it would be difficult to estimate the coal consumption directly, it is given fairly closely by the coal production, at least during the last decades, where wood as fuel had become negligible and export and import, besides more or less balancing each other, were small compared with the production. Coal has been mined since 1822. Table I gives the decennial averages, in millions of tons per year.

Table I

AVERAGE COAL PRODUCTION OF THE UNITED STATES
(decennial average)

Year	Million tons per year	Per cent increase per year
1825	0.11	....
30	0.32	22.4
35	0.83	19.7
40	1.92	17.0
45	4.00	14.5
50	7.46	10.45
55	10.8	8.35
60	16.6	8.72
65	25.9	9.22
70	40.2	8.58
75	56.8	7.42
80	82.2	7.95
85	122	6.80
90	160	5.40
95	206	5.75
1900	281	6.96
05	404	6.60
10	532	....

It s assumed that 867 million tons will be this year's coal consumption. As it is difficult to get a conception of such an amount, I may be allowed to illustrate it. One of the great wonders of the world is the Chinese Wall running across the country for hundreds of miles, by means of which China unsuccessfully tried to protect its northern frontier against invasion. Using the coal produced in one year as building material, we could with it build a wall like the Chinese Wall, all around the United States, following the Canadian and Mexican frontier, the Atlantic, Gulf and Pacific Coasts, and with the chemical energy contained in the next year's coal production, we could lift this entire wall up into space, 200 miles high. Or, with the coal produced in one year used as building material, we could build 400 pyramids, larger than the largest pyramid of Egypt.

It is interesting to note that 100,000 tons of coal were produced in the United States in 1825; 1,000,000 tons in 1836; 10,000,000 tons in 1852; and 100,000,000 tons in 1882. The production will reach about 1,000,000,000 tons in 1920, and, if it continues to increase at the same rate, it would reach 10,000,000,000 tons in 1958.

Estimating the chemical energy of the average coal as a little above 7000 cal., the chemical energy of one ton of coal equals approximately the electrical energy of one kilowatt year (24 hour service.) That is, one ton of coal is approximately equal in potential energy to one kilowatt-year.

Thus the annual consumption of 867,000,000 tons of coal represents, in energy, 867,000,000 kilowatt-years.

However, as the average efficiency of conversion of the chemical energy of fuel into electrial energy is probably about 10 percent, the coal production, converted into electrical energy, would give about 87,000,000 kilowatts.

Assuming, however, that only one half of the coal is used for power, at 10 percent. efficiency, the other half as fuel, for metallurgical work etc., at efficiencies varying from 10 percent. to 80 percent., with an average efficiency of 40 percent., then we get 217,000,000 kilowatts (24 hour service) as the total utilized energy of our present annual coal production of 867 million tons.

Potential Water Power of the United States

Without considering the present limitation in the development of water powers, which permits the use of only the largest and most concentrated powers, we may try to get a conception of the total amount of hydraulic energy which exists in our country, irrespective of whether means have yet been developed or ever will be developed for its complete utilization. We therefore proceed to estimate the energy of the total rainfall.

Superimposing the map of rain fall in the United States, upon the map of elevation, we divide the entire territory into sections by rainfall and elevation. This is done in Table II, for the part of our continent between 30 and 50 degrees northern latitude.

As obviously only the general magnitude of the energy value is of interest, I have made only few sub-divisions: five of rainfall and four of elevation as recorded in columns 1 and 2 of Table II. The third column gives the area of each section, in millions of square kilometers, the fourth column the estimated

In. rain fall	Ft. elevation	Area $m^2 10^{12} \times$	Avg. elevation	Avg. rainfall	Kg-m. per m^2; $10^3 \times$	Kg-m otal $15^{15} \times$
>10	>5000	0.54	2100	12.5	263	142
	1000-5000	0.29	900		112	32.5
10-20	>5000	1.18	2100	37.5	787	930
	1000-5000	1.96	900		338	660
20-30	1000-5000	0.32	900	62.5	563	183
	100-1000	0 97	150		94	91
30-40	1000-5000	0.35	900	87.5	786	275
	100-1000	1.40	150		131	184
40-60	1000-5000	0.27	900	125	1130	305
	100-1000	1.03	150		188	194
						$\Sigma = 2996$ 3000

Table II

TOTAL POTENTAL WATER POWER OF UNITED STATES

average elevation, in meters, and the fifth column average rainfall, in centimeters. The sixth column gives the energy, in kilogram-meters per square meter of area. The last column gives the total energy of the section in kilogram-meters, which would be represented by the rainfall if the total hydraulic energy of every drop of rain were counted, from the elevation where it fell, down to sea level.

As seen from Table II, the total rainfall of the North American Continent between 30 deg. and 50 deg. latitude represents 3000 X 10^{15} kg-m. This equals 950,000,000 kilowatt years (24 hour service). That is, the total potential water power of the United States, or the hydraulic energy of the total rainfall, from the elevation where it fell, down to sea level, gives about 1,000,000,000 kilowatts.

However, this is not available, as it would leave no water for agriculture; and even if the entire country were one hydraulic development, there would be losses by seepage and evaporation.

An approximate estimate of the maximum potential power of the rainfall after a minimum allowance for the agriculture and for losses is made in Table III, allowing 12.5 cm. rain fall for wastage, and 37.5 and 25 cm., respectively, for agriculture where such is feasible.

creek throughout its entire length, from the spring to the ocean, and during all seasons, including all the waters of the freshets, were used and could be used. It would mean that there would be no more running water in the country, but stagnant pools connected by pipe lines to turbines exhausting into the next lower pool. Obviously, we could never hope to develop more than a part of this power.

Discussion

The maximum possible hydraulic energy of 230,000,000 kilowatts, is little more than the total energy which we now produce from coal, and is about equal to the present total energy consumption of the country, including all forms of energy.

This was rather startling to me. It means that the hope that when coal once begins to fail we may use the water powers of the country as the source of energy, is and must remain a dream, because if all the potential water powers of the country were now developed, and every ran drop used, it would not supply our present energy demand.

Thus hydraulic energy may and should supplement that of coal, but can never entirely replace it as a source of energy. This probably is the strongest argument for efforts to increase the efficiency of our methods of using coal.

Avg. rainfall cm.	Avg. elevation *m.*	Area m^2 $10^{12} \times$	Wastage cm.	Agriculture cm.	Available rainfall cm.	Kg. m. per m^2 $10^3 \times$	Kg-m total $10^{15} \times$
12.5	2100	0.54	12.5	----	----	----	----
----	900	0.29	12.5	----	----	----	----
37.5	2100	0.39	12.5	25	----	----	----
----	2100	0.79	12.5	----	25	525	415
----	900	0.98	12.5	25	----	----	----
----	900	0.98	12.5	----	25	225	220
62.5	900	0.21	12.5	37.5	12.5	112	23
----	900	0.11	12.5	----	50	450	50
----	150	0.97	12.5	37.5	12.5	19	18
87.5	900	0.35	12.5	37.5	37.5	337	118
----	150	1.40	12.5	37.5	37.5	56	78
125	900	0.27	12.5	27.5	75	674	182
----	150	1.03	12.5	37.5	75	112	116
							$\Sigma = 1220$

Table III

AVAILABLE POTENTIAL WATER POWER OF THE UNITED STATES

This gives about 1200 X 10^{15} kg-m. as the total available potential energy, which is equal to 380,000,000 kilowatts (24 hour service). Assuming now an efficiency of 60 percent. from the stream to the distribution center, gives 230,000,000 kilowatts (24 hour service) as the maximum possible hydroelectric power, which could be produced, if every river, stream, brook or little

A source of energy which is practically unlimited, if it could only be used, is solar radiation. The solar radiation at the earth's surface is estimated at 1.4 cal. per cm^2. per min. Assuming 50 percent. cloudiness, this would give an average throughout the year (24 hours per day), of about 0.14 cal per $cm.^2$ horizontal surface per min., and on the total area considered in the preceding table, 8.3 million square kilometers, of North America between 30 and 50 latitude, a total of approximately 800,000,000,000 kilowatts (24 hour service,) or a thousand times as much as the total chemical energy of our coal consumption. This is 800 times as much as the potential energy of the total rainfall.

Considering that the potential energy of the rainfall from surface level to sea level, is a small part of the potential energy spent by solar radiation in raising the rain to the clouds, and that the latter is a small part of the total solar radiation, this is reasonable.

Considering only the 2.7 million square kilometers of Table III, which are assumed as unsuited for agriculture, and assuming that in some future time, and by inventions not yet made, half of the solar radiation could be collected, this would give an energy production of 130,000,000,000 kilowatts.

Thus, even if only one-tenth of this could be realized, or 13,-000,000,000 kilowatts, it would be many times larger than all the potential energy of coal and water. Here, then, would be the great source of energy for the future.

II. Hydroelectric Station

In developing the country's water powers, up to the present time only those of greatest energy concentration have been considered; that is, those where a large volume and a considerable head of water were available within a short distance.

This led to the present type of hydroelectric generating station, as best solving the problem. The equipment of such a station comprises the following apparatus:

Three-phase synchronous direct-connected generators.

Hydraulic turbines of the highest possible efficiency.

Hydraulic turbine speed governing mechanism.

An exciter plant comprising either exciters directly connected to the generators, or several separate exciter machines, connected to separate turbines.

Exciter busbars.

Voltmeter and ammeters in exciters and in alternator field circuits.

Field rheostats of the alternators.

Low-tension busbars, either in duplicate, or with transfer or synchronizing bus.

Circuit breakers between generators and busbars, usually non-automatic.

Circuit breakers between transformers and busbars, usually automatic, with the time limit.

Voltmeters and potential transformers at the generators.

Synchronoscopes or other synchronozing devices.

Ammeters and current transformers at the generators.

Voltmeter and potential transformers at the busbars.

Ammeters and current transformers at the step-up transformers.

Totalling ammeter for the station output.

Integrating wattmeter.

Relays, interlocking devices etc., etc.

Step-up transformers.

High-tension busbars, possibly in duplicate.

High-tension circuit breakers between transformers and high-tension busbars.

High-tension circuit breakers between high-tension busbars and lines.

Lightning arresters in the transmission lines, with inductances etc.

Ground detectors arcing-ground or short-circuit suppressors, voltage indicators etc.

Automatic recording devices (multi-recorder), rarely used, though very desirable.

Due to the vast amount of energy controlled by modern stations, the auxiliary and controlling devices in these stations have become so numerous as to make the station a very complex structure, requiring high operating skill and involving high cost of installation. At the same time, not only are all these devices necessary for the safe operation of the station, but we must expect that with the further increase in capacity of our electric systems additional devices will become necessary for safe and reliable operation. One such device I have already mentioned—automatic recording apparatus, such as the multi-recorder.

With this type of station it is obviously impossible in most cases to develop water powers of small and moderate size. A generating station of 1000 hp. will rarely, and one of 100 hp. will hardly ever be economical.

On the other hand, 100 hp. motor installation is a good economical proposition, and the average size of all the motor installations is probably materially below 100 hp.

Looking over Tables II and III, especially the latter, it is startling to see how large a part of the potential water power of the country is requested by comparatively small areas of high elevation, in spite of the relatively low rainfall of these areas. As most of these areas are at considerable distance from the ocean, most of the streams are small in volume. That is, it is the many thousands of small mountain streams and creeks, of relatively small volume of flow, but high gradients, affording fair heads, which apparently make up the bulk of the country's potential water power.

Only a small part of the country's hydraulic energy is found so concentrated locally as to make its development economically feasible with the present type of generating station. Therefore, some different, and very much simplier type of generating station must be evolved before we can attempt to develop economically these many thousands of small hydraulic powers, to collect the power of the mountain streams and creeks.

Simplification of Hydroelectric Station

In the following, in discussing the simplification of the hydroelectric station to adopt it to the utilization of smaller powers, we limit ourselves to the case where the smaller hydraulic stations feed into a system containing some large hydraulic or steam turbine stations, to which the control of the system may be regulated.

1. We may eliminate the low tension busbars, with generator circuit breakers and transformer low-tension circuit breakers, and connect each generator directly to its corresponding transformer, making one unit of generator and transformer, and do the switching on high-tension busbars, and locating high-tension busbars and circuit breakers outdoors. While it is dangerous to transformers to switch on the high-tension side, due to the possiblity of cumulative oscillations, this danger is reduced by the permanent connection of the transformer with the generator circuit, and is less with the smaller units used in smaller power stations, and thus permissible in this case.

However, the simplification resulted therefrom is not so great, as ammeters, voltmeter, and synchronizing devices with their transformers are still retained on the low-tension circuits.

2. As it is not economical to operate at partial load, proper operation of a hydraulic station on a general system is to operate as many units fully loaded as there is water available, and increase or reduce the number of units (of turbine, generator and transformer, permanently joined together), with the charging amount of available water, thus using all the available energy of the water power.

In this case, the turbine governors, with their more or less complex hydraulic machinery, may be omitted. If, then, the generators are suddenly shut down by a short circuit which opens the circuit breakers, the turbines will race and run up to their free running speed, until the gates are shut by hand. However, generators and turbines must stand this; as even with use of governors the turbines may momentarily run up to their free speed in case of a sudden opening of the load before the governors can cut off the water. Where this is not desirable some simply excess speed cutoff may be used.

3. When dropping the governing of the turbines, and running continuously at full load, the question may be raised whether generator ammeters are necessary, as the load is constant, and is all the power the water can give; and it might appear that ammeters with their current transformers, etc. could be omitted.

However, with synchronous generators, the current depends not only on the load, but also on the power factor of the load. With excessively low power factor due to wrong excitation, the generators may be overheated by excess current, while the power load is well within their capacity. Thus ammeters are necessary with synchronous generators. As soon, however, as we drop the use of synchronous generators, and adopt induction generators, the ammeters with their current transformers may be omitted, since the current and its power factor is definitely fixed by the load, synchronizing devices become unnecessary, together with potential transformers, generator voltmeters, etc. A station volmeter may be retained for general information, but it is not necessary either, as the voltage and frequency of the induction-generator station are fixed by the controlling sychronizing main station of the system.

4. With the adoption of the induction generator, the entire exciter plant is eliminated, as the induction generator is excited by lagging currents received from synchronous machines, transmission lines and cables existing in the system. This avoids the use of exciter machines, exciter busses, ammeters, voltmeters, alternator field rheostats, etc. in short, most of the auxiliaries of the present synchronous station become unnecessary.

The solution of the problem of the economic development of smaller water powers is the adoption of the induction generator.

Stripped of all unnecessary equipment, the smaller hydroelectric station thus would comprise:

Hydraulic turbines of simplest form, continuously operating at full load, without governors.

Low-voltage induction generators direct connected to the turbines.

Step-up transformers direct connected to the induction generators.

High-tension circuit breakers connecting the step-up transformers to the transmission line. In smaller stations, even these may be dispensed with and replaced by disconnecting switches and fuses.

Lightning arresters on the transmission line where the climatic or topographical location makes such necessary.

A station voltmeter, a totalling ammeter or integrating wattmeter and a frequency indicator may be added for the information of the station attendant, but are not necessary, as voltage, current, output, and frequency are not controlled from the induction generator station, but from the main station, or determined by the available water supply.

It is interesting to compare this induction generator station layout with that of the modern synchronous station given above. However, it must be forgotten that the simplicity of the induction generator station results from the relegation of all the functions of excitation, regulation and control, to the main synchronous stations of the system, and the induction generator stations thus are feasible only as adjuncts to at least one large synchronous station, hydraulic, or steam turbine, in the system, but can never replace the present synchronous generator stations in their present field of application.

Automatic Generating Stations

With the enormous simplification resulting from the use of the induction generator, it appears entirely feasible to make smaller hydroelectric generating stations entirely automatic, operating without attendance beyond occasional, weekly or daily inspection.

Such an automatic generating station would comprise a turbine with low-voltage induction generator, housed under a shed, and a step-up transformer, outdoors, connecting into the transmission line with time fuses and disconnecting switches.

It is true that in the big synchronous generating stations of thousands of kilowatts the cost of the auxiliaries, as exciter plant, regulating and controlling devices, etc., is only a small part of the total station cost and little would therefore be saved by the use of induction generators. No induction generators would, however, be used for such stations. But the cost of auxiliaries and controlling devices, and the cost of the required skilled attendance, decreases far less with decreasing station size than that of the generators, whether synchronous or induction; in other words, with decreasing size of the station, *per kilowatt output,* the cost of auxiliaries and controlling devices and of attendance increases at a far greater rate than that of the generators, and very soon makes the synchronous station of the present type uneconomical.

It is also true that in the big modern hydraulic power systems, the cost of the generating station ususally is a small part of the cost of the hydraulic development. Therefore any saving in the cost of the generating station would be of little influence in determining, whether the hydraulic development would be economical. With decreasing size of the water power the cost of the hydraulic development *per kilowatt* output usually increases so rapidly as very soon to make the development of the water power uneconomcial, no matter how simple and cheap the station is.

However, the value of the induction generator is not so much in reducing the cost of the generating station, as in the reduction of the cost of the hydraulic development, by making it possible to apply to the electric generator the same principle, which has made the electric motor economically so successful; that is, *to collect the power electrically, just as we distribute it electrically.*

We do not, as in the days of the steam engine, convert the electric power into mechanical power at one place, by one big motor, and distribute the power mechanically, by belts and shafts, but we distribute the power electrically, by wires, and convert the electric power to mechanical power, wherever mechanical power is needed, by individual motors throughout mill and factory.

In the same way we must convert the hydraulic, that is, mechanical power into electrical power by individual generators located along the streams or water courses within the territory, whenever power is available, and then collect this power electrically by medium-voltage collecting lines and high-voltage transmission lines, and so eliminate most of the cost of the hydraulic development, to solve the problem of the economical utilization of the country's water powers. If we attempt to collect the power mechanically; that is, by a hydraulic development, gathering the waters of all the streams and creeks of a territory together into one big station, and there convert it into electric power, the cost of the hydraulic development makes it economically hopeless except under unusully favorable conditions, where a very large amount of power is available within a limited territory, or where nature has done the work for us in gathering considerable power at a waterfall, etc.

It is the old problem, and the old solution: If you want to *do it economically, do it electrically.*

Naturally, then, we would use induction generators in these small individual stations just as we use induction motors in invidual motor installations; but where large power is available, there is the field of the synchronous generator, and the induction generator is undesirable, just as the synchronous motor is preferabe where large power is required, unless the synchronous motor is excluded by conditions of starting torque, etc.

At first, and for some time to come, we would not consider utilizing anywhere near as small sizes of induction generators as we do in induction motors. However, there are undoubtedly many millions of kilowatts available in water powers throughout the country which can be collected by induction-generator stations from 50 hp. upwards, and that at fair heads, requiring no abnormal machine design (no low speed).

Consider for instance a New England mill river with a descent, in its upper course, of about 1100 ft. within 5 miles of varying gradient. At three places, where the gradient is steepest, by a few hundred feet of cast iron pipe and a small dam of 20 to 30 ft. length, and a few feet height—just enough to cover the pipe intake—an average head of 150 feet can be secured, giving an average of 75 hp. each, or a total of 225 hp. or 170 kw. This would use somewhat less than half the total potential power. The development of the other half, requiring greater length of pipe line, or involving lower heads, would be left to meet future demands for additional power.

The installation of an electric system of 170 kw. would hardly be worth while, but there are numerous other creeks throughout the territory from which to collect power, where, within a few miles, there passes a high potential transmission line, coming from a big synchronous station, into which the power collecting line coming from the induction generator stations would be tied and from which they would be controlled.

Thus the large modern synchronous station has its field, and is about as perfect as we know how to build for large concentrated powers; but beyond this, there is a vast field, and therefore an economic necessity of the development of a different type of hydraulic generating station to collect the scattered water powers of the country; and that is the induction generator station, to which I wish to draw attention.

I must caution, however, not to mistake small power and low head power. There are on the lower courses of our streams some hydraulic powers which are relatively small due to their low heads, and which cannot be economically developed by the synchronous generator, due to the low head and correspondingly low speed. The designing characteristics of the induction generator, with regard to low-speed machines, are no better if anything rather worse than those of the synchronous generator, and the problem of the economical utilization of the low-head water power still requires solution. It is not solved by the induction generator. The latter's characteristic is simplicity of the station, giving the possibility of numerous small automatic generating stations.

III. Induction Generator Station

An induction motor at no load runs at, or rather very close to synchronism. If it is driven above synchronism by mechanical power, current and power again increase, but the electric power is outflowing, and the induction machine consumes mechanical power, and generates electrical power, as an induction generator.

The maximum electrical power which an induction machine can generate as an induction generator is materially larger than the maximum mechanical power, which the same machine, at the same terminal voltage, can produce as an induction motor.

Resolving the current of the induction machine into an energy component and a wattless or reactive component, we find that the energy current is inflowing, representing consumption of electric power (which is converted to mechanical power) below synchronism. It becomes zero near synchronism; above synchronism the energy current is in the reverse direction, or outflowing, supplying electric power to the system (which is produced from the mechanical power plant input into the machine), and the induction machine then is a generator.

The wattless or reactive component is a minimum at synchronism, and increases with the slip from synchronism. It is in the same direction whether the slip is below synchronism, as in a motor, or above synchronism, as in a generator. That is, the induction machine always consumes a lagging current (representing the exciting current and the reactance voltage), or, what amounts to the same, produces a leading current. The latter way of putting it is frequently used with induction generators, by saying that the current produced by the induction generator is leading, while the current consumed by the induction motor is lagging. Instead of saying, however, that the reactive component of the current generated by the induction generator is leading, we may say and this makes it often more intelligible that the induction generator generates an energy current and consumes a lagging reactive current, while the induction motor consumes an energy current and consumes a reactive lagging current.

As with the increasing voltages and increasing extent of our transmission systems the leading currents taken by transmission lines and underground cables are becoming increasingly larger, the induction generator appears specially advantageous, as tending to offset the effect of line capacity. We may thus say that the induction generator (and induction motor) consumes a lagging reactive current, which is supplied by the synchronous generators, synchronous motors, converters, and other synchronous apparatus in the system, and by the capacity of lines and cables. Or we may say that the lagging current consumed by the induction generator neutralizes the leading current consumed by the capacity of lines and cables. Or we may say that the leading current produced by the induction generator supplies the capacity of lines and cables: these are merely three different ways of expressing the same facts.

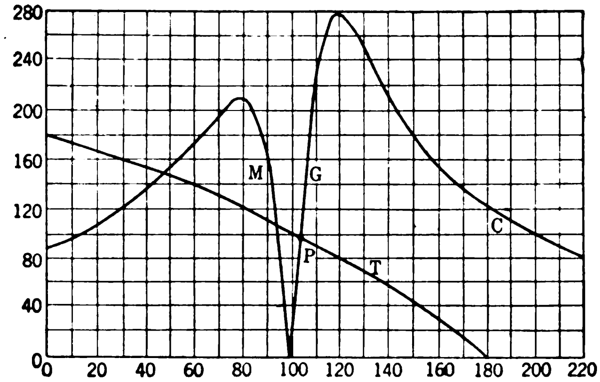

Fig. 1—Small Hydraulic Induction Generator Plant Constant Terminal Voltage.

In Fig. 1 are shown the torque curves, at constant terminal voltage, of a typical moderate size induction machine. *M* is the torque produced as an induction motor below synchronism, and *G* the torque consumed as an induction generator above synchronism, synchronism being chosen as 100 percent. *T* is an assumed torque curve of a hydraulic turbine.

As seen, the point where *P* and *G* and *T* intersect, is 4 percent. above synchronism, and this induction genrator thus operates on full load at 4 percent. slip above synchronism or no-load. Assume now, that the power goes off, by the circuit breakers opening. The turbine then speeds up to 80 percent. above synchronism, where the curve *T* becomes zero. If at this free running turbine speed the circuit is closed and voltage put on the induction generator, the high torque consumed by the induction generator causes the turbine to slow down, and as at all speeds above 104, the torque consumed by the induction generator is very much higher than that given by the turbine, the machine slows down rapidly, to the speed where the induction generator torque has fallen to equality with the turbine torque, at speed 104, and stable condition is restored.

Inversely, if the flow of water should cease, the induction machine slows down to a little below spnchronism, and there continues to revolve as induction motor.

In starting, the circuit may be closed before admitting the water, and the turbine started by the induction machine as a motor, on the torque curve *M*, running up to speed 100, and then, by admitting the water, the machine is speeded up 4 percent. more and thereby made to take the load as generator. Or the turbine may be started by opening the gates, running up to speeu 180, and then, by closing the circuit, the induction machine in taking the power slows the speed down to normal.

With larger machines, the most satisfactory way of starting, as involving the least disturbance, probably would be, first to open the gates partly while the turbine speeds up, and when it has reached a speed in the neighborhood of synchronism, say be tween 95 and 105, the circuit is closed and the water gates opened fully.

Inability Conditions of Induction Generator

In Fig. 1, the torque consumed by the induction machine, at all turbine speeds above full load P, is much highr than the torque of the turbine. However, the induction generator torque curve has a concave range, marked by *C*, and if the induction generator should be such as to bring the generator torque curve at *C* below the turbine curve *T*, the speed, when once increased beyond the range C, would not spontaneously drop back to normal. While in Fig. 1, *C* is much higher than *T*, curve *C* represents the theoretical, but not real case of constant terminal voltage at the induction machine. The voltage however is kept constant at the controlling synchronous main station, and thus must vary with the load in the induction generator station. Assuming an extreme case of 10 percent. resistance and 20 percent. reactance in the line from the induction machine station to the next synchronism station, we get the modified torque curve shown in Fig. 2. As seen, at full load *P*, there is practically no change; about 4 percent. slip above synchronism. The maximum torque of generator *G* and motor *M*, and the torque at the concave part of the induction generator curve, *C*, have greatly decreased. However, *C* is still above *T*, that is, even under this extreme assumption, the induction generator would pull the turbine down from its racing speed of 180, to the normal full load speed of 104, though the margin has become narrow.

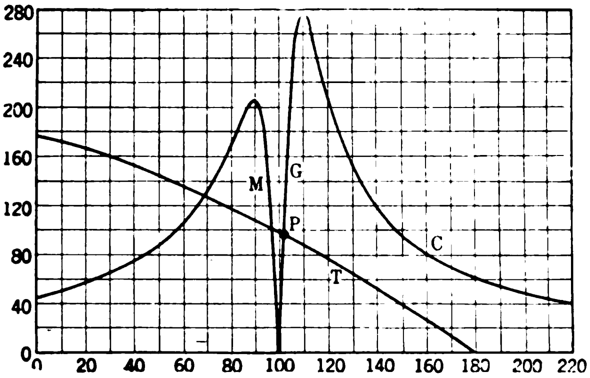

Fig. 2.—Small Hydroelectric Induction Generator Plant—Constant Voltage in Synchronous Station.

Assuming however an induction machine with much less slip, with only half the rotor resistance of Figs. 1 and 2. At constant

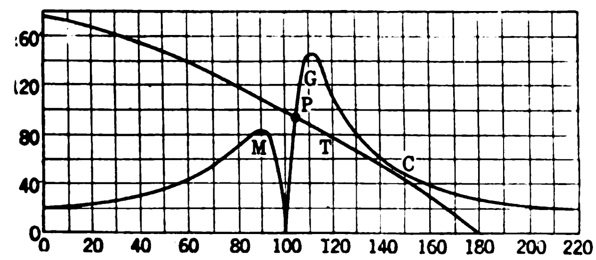

Fig. 3.—Large Hydroelectric Induction Generator Plant—Constant Terminal Voltage.

terminal voltage, this gives the curves shown in Fig. 3. The full load *P* is at speed 102, or 2 percent. above synchronism, and while the curve branch *C* is much lower, the conditions are still perfectly stable. Assuming however, with this type of low resistance rotor, a high line impedance, 10 percent. resistance and 20 percent. reactance, as in Fig. 2. We then get the condition shown in Fig. 4. The range *C* drops below *T*, and the induction generator torque curve *G* intersects the turbine torque curve *T* at three points: *P*, P_1 and P_2. Of these three theoretical running speeds, $P = 102$ $P_1 = 169$ and $P_2 = 113.5$, two are stable, *P* and P_1; while the third one, P_2, is unstable, and from P_2, the speed must either decrease, reaching stability at the normal full load point *P*, or the machine speed up to P_1

If with the conditions represented by Fig. 4, the turbine should —by an opening of the circuit for instance—have speeded up to its free running speed 180 closing the circuit does not bring the speed back to normal, *P*, but the machines slow down only to speed P_1, where stability is reached, at very little output and very large lagging currents in the induction generator. To restore normal condition then would require shutting off the water,

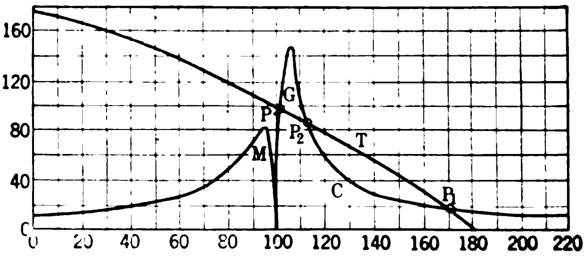

Fig. 4—Large Hydroelectric Induction Generator Plant—Constant Voltage in Synchronous Main Station.

at least sufficiently to drop the turbine torque curve *T* below C, and then letting the machines slow down to synchronism. They would not go below synchronism, even with the water gates entirely closed, as the induction machine as a motor, on curve *M*, holds the speed.

A solution in the case Fig. 4 would be the use of a simple excess speed governor, which cuts off the water at 5 to 10 percent. above synchronism.

However, the possibility of difficulty due to the "dropping out of the induction generator" as we may call it in analogy to the dropping out of the induction motor, are rather less real than it appears theoretically. In smaller stations, such as would be operated without attendance, as automatic stations, the torque curve of the induction generator, as a small machine, would be of the character of Figs. 1 and 2, and thus not liable to this difficulty. The low resistance type of induction machines, as represented in Figs. 3 and 4, may be expected only with the larger machines, used in larger stations. In those, some attendant would be present to close the water gates in case of the circuit breakers opening, or a simple cheap excess speed cut-off would be installed at the turbines, keeping them within 10 percent. of synchronism, and with this range, no dropping out of the induction generator can occur.

It is desirable however to realize this speed range of possible instability of the induction generator, so as to avoid it in the design of induction generators and stations.

Collection of Fuel Power by Steam Turbine Induction Generator

The Automatic Steam Turbine Induction Generator Station

The same reason which in the preceding led to the conclusion that in the (automatic) induction generator station is to be found the solution of the problem of collecting the numerous small amounts of hydraulic energy, which are scattered throughout our country along creeks and mountain streams, also applies, and to the same extent, to the problem of collecting the innumerable small quantities of mechanical or electrical energy, which are, or can be made available wherever fuel is consumed for heating purposes. Of the hundred millions tons of coal, which are annually consumed for heating purposes, most is used as steam heat. Suppose then, we generate the steam at high pressure—as is done already now in many cases for reasons of heating economy—and interpose between steam boiler and heating system some simple form of high pressure steam turbine, directly connected to an induction generator, and tie the latter into the general electrical power distribution system. Whenever the heating system is in operation, electric power is generated, as we may say as "by-products" of the heating plant, and fed into the electric system.

The power would not be generated continuously, but mainly in winter, and largely during the day and especially the evening. That is, the maximum power generation by such fuel power collecting plant essentially coincides with the lighting peak of the central station, thus occurs at the time of the day, and the season when power is most valuable. The effect of such fuel power collection on the central station should result in a material improvement of the station load factor, by cutting off the lighting peaks.

The only difference between such turbine induction generator stations, collecting the available fuel power scattered throughout the cities and towns, and the hydraulic induction generator stations collecting the powers of the streams throughout the country, is that in the steam turbine plant an excess speed cut-off must be provided, as the free running steam turbine speed is usually not limited to less than double speed, as is the case with the hydraulic turbine. Otherwise however, no speed governing is required. A further difference is, that the greater simplicity and therefore lower investment of the steam turbine plant would permit going down to smaller powers, a few kilowatts perhaps.

It is interesting to note, that even with a very inefficient steam turbine, the electric generation of such fuel power collecting plant interposed between boiler and heating system, takes place with practically 100 percent. efficiency, because whatever energy is wasted by the inefficiency of the steam turbine plant, remains as heat in the steam, and the only loss is the radiation from turbine and generator, and even this in most cases is useful in heating the place where the plant is located. The only advantage of a highly efficient turbine, is that larger amounts of electric power can be recovered from the fuel, and the question thus is that between the investment in the plant, and the value of the recovered power.

If then the total efficiency, from the chemical energy of the fuel to the electric power, were only 3 percent., it would mean that 3 percent. more coal would have to be burned, to feed the same heat units into the heating system. At an average energy value of 30,000 kj. per kg. of coal, this would give per ton of coal, 900,000 kj. or 250 kw-hr. At a bulk value of ½ cent per ky-hr. it would represent a power recovery value of $1.25 per ton of coal. This is quite considerable, more than sufficient to pay the interest on the investment in the very simple plant required.

At first, the steam turbine induction generator plant, proposed for the collection of fuel power, would appear similar to the isolated plant which, though often proved uneconomical, still has successfully maintained its hold in our northern latitudes, where heating is necessary through a considerable part of the year. However, the difference between the steam turbine induction generator plant and the isolated steam electric plants in our cities, is the same as that between the automatic hydroelectric induction generator station, and the present standard synchronous generator station: by getting rid of all the complexity and complication of the latter, the induction generator station becomes economically feasible in small sizes; but it does so only by ceasing to be an independent station, by turning over the functions of regulation and control to the central main station and so becoming an adjunct to the latter. But by this very feature, the turbo induction generator plant might afford to the central station, the public utility corporation, a very effective means of combatting the installation of isolated plants, by relieving the prospective owner of the isolated plant of all trouble, care and expense and incidental unreliability thereof, supplying central station power for lighting, but at the same time utilizing the potential power of the fuel burned for heating purposes. The simplest arrangement probably would be that the fuel power collecting plants scattered throughout the city would, as automatic stations, be taken care of by the public utility corporation, their power paid at its proper rates, those of uncontrolled bulk power, while the power used for lighting is bought from the central station at the proper lighting rates.

As this however means a new adjustment of the relation between customer and central station, and is not merely an engineering matter like the hydroelectric power collection, I have placed it in an appendix.

Discussion

We realize that our present method of using our coal resources is terribly inefficient. We know that in the conversion of the chemical energy of coal into mechanical or electrical energy, we have to pass through heat energy and thereby submit to the excessively low efficiency of transformation from the low grade heat energy to the high grade electrical energy. We get at best 10 to 20 percent. of the chemical energy of the coal as electrical energy; the remaining 80 to 90 percent. we throw away as heat in the condensing water, or worse still, have to pay for getting rid of it. At the same time we burn many millions of tons of coal to produce heat energy, and by degrading the chemical energy ino heat, waste the potential high grade energy which those millions of tons of coal could supply us.

It is an economic crime to burn coal for mere heating without first taking out as much high grade energy, mechanical or electrical, as is economically feasible. It is this feature, of using the available high grade energy of the coal, before using it for heating, which makes the isolated station successful, though it has every other feature against it. To a limited extent, combined electric and central steam heating plants have been installed, but their limitation is in the attempt to distribute heat energy, after producing it in bulk, from a central station. Here again we have the same rule; to do it efficiently, do it electrically. In the efficiency of distribution or its reverse, collection, no other form of energy can compete with electric energy, and the economic solution appears to be to burn the fuel wherever heating is required, but first take out its available high grade energy, and collect it electrically.

Assume we use 200,000,000 tons of coal per year for power, at an average total efficiency of 12 percent. giving us 24,000,000 kw. (referred to 24-hr. service) and use 200,000,000 tons of coal for heating purposes, wasting its potential power.

If then we could utilize the waste heat of the coal used for power generation, even if thereby the average total efficiency were reduced to 10 percent., we would require only 240,000,000 tons of coal, for producing the power, and would have left a heating equivalent of 216,000,000 tons of coal, or more than required for heating. That is, the coal consumption would be reduced from 400,000,000 to 240,000,000 tons, a saving of 160,000,000 tons of coal annually.

Or, if from the 200,000,000 tons of coal, which we degrade by burning it for fuel, we could first abstract the available high grade power, assuming even only 5 percent. efficiency, this would give us 10,000,000 kw. (24-hr. rate), at an additional coal consumption of 10,000,000 tons, while the production of the 10,000,000 kw. now requires 100,000,000 tons of coal, more or less, thus getting a saving of 90,000,000 tons of coal; or putting it the other way, a gain of 9,000,000 kw.—12,000,000 hp.—24-hr. service, or 36,000,000 horse power for an 8-hr. working day.

It is obvious that we never could completely accomplish this but even if we recover only one-quarter, or even only one-tenth of this waste, it would be a vast increase in our national efficiency.

Thus the solution of the coal problem, that is, the more economic use of fuel energy, is not only the increase of the thermodynamic efficiency of the heat engine, in which a radical advance is limited by formidable difficulties; but is the recovery of the potential energy of all the fuel, by electric collection.

Turbo Induction Generator

Assume then that wherever fuel is burned to produce steam for heating purposes, instead of a low-pressure boiler giving a few pounds over-pressure only, we generate the steam at high pressure, at six atmospheres (90 lbs.) or, in larger plants, even at 15 atmospheres (225 lb.) passing the steam through a high pressure turbine wheel directly connected to an induction generator tied into the electric supply system, and then exhaust the steam at 1.25 atmospheres (19 lb.) into the steam heating system, or at 0.48 atmospheres (7 lb.) into a vacuum heating system.

der the assumption, that the use of the heating plant is equivalent to full capacity during one quarter of the time, and the turbine induction generator plant 50 percent. larger, to take care of maximum loads. As seen, the volume of the recovered power would be a substantial percentage of the fuel cost.

With 100,000,000 tons of coal used for heating purposes annually, assuming an average recovery of 600 kw-hr. per ton, this gives a total of 60,000,000,000 kw-hr. per year. One-quarter of this is more electric power than is now produced at Niagara, Chicago, New York and a few other of the biggest electric systems together.

Per ton of coal: Chemical energy, 30×10^6 kj: Heat energy of steam from boiler, at 75 percent. boiler efficiency, 22.5×10^6 kj.

	Boiler press		Dist press		Carnot-efficiency percent.	Output at 50 percent. efficiency		Value of power at ½c per kw-hr. $----	Avg. kw., assuming 25% time of use	Tons of coal per kw.	Size of induction generator, per 100 tons coal annually
	atm.	lb.	atm.	lb.		kj. × 1000	kw-hr.				
Steam Heating	6	90	1.25	19	12.3	1380	385	1.92	0.176	5.7	25 kw.
	15	220	1.25	19	19.8	2230	620	3.10	0.283	3.5	45 kw.
Vacuum Heating	6	90	0.48	7	18.1	2030	565	2.82	0.258	3.9	40 kw.
	15	2.0	0.48	7	25.0	2820	810	4.05	0.37	2.7	55 kw.

At a fuel value of the coal of 30,000 kj. per kg. we have (see table)

From this it would follow that the average magnitude of the steam turbine induction generator plant for power collection from fuel in heating plants, would be about one-quarter to one-half kw. per ton of coal burned annually, un-

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SAVE THE TIN

As a result of comparatively recent developments of the war, the supply of pig tin imported into the United States has been seriously restricted. The shortage of shipping in service to the Orient has prevented receipt of the large proportion of tin formerly obtained from the Dutch East Indies.

The War Service Committee of the Electrical Manufacturing Industry makes a strong plea for the conservation of tin in the use of babbitt metal, alloy castings and in tinning and soldering. They suggest the following measures:

The use of lead-base babbitt, or the reduction of tin-content in tin-base babbitt where its use is absolutely necessary.

The use of the thinnest section of babbitt metal consistent with a satisfactory bearing.

The reduction of the percentage of tin in alloy castings.

The use of a mixture of lead and tin for solder with a proportion of 55, 60 or even 70 percent. lead.

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PATENT OFFICE NEEDS HELP

The United States Patent Office at Washington, D. C. is in need of technically trained help. Men or women are desired who have a scientific education, particularly in higher mathematics, chemistry, physics, and French or German, and who are not subject to the draft for military service. Engineering or teaching experience in addition to the above is valued. The entrance salary is $1500.

Examinations for the pasition of assistant examiner are held frequently by the Civil Service Commission at many points in the United States. One is announced for August 21 and 22, 1918. Details of the examination, places of holding the same, etc., may be had upon application to the Civil Service Commission, Washington, D. C., or to the United States Patent Office, Washington.

Should the necessity therefore arise, temporary appointments of qualified persons may be made pending their taking the Civil Service Examination. Application for such appointment should be made to the Patent Office at Washington.

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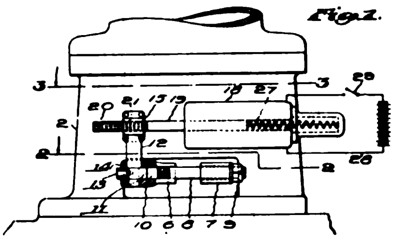
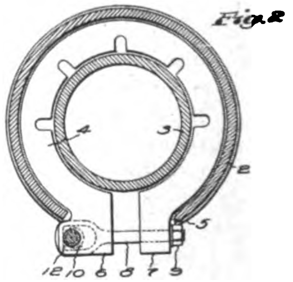
MACHINE TOOL CONTROL

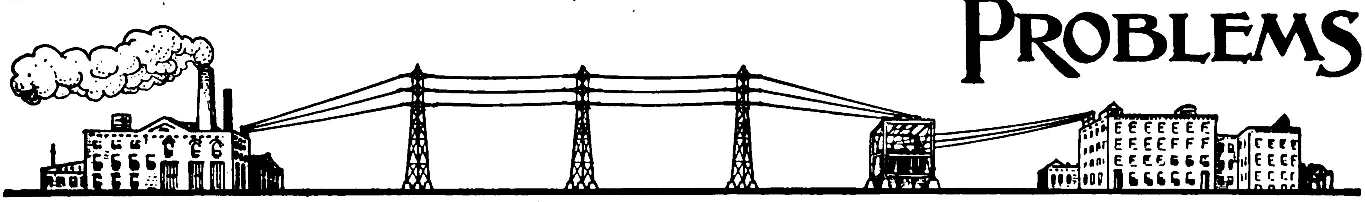
The certainty and promptness, as well as the ability to place the control point at the most convenient spot, which characterizes the electrical control of machine tools, is taken advantage of to control and secure the adjustment of the standard or column of a radical drill and for similar uses according to a patent recently granted to Mr. Willard T. Sears, Philadelphia, Pa. His





device is well shown in the cuts wherein the column 3 is surrounded by a clamping ring 4 in the bed plate 2. The ends of the ring are connected by bolt 8 and cam 11 draws the clamping ring together. The cam is operated by pinion 21 driven by a rack 20 which is the plunger of the electromagnet 18. The drill arm may be released and adjusted to any desired position and may be locked in position by simply opening or closing the switch 29 which may be located at the most convenient point about the machine. Patent No. 1,185, 839.

POWER PLANT, LINE AND DISTRIBUTION PROBLEMS



A Record of Successful Practice and Actual Experiences of Practical Men

HOW TO WIND A MAGNET

By T. Schutter

In winding a magnet, it must be borne in mind that the winding is usually intended to occupy a given space. For this reason it is sometimes necessary to predetermine the amount of wire required, its resistance and its operating temperature.

These factors can be easily determined by means of a few simple equations. These equations are given below. The symbols which will be used and their meaning are:

a = Number of turns per layer.
b = Number of layers.
c = Number of turns on entire coil.
d = Diameter of bare wire in mils (1/1000 of an inch).

$$(1)\quad a = \frac{1}{d + i}$$

$$(2)\quad b = \frac{h}{d + i}$$

$$(3)\quad c = a \times b.$$

$$(4)\quad m = \frac{(2\ D \times 2\ h) \times \pi}{2}$$

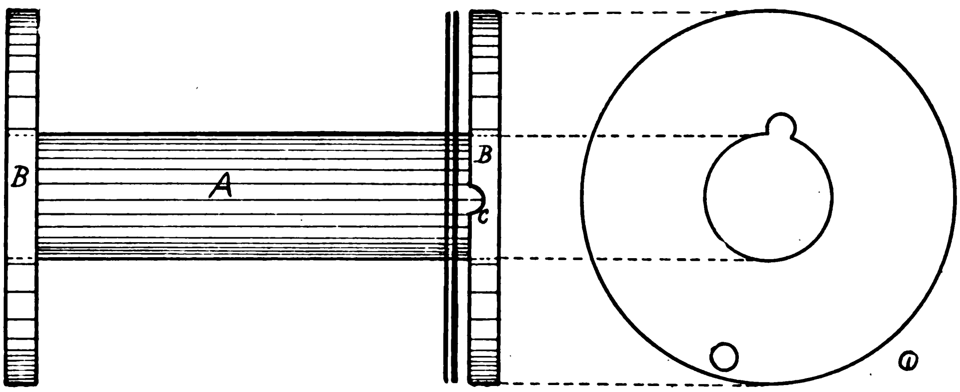


Fig. 1

h = Allowable winding space (round coils only).
i = Thickness of insulation on both sides of wire.
l = Length of spool or distance between heads.
m = Length of average turn in inches (round coils).
t = Thickness of coil (rectangular coil only).
B = Breadth of pole piece or core.
D = Diameter of pole piece or core.
E = Operating voltage of coil.
F = Length of wire used on coil, in feet.
H = Height of pole piece or core.
I = Current taken by coil in amperes.
K = Specific resistance, 10.8 ohms cold, 12.8 ohms hot.
L = Length of pole piece or core.
K = Resistance of coil.
S = Radiating surface of coil.
T = Room temperature.
$T°$ = Temperature of coil above room temperature when in operation.
W = Watts absorbed by coil.
M = Length of an average turn. (rectangular coils).

The calculations will be divided into two parts—round coils and rectangular coils. The formulas for round coil calculations are as follows:

$$(5)\quad F = \frac{m \times c}{12}$$

$$(6)\quad R = \frac{F \times K}{d^2}$$

$$(7)\quad I = \frac{E}{R}$$

$$(8)\quad W = I^2 \times R \text{ or } E \times I$$

$$(9)\quad T° = \frac{T \times W}{S}$$

The calculation and formulas for rectangular coils are as follows:

$$(1)\quad A = \frac{H}{d + i}$$

$$(2)\quad b = \frac{t}{d + i}$$

$$(3)\quad C = a \times b.$$

$$(4)\quad M = 2\ B + 2\ L + 4\ t$$

$$(5)\quad F = \frac{M \times C}{12}$$

$$(6)\quad R = \frac{F \times K}{d^2}$$

$$(7)\quad I = \frac{E}{R}$$

$$(8)\quad W = I^2 \times R \text{ or } E \times I$$

$$(9)\quad T^\circ = \frac{T \times W}{S}$$

Before taking up details and working out some problems, it were advisable to dwell a while on the precautions that should be taken in preparing, insulating and winding field coils or magnet coils. These general observations will be found helpful later on.

Electromagnet coils are usually wound directly on the core. Fibre ends or heads are usually placed so as to prevent the windings from slipping off the ends of the core. The core and fibre ends give the complete unit the shape of a spool, as shown in Fig. 1.

The core *A* should be insulated either with several turns of sheet fibre about .007 of an inch in thickness, (the thickness of the insulation around the core will depend entirely on the operating voltage of the coil), and one end or head should be drilled so

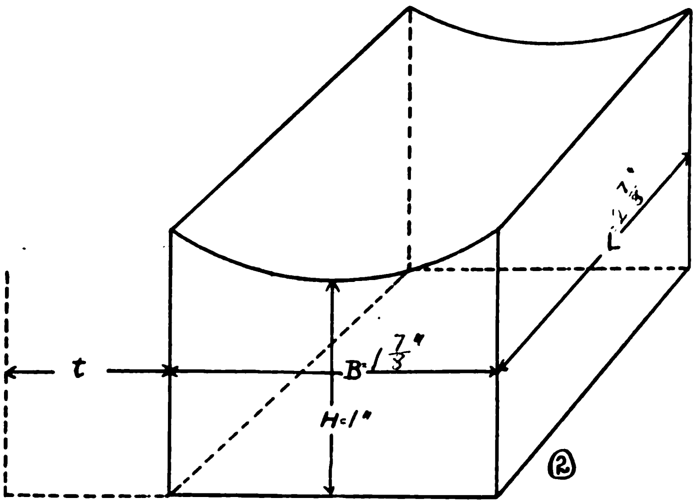


Fig. 2

as to allow the leads to come out through the ends or heads, or it can be arranged as shown at *B* Fig. 1, where the end or head has been gouged out so as to allow the lead to lay in flush, then a thin fibre washer is placed as at *C* Fig. 1.

The leads should be reinforced by splicing a piece of No. 18 B & S gauge flexible wire on both the beginning and ending of the winding. This flexible lead should take at least one turn around the coil, at the beginning as well as at the end, before being brought out from the coil for line connection.

The windings on all magnet coils should be wound in layers as close together as possible. When a small size of wire is being used, a sheet of some very thin insulating material, (usually wax paper is used for this purpose) should be placed between every four or five layers, but when heavier wires are used a sheet of wax paper is placed between every layer. These sheets of wax paper should be snuggly fitted so that they cover the end-turns of a layer as well as the center ones, as in many cases the difference in potential between the end-turns of two succeeding layers may be large, resulting in the liklihood of a breakdown of the insulation on the wires. This would cause a short circuit.

To illustrate this, assume a magnet wound with but two layers. Here the difference in potential between the first turn on the bottom and the last turn on the top layer, (which will be directly over one another) would be equal to the full line potential. If the insulation between two turns should break down, it would cause a dead short circuit.

On some magnets each layer is painted with shellac to reinforce the cotton insulation. On the more modern magnets the wire is coated with enamel, and in some cases a single covering of cotton is placed over this. The enameled wire gives better service when required to work under a heavy load, as it can stand more heat without being in danger of burning out.

When cotton insulation is subject of a temperature of about 180 degrees F. it will begin to char and gradually burn; but enamel insulation can stand a much higher temperature without that danger.

The winding of field coils is somewhat different from the winding of magnets. Field coils are wound over a form, then they are tapped, dipped into an insulating compound, and baked.

A pole piece for which a field coil is to be wound is shown in Fig. 2. The meanings of the lettered dimensions will be found in the previously printed list. When a pole piece is to be measured up for making a winding form as shown in Fig. 3, a certain amount of allowance must be made for insulation when taking the dimensions of *B* and *L*, Fig. 2. This amount of allowance depends entirely on the kind of insulation material that is to be used and also the amount to be employed.

On small field coils and on coils used on low voltages, about 1/16 of an inch on all sides is sufficient. This distance is increased as the sizes of coil and the voltages are increased.

When making a form the dimensions are taken as follows: *H* will be the thickness of the form, and is measured from the lowest part of the pole arc to the base of the pole, *B* and *L* plus the allowance for insulation. When the form is completed it must be perfectly square. Then drill a hole through the center parallel to the dimension *H*, through which a spindle will be placed for winding. The form should be cut in two parts as shown by the line *C*, Fig. 3.

The form is now divided into two parts, *A* and A^1. These two sections are fastened to the side pieces, *B* and B^1, as shown in Fig. 3.

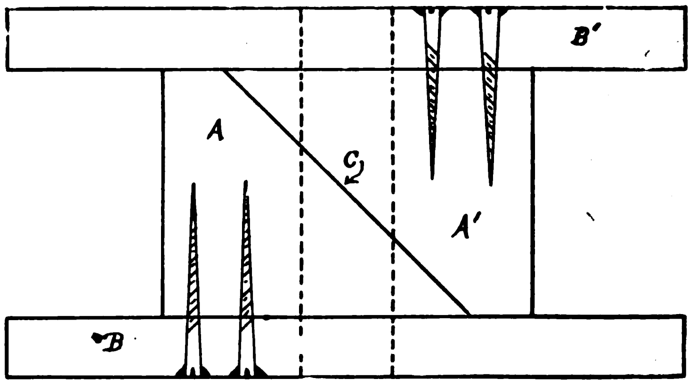


Fig. 3

The following data involves a practical problem of magnet winding, and the dimensions of which are as given in Fig. 4.

The magnet under construction will be of the round type, and it will be wound with No. 29 B & S gauge, single cotton-covered wire. The diameter of the bare wire is 11.3 mils or .0113 of an inch; the thickness of the insulation on both sides of the wire is 3.7 mils or .0037 of an inch. This will make a total of 15 mils, or .015 of an inch as the outside diameter of the wire.

The winding of the magnet will be placed in layers, and the first steps will be to find the number of turns per layer, the number of layers, and the number of turns on the entire coil. We have then:

$$A = \frac{l}{d + i} = \frac{3 \text{ in.}}{.0113 \text{ in.} + .0037 \text{ in.}} \text{ in.} = \frac{3000}{15} = 200$$

turns per layer.

$$b = \frac{h}{d + i} = \frac{1 \text{ in.}}{.0113 \text{ in.} + .0037 \text{ in.}} = \frac{1000}{15} = 66$$

layers.

$c = a \times b = 200 \times 66 = 13{,}200$ turns on the entire coil.

The next step is to determine the length of the average or mean turn, which is to turn midway between the inside or first layer and the outside or last layer of the winding. In Fig. 4a the inner circle (1) shows the diameter of the first layer, while the outer circle (3) shows the diameter of the top layer. Circle (2)

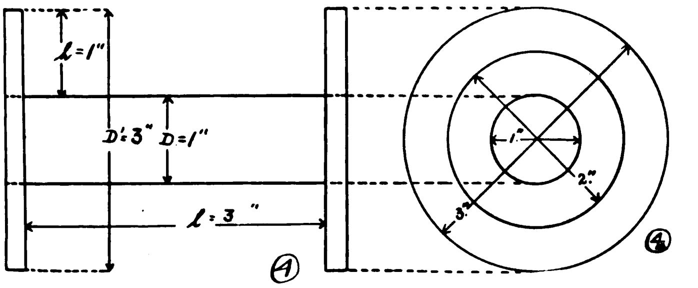


Fig. 4

is placed midway between the outer and inner circles and shows the diameter of the average or mean turn. Then its length in inches may be found as follows:

$$m = \frac{\overset{2}{(2\,D + 2\,h) \times \pi}}{2} = \frac{\overset{2}{2 \times 1 + 2 \times 1) \times 3.1416}}{1}$$

= 6.2832 inches.

The next step is to determine the number of feet of wire used on the coil, and its resistance.

$$F = \frac{m \times c}{12} = \frac{6.2832 \times 13200}{12} = 6911.52 \text{ ft. of wire}$$

used to wind the coil. Then

$$R = \frac{F \times R}{d2^2} = \frac{6911.25 \times 10.8}{11.3 \times 11.3} = 584.5$$

ohms as the resistance of the coil.

The next steps are to find the current this coil will consume when operated on a 110-volt supply circuit, and the energy absorbed by the coil.

$$I = \frac{E}{R} = \frac{110}{584.5} = .17 \text{ amperes; then the energy absorbed}$$

will be.

$W = I^2 R$ or $.17^2 \times 584.5 = 16.9$ watts.

When a magnet coil is put into operation it will heat up, and the rise in temperature will depend on the amount of surface over which the heat can be radiated. On a stationary coil an allowance of .5 of a watt per inch of radiating surface is considered as satisfactory. The radiating surface of this coil will be:

$$S = (D^1 \times \pi\, l) + (D^{12} \times .7854 \times 2) =$$
$$(3 \times 3.1416 \times 3) + 3 \times 3 \times .7854 \times 2 = 42.4$$

square inches of radiating surface. This includes the cylindrical area plus the area of both ends.

Assuming that the temperature of the room in which this coil is operated is 75° F; then to find the number of degrees that the coil will heat above the room temperature proceed as follows:

$$T^\circ = \frac{T \times W}{S} = \frac{75 \times 16.9}{42.4} = 30^\circ \text{ F approximately.}$$

This temperature rise is satisfactory, as cotton insulation will stand 160° F without serious damage. It begins to char very slowly at 168° F. Since the total temperature of this coil is $75^\circ + 30^\circ = 105^\circ$ F, it will be seen that the conditions are then entirely satisfactory.

The foregoing explanation and calculation was for a round field or magnet coil. The calculation for rectangular coils are somewhat different, and are as follows:

By taking the pole piece, shown in Fig. 2, for example, and substituting the following dimensions for the different letters: $B = 1\tfrac{7}{8}$ in.; $H = 1$ in.; $L = 2\tfrac{7}{8}$ in.; $t = 1$ in.

This style of coil is wound on a form, as shown in Fig. 3. In taking the dimensions for this form, an allowance is made for taping on B and L of about $\tfrac{1}{8}$ in. This will make a winding form of 2 in. by 3 in. by 1 in. For the winding, the same size of wire will be used as that used for the round coil (No. 29 B & S gauge wire) where $d = .0113$ in. or 11.3 mils and $i = .0037$ in. or 3.7 mils.

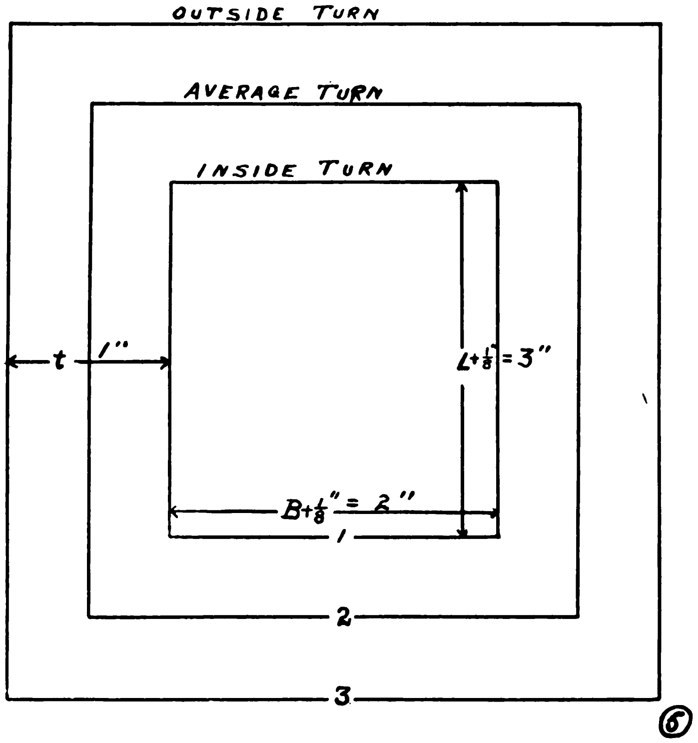


Fig. 5

The first steps are to determine the number of turns per layer, the number of layers and the number of turns on the entire coil. Then we have:

$$a = \frac{H}{d + i} = \frac{1 \text{ in.}}{.0113 + .0037} = \frac{1000}{15} = 66 \text{ turns per}$$

per layer.

$$b = \frac{t}{d + i} = \frac{1 \text{ in.}}{..0113 + .0037} = \frac{1000}{15} = 66 \text{ layers.}$$

$c = a \times b = 66 \times 66 = 4356$ turns on entire coil.

The next step is to determine the length of the average or mean turn, the length of wire used on entire coil in feet, and its resistance.

$M = 2\,B + 2\,H + 4\,t. = 2 \times 2$ in. $+ 2 \times 3$ in. $+ 4$ in. = in. length of average or mean turn.

$$F = \frac{M \times C}{12} = \frac{14 \times 4356}{12} = 5082 \text{ ft. of wire used}$$

on entire coil.

$$R = \frac{E \times K}{d^2} = \frac{5082 \times 10.8}{11.3 \times 11.3} = 427 \text{ ohms.}$$

The next step is to find the number of square innches of exposed surface over which the heat produced due to operation can be radiated, current drawn when operated on a 110-volt supply

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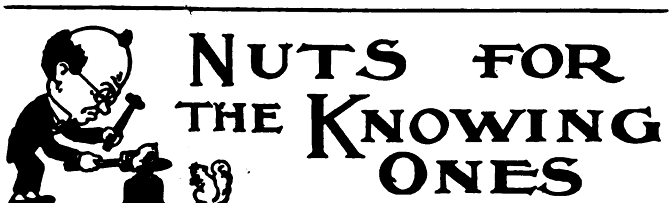

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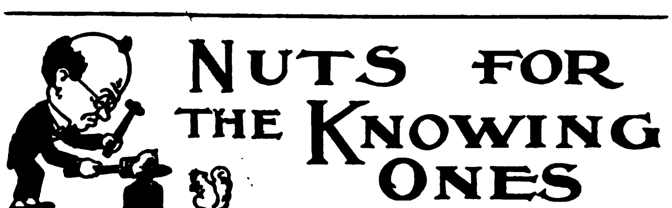

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rid of the copper. The Canadian experiments, however, show that a very satisfactory result can be obtained by a special treatment of the ores without making any effort to eliminate the copper content.

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According to the *Scientific American,* for the last two years of war the biplane type has been in practically universal use, although during the last year the British have employed a few squadrons of Sopwith triplanes with excellent results. However, at present there are many indications that designers are again swinging back to the monoplane in search of greater speed, better climbing ability, and greater maneuvering power. In a recent British official statement it is admitted that excellent results are being obtained at the front with a new monoplane. On the other hand, the Germans are now trying their hand at triplanes, and it is reported that they are rapidly increasing the number of this type flying at the front.

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The chief parts of a Tungar rectifier are a bulb, a compensator, a reactance. The bulb looks much like an incandescent lamp. In addition to the low-voltage filament it has another electrode, the "anode." In the bulb is an inert gas—argon. The combination of the heated filament and the gas makes it possible for current to flow in but one direction—from anode to cathode. Therefore, only uni-directional or direct current can flow from the rectifier. The efficiency of the 6-ampere, 75-volt Tungar rectifier is about 75 percent. at full load.

This rectifier is primarily intended for use by public garages and battery service stations which care for starting and lighting batteries used in gasoline-driven automobiles.

✦ ✦ ✦

The Franklin Institute of the State of Pennsylvania, one department of which has since 1824 annually reported upon inventions with a view of making awards, has so far found but 1,700 inventions worth reporting upon, or an average of 18 a year, though the number of patents granted each year runs into the hundreds of thousands! The Institute is trustee of a number of funds for making awards for meritorious inventions, but has, since 1824, only been able to make such awards in 400 cases, or at the rate of just over four a year, while the interest on one of the funds—the John Scott Legacy Medal and Premium, has accumulated to several thousands of dollars!

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Measured in terms of average labor, copper, wire, car equipment, machinery, coal, and in fact all supplies which it uses in providing public service, the purchasing power of a nickel, as compared with the pre-war period, varies slightly from 2½ cents. If 5 cents was ever a proper rate of fare, the present rate should approximate 10 cents. What business law operates differently for the seller of street car transportation and the seller of pie, hardware, shoes, clothing and everything else? Think for a moment that the nickel is in reality only 2½ cents, and it will be clear that you cannot fairly purchase with it street car rides costing more than 5 cents.

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GOVERNMENT EXHIBIT OF FOREIGN ELECTRICAL GOODS

There is on display at the local district office of the Bureau of Foreign and Domestic Commerce, in room 734 of the New York Customhouse, at Battery Place, a large technical collection of samples of electrical goods used in foreign countries. The exhibit is made up of a comprehensive selection of the goods most employed in electrical work in various foreign countries and includes wiring devices, heating appliances, electrical porcelains, dry cells, flash lights, electric bells, conduit and conduit fittings, insulating wire, etc.

These samples have been forwarded mainly in connection with the special investigations undertaken in South America by P. S. Smith, and in Australia, New Zealand, China, Japan, and Eastern Siberia by R. A. Lundquist, special agent of the bureau. Complete data accompany each article on exhibit, giving country of origin, where obtained, how used, selling price, etc.

There are several hundred items in the exhibit, and these have been specially arranged by T. O. Klath, commercial agent in charge of the bureau's exhibit room, for inspection by electrical manufacturers and exporters in order that they may make a personal study of the classes of goods with which their products come into competition abroad.

These samples of foreign goods available through the efforts of the Bureau of Foreign and Domestic Commerce, are being made broad use of by the manufacturers of the United States. An interesting case was recently learned of, where an electrical manufacturer immediately visited the sample room upon learning of the arrival of a shipment of goods from a foreign market, and carefully studied certain items in which he was interested. Returning to his plant, he developed a similar line of superior design, cabled quotations and data to his agents in the market, and began selling a new line which has rapidly grown to large volume.

There is a wide field abroad for standard American electrical goods, as well as for adaptions of American designs to foreign requirements, and when our electrical manufacturers study the types of goods now in use in such market, they can obtain a grasp of the standards and of the conditions existing that can be secured in no other way except by a personal visit to the field, and this knowledge will enable them to push the sale of their goods with the best possible efficiency.

R. A. Lundquist, himself a consulting engineer, who conducted the investigations in Australia, New Zealand, and the Far East, will be in the city for a time, and will discuss with visitors the uses of the various items in the exhibit and the electrical practices in the different countres from which the samples have been secured.

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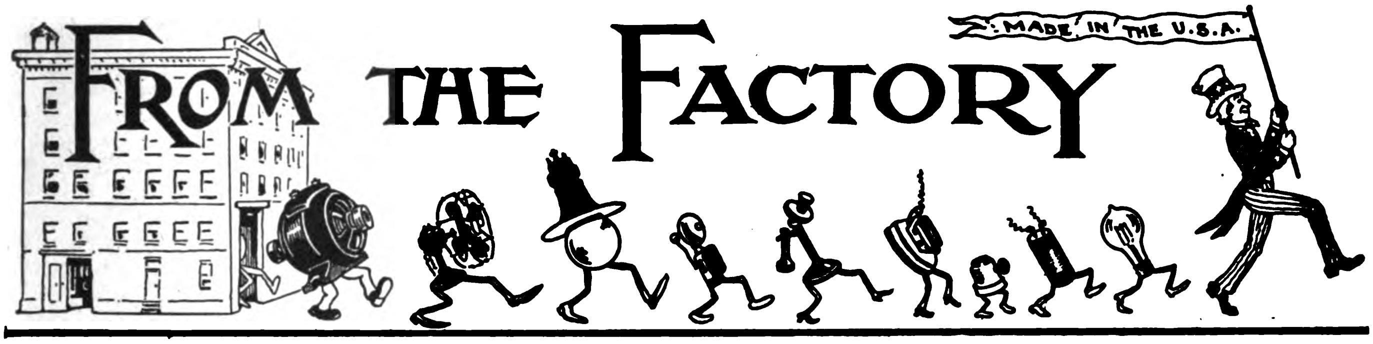
FOREIGN TRADE AFTER THE WAR

Edward N. Hurley, chairman of the United States Shipping Board, says we are rapidly building the mechanical equipment for regular steamship lines all over the world. The fast troop ship can be converted for combined passenger and cargo service and placed on regular lines, reaching the whole of Central America, South America, the Pacific, and the British Colonies. We shall undoubtedly have our own liners to Great Britain, European, and Mediterranean ports. Our refrigerator ships, now carrying meat and dairy products to feed the allies, will carry meat, fruit, butter, eggs, and perishables to other countries. Our cargo ships can be organized on the triangular system, which has made British and German shipping profitable. That is, a British ship left Wales with a cargo of coal for South America, picked up a cargo of nitrates for the United States, and returned with a cargo of wheat to England. Thus British export and import trade were both facilitated, and on the third leg of the triangle the British ship did a delivery job for a foreign nation, thus adding to tonnage and revenue. If 25,000,000 tons of American shipping can be kept busy in our own export and import trade, then the development of this third leg in the triangle will keep 30,000,000 to 35,000,000 tons of American shipping employed

To keep this great new merchant marine busy we must have a radical change in American business thinking. Every manufacturer and trader in the United States, every banker, farmer, miner and consumer must begin to think now about American merchant ships as a great modern international delivery service.



Short Stories About Electrical Goods Offered By Manufacturers

INTERCHANGEABLE CONNECTING BLOCK, ROSETTE AND RECEPTACLE

The Bryant Electric Co. of Bridgeport, Conn., has just placed on the market a new connecting block. This block consists of two pieces of poreclain fastened together from the exterior by means of two screws, which are retained by fibre washers in their holes in the top piece, even when the two parts of the block are separated. These screws also form the current-carrying contacts between the top and base. The base of the block, as will be noted in illustration, Fig. 1, has a substantial recess for the two firmly fixed binding plates, each of which has four binding screws, to permit of ready connection of wires for additional circuits as may be needed. Thus, it is unnecessary to remove the fitting or awkardly splice and solder the wires as required, because there is ample room for handling the wires through the round opening in the base.

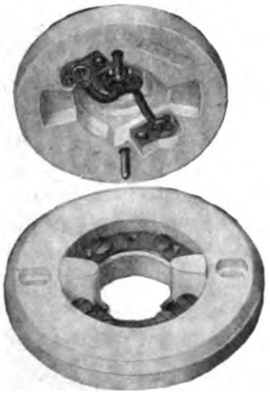


Fig. 1

Fig. 2

Fig. 3

Interchangeable connecting block, rosette, and receptacle. Bryant Electric Co., Bridgeport, Conn.

Fig. 2 shows a small film or "knock-out" of porcelain in the center of the cap. A light blow will serve to knock this out, transforming the "block" into a rosette. Wires can be passed through this opening and fastened at the binding screws as shown in the upper view of Fig. 1, so that drop light or switch fixture can be attached.

Another interchangeable feature of this block is that to this same style base a porcelain lamp receptacle (as shown in Fig. 3) can be attached. The heavy lugs shown in base fit into the recesses moulded into both the top piece of the block or rosette and the lamp receptacle base and insure the correct relative position of the parts so that the fastening screws (which also serve as current connections) can be easily and properly fastenend.

These devices, designated as List No. 566 for the rosette-connecting block, and No. 4122 for the receptacle, are designed for attachment to standard 3¼ in. outlet boxes and to No. 700 Adapti boxes. They are National Electrical Code approved.

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STANDARD DOME REFLECTORS

The Reflector Commttee of the Associated Manufacturers of Electrical Supplies has given encouraging evidence of progress through its announcement of the adoption of standard designs for porcelain-lined metal dome reflectors suitable principally for industrial lighting. The specifications standardized and recommended by the representatives of reflector and lamp manufacturers, after a thorough and exhaustive consideration of requirements, are for reflectors of the dome type for direct lighting to accommodate mazda C lamps ranging from 75 watts to 1000 watts, inclusive.

The trade designation adopted for reflectors made according to the specifications of the Reflector Committee is "R-L-M Standard," an abbreviation of "Reflector and Lamp Manufacturers' Standard." A copyrighted mark of identification for R-L-M standard reflectors to be used by all Association Manufacturers is in course of preparation.

The announcement of a standard industrial lighting reflector is only the beginning of a very necessary and desirable work toward standardization and elimination of waste and inefficiency in lighting apparatus, which the Reflector Committee as a unit and the Association Manufacturers of Electrical Supplies are organized and equipped to accomplish.

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NON-GLARE LAMP SHIELD

The Benjamin Electric Mfg. Co., 128 South Sangamon St., Chicago, Ill., is manufacturing a new device for eliminating the glare from high power gas-filled lamps. It is composed of glass or metal, is bowl-shaped, and hangs under the lamp bulb. It is easily removed for cleaning.

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IMPROVED ARC LAMP CARBON HOLDER

An important improvement is announced in the Kliegl arc lamp carbon holders for Kliegl universal hand feed arc lamps as manufactured by the Universal Electric Stage Lighting Co., 240 West 50th St., New York City.

Heretofore the bottom holders were not made for a wide range of carbon sizes, whereas as now made for 70 ampere lamps, the holder is adjustable and will take with equal ease ¾ inch or 5/16 inch carbons or any intermediate sizes. The photograph distinctly shows how this is accomplished without need of explaining the mechanical details. It shows a ¾ inch carbon in the top holder and a ⅜ inch. carbon in the bottom holder.

A smaller carbon holder is made for 35 ampere lamps and is adjustable in the same way to take any carbon diameter from ⅝ inch to 5/16 inch. inclusive.

It will be noted that the carbons can be adjusted sideways as well as vertically thus maintaining perfect alignment and constantly focusing in the center of the lens.

A special arrangement has been made for fastening lugs with asbestos wire. A carbon drop, of course, is always provided on all carbon holders.

PORTABLE LAMP

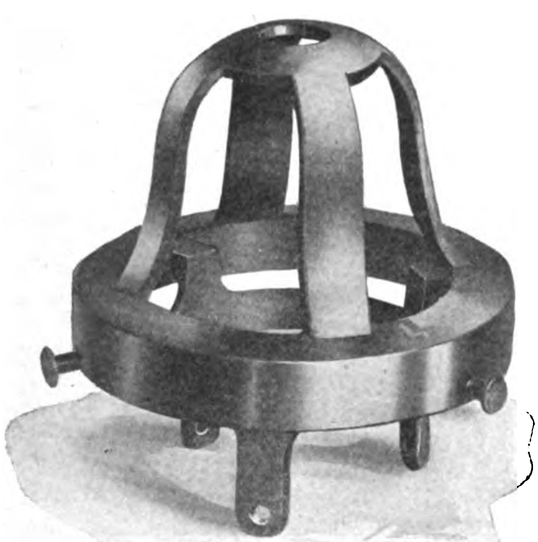
A portable lamp is being manufactured by the Anderson Electric Specialty Company, 118 South Clinton Street, Chicago, Ill. This lamp consists of an Adapt-a-Lite extension unit, 10 ft. of cord and socket, an adjustable shade and a bracket base.

The bracket base combines a base for use as a table lamp, means for hanging on a wall, a clamp for attaching to the frame of a bed or edge of a desk or table. The socket may be detached from the bracket base and wound up to the reel when desired.

The shade is quickly adjusted to direct the light rays in any direction. The device can be attached to any lamp socket.

KWIKFIT HOLDER

This is a combination reflector and bowl holder, recently put on the market by Fensterer & Ruhe, 37 Murray Street, New York. Designed for use with large two-piece units, it is said to be both simple and labor saving. It is made of cast metal and holds both glassware and socket. It's design is such as to eliminate holes in reflectors; it also eliminates rosettes and hooks.



Kwikfit holder, Fensterer & Ruhe, 37 Murray Street, New York.

FLEXIBLE CHARGING OUTFIT

A commutating rectifier for charging batteries without overheating them is being manufactured by the Stahl Rectifier Company, 1401 West Jackson Boulevard, Chicago. Three rectifying commutators with one-quarter of the sections dead produce pulsating currents, which, the manufacturers claim, allows charging at a high rate without overheating the batteries. Because of an independent regulator for each circuit these three circuits can be charged at any rate from 4 amperes to 12 amperes. One circuit can be charging one line of batteries at a rate of 10 amperes, another circuit can be charging at a rate of only 5 amperes, and a third circuit can be charging at an entirely different rate—all three operating at the same time.

MAKING TEMPERATURE TRIP THE CIRCUIT-BREAKER

The oldest form of overload protection is electro-magnetic, cutting off the current if it reaches a value deemed dangerous. The fact that most electrical apparatus can withstand momentary overloads without danger has gradually led operators to push up the current values at which electromagnetic protective devices will operate, or to dispense with them entirely, rather than undergo the inconvenience of having them disconnect the machinery on momentary peaks.

A method of visual protection on the basis of temperature was the next step. Exploring coils were built into the apparatus and used to indicate the temperature of hot spots by means of electrical instruments.

The latest step is a relay, the type CT, built by the Westinghouse Electric & Mfg. Co., which automatically trips the circuit-breaker when the temperature reaches the danger point under excessive current. It may be used to protect any alternating-current apparatus from excessive heating if the apparatus is so arranged that exploring coils can be installed.

The relay is intended to protect apparatus against overheating from sustained overloads. To afford this protection with the least interruption of service, the breaker should be tripped through the direct effect of the temperature of the apparatus. The relay should be so arranged that it prevents the breaker from tripping if the overload is of such short duration that the temperature does not rise to a dangerous value; while if the overload apparatus persists the breaker must be tripped out as soon as the temperature rises beyond the critical value. The type CT temperature relay operates on the wheatstone bridge principle. The construction of the exploring coils will vary, depending on the kind of apparatus with which they are to be used.

TRANSFER RELAY

Protective relays that operate by closing a separate direct-current tripping circuit, which in turn trips the circuit-breaker, have proved more serviceable than "shunt-trip" relays and have come into general use. In some cases, however, a separate direct-current tripping circuit is not available and other means must be sought. The use of "transfer" relays in the best solution so far obtained, for they energize the trip coil off the circuit-breaker through current transformers. The type BT relay can be applied to any make of circuit-closing relay with similar characteristics.

The breaker operates solely through the current transformer and the relays. When there is no fault on the line, the trip coil of the breaker is mechanically and electrically isolated from the circuit, avoiding liklihood of tripping due to imperfection in the relay contacts ordinarily shunting the trip coil.

The relay contains two series coils—an upper or operating coil and a lower or holding coil. The holding coil holds down the armature core, until a third coil, wound on the same magnetic circuit and known as the releasing coil is short-circuited by the protective relay. The releasing coil acts as the secondary of a transformer and when short-circuited, a current flows through it, demagnetizing the core. The holding coil, therefore, allows the operating coil to raise the core which operates the transfer switch, thus closing the trip coil circuit.

The transfer switch and other current carrying parts of the relay are designed to carry 5 amperes continuously, but during times of short circuit the switch may be called on to handle as much as 100 or 200 amperes.

PROTECTION AGAINST REVERSED PHASES

If a three-phase motor is disconnected from a circuit and the phases reversed when it is reconnected, it will naturally run backward. Such a reversal may occur and has occurred when the motor is disconnected for repairs, through an error in reconnecting leads at the power house, or substation, or from a number of other causes.

In many cases the reversal of rotation of a motor, aside from the inconveniences it causes, is not a serious matter as the error can be corrected at the motor terminals. In other cases, however, serious consequences may result. The reversal of an elevator motor, for instance, might result in wrecking the machinery and loss of life.

To protect motors against phase reversal where such protection is necessary, the Westinghouse Electric & Mfg. Co. has developed a reverse-phase relay. If a phase is reversed, or if a phase fails, or if the voltage drops below 75 percent. of normal, the relay contacts close and trip the circuit-breaker, either through a shut-trip coil or by short-circuiting an under voltage trip coil having a series reverse resistor.

The relay operates on the induction principle. When properly connected the torque holds the contacts open against the restraint of a spiral spring. On low voltage the torgue diminishes and the spring closes the contacts. On reversal of phase connections the reversed torque assists the spring in closing the contacts.

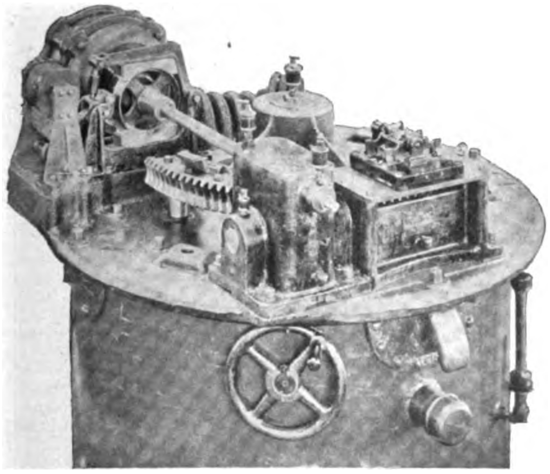
The contacts will close 5 amperes at 250 volts or less.

POLYPHASE INDUCTION REGULATORS

The largest kva capacity polyphase regulator ever built has just been completed for the Hartford Electric Light and Power Company of Hartford, Conn.

The rating is 1000 kva., three-phase, 60 cycles and provides 100 percent. regulation on a 10,000 kva., 11,000 volt, three-phase, 526 ampere circuit. The regulator is an oil immersed, forced-oil-cooled type, which is a new but very successful departure in the method of cooling regulators.

In this method of cooling, the cold oil is forced in at the bottom of the regulators through the lower portion of the windings, which extend below the core, and which are especially spaced so as to give a free passage for the oil. As



Three-phase, oil-immersed forced oil regulator. General Electric Co., Schenectady, N. Y.

the oil passes upward it is forced through three separate and distinct passages, each passage being of such size as to allow a flow of oil in proportion to the heat generated.

One oil passage is inside the motor shaft, one outside the stator iron between the regulator and the tank, and the third through the gap between the shunt and series windings. After passing through the upper portion of the windings, which are spaced in the same manner as the lower portion, the oil overflows into a channel along the inside of the tank. In order that the flow into the channel be uniform from all directions a special distributor is provided. From the channel the oil is conducted by gravity through a series of cooling coils to a storage tank and from the storage tank is again forced through the regulator.

The regulator is of the skeleton frame design with a sturdy mechanical construction.

The conductors of the windings are heavily insulated and the insulation on the outside of the coils is in proportion. The strand insulation of the shunt winding is exceptionally strong and additional insulation is used between layers. The series coils are of one turn per layer and the turns are insulated from each other with insulation which will withstand a potential greater than the full line voltage.

In order to allow free passage of the oil through the coil insulation into the coil, each coil is provided with a vent at the bottom. In addition the complete machine is given a vacuum oil treatment to remove any air pockets that may exist in the coils.

The parts of the coils which extend above and below the core are provided with mechanical reinforcing to withstand the strains due to short circuits. The shunt coils are banded to an iron support and around the series coils is placed a heavy iron ring, properly insulated to which each coil is coded securely.

The regulator is motor operated and will travel from one limit to the other limit in 40 seconds.

The dimensions of the regulator are 4 ft. 6 in. at the base, with a height overall of 10 ft. 3½ in. The weight is approximately 23,000 lbs.

METERS FOR WIRELESS AND HIGH-FREQUENCY WORK

A high grade hot wire measuring instrument designed particularly for wireless and other high-frequency work, depending for its operation upon the expansion of a metal strip which is heated by the current to be measured, has been developed by the Westinghouse Electric & Mfg. Co. The slight sag in this conducting strip is magnified several hundred times on the scale by means of a combination of wires and a deflecting spring.

The conducting strip is made of special non-corrosive material. The separating posts have the same temperature coefficient of expansion as the conductng strip, so that the changes in room temperature do not cause an error in the reading of the instrument.

The instruments are furnished in two forms, for flush mounting and portable. Similar instruments for switchboard mounting are also supplied. The flush-mounting form, known as type EH is of the round open-face type. The face is 3 in. in diameter, and the diameter outside the flange is 3¾ in. It has a black rubberoid case and rim, with white dial.

The portable form known as type PH, is mounted in a morocco-leather-covered wooden case with heavy glass over the dial. The case is 3¾ in. by 4⅜ in. by 2 in. thick.

The scale plate is made of metal, and the scale subtends an arc of 90 degrees, being 2⅜ in. long.

SPHERE-GAP LIGHTING ARRESTER

A sphere-gap lightning arrester now being manufactured by the Electrical Engineers' Equipment Company of Chicago consists essentially of a sphere gap and a horn gap in series with resistance to ground. This construction has been adopted by the company since it has been shown that a sphere gap will handle high-frequency surges more rapidly than a horn gap. The horn gap is used to dissipate the arc which results from the surge, as this arc will follow up the horns and extinguish itself. The resistance tube is placed in series with the horn gap and affords a straight path to ground creased beyond the range C, would not spontaneously drop back to normal. While in Fig. 1, C is much higher than T, curve C represents the theoretical, but not real case of constant terminal voltage at the induction machine. The voltage however is kept constant at the controlling synchronous main station, and thus must vary with the load in the induction generator station. Assuming an extreme case of 10 percent. resistance and 20 percent. reactance in the line from the induction machine station to the next synchronism station, we get the modified torque curve shown in Fig. 2. As seen, at full load P, there is practically no change; about 4 percent. slip above synchronism. The maximum torque of generator G and motor M, and the torque at the concave part of the induction generator curve, C, have greatly decreased. However, C is still above T, that is, even under this extreme assumption, the induction generator would pull the turbine down from its racing speed of 180, to the normal full load speed of 104, though the margin has become narrow.

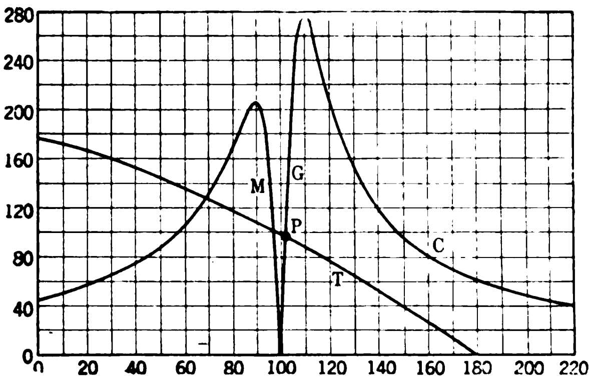


Fig. 2.—Small Hydroelectric Induction Generator Plant—Constant Voltage in Synchronous Station.

Assuming however an induction machine with much less slip, with only half the rotor resistance of Figs. 1 and 2. At constant

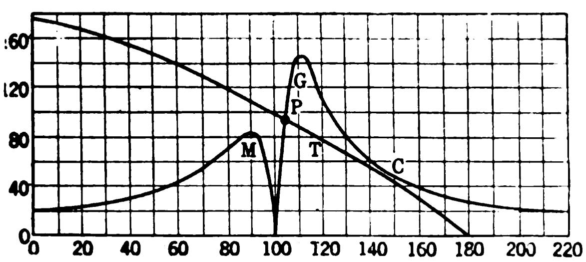


Fig. 3.—Large Hydroelectric Induction Generator Plant—Constant Terminal Voltage.

terminal voltage, this gives the curves shown in Fig. 3. The full load P is at speed 102, or 2 percent. above synchronism, and while the curve branch C is much lower, the conditions are still perfectly stable. Assuming however, with this type of low resistance rotor, a high line impedance, 10 percent. resistance and 20 percent. reactance, as in Fig. 2. We then get the condition shown in Fig. 4. The range C drops below T, and the induction generator torque curve G intersects the turbine torque curve T at three points: P, P_1 and P_2. Of these three theoretical running speeds, $P = 102$ $P_1 = 169$ and $P_2 = 113.5$, two are stable, P and P_1; while the third one, P_2, is unstable, and from P_2, the speed must either decrease, reaching stability at the normal full load point P, or the machine speed up to P_1

If with the conditions represented by Fig. 4, the turbine should —by an opening of the circuit for instance—have speeded up t its free running speed 180 closing the circuit does not bring the speed back to normal, P, but the machines slow down only to speed P_1, where stability is reached, at very little output and very large lagging currents in the induction generator. To restore normal condition then would require shutting off the water,

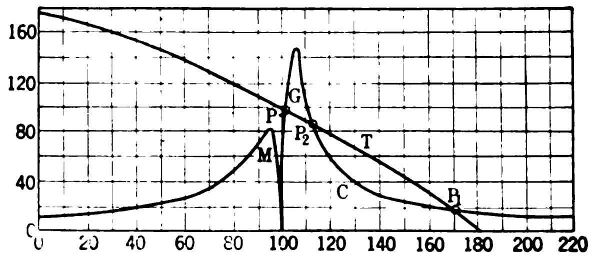


Fig. 4—Large Hydroelectric Induction Generator Plant—Constant Voltage in Synchronous Main Station.

at least sufficiently to drop the turbine torque curve T below C, and then letting the machines slow down to synchronism. They would not go below synchronism, even with the water gates entirely closed, as the induction machine as a motor, on curve M, holds the speed.

A solution in the case Fig. 4 would be the use of a simple excess speed governor, which cuts off the water at 5 to 10 percent. above synchronism.

However, the possibility of difficulty due to the "dropping out of the induction generator" as we may call it in analogy to the dropping out of the induction motor, are rather less real than it appears theoretically. In smaller stations, such as would be operated without attendance, as automatic stations, the torque curve of the induction generator, as a small machine, would be of the character of Figs. 1 and 2, and thus not liable to this difficulty. The low resistance type of induction machines, as represented in Figs. 3 and 4, may be expected only with the larger machines, used in larger stations. In those, some attendant would be present to close the water gates in case of the circuit breakers opening, or a simple cheap excess speed cut-off would be installed at the turbines, keeping them within 10 percent. of synchronism, and with this range, no dropping out of the induction generator can occur.

It is desirable however to realize this speed range of possible instability of the induction generator, so as to avoid it in the design of induction generators and stations.

Collection of Fuel Power by Steam Turbine Induction Generator

The Automatic Steam Turbine Induction Generator Station

The same reason which in the preceding led to the conclusion that in the (automatic) induction generator station is to be found the solution of the problem of collecting the numerous small amounts of hydraulic energy, which are scattered throughout our country along creeks and mountain streams, also applies, and to the same extent, to the problem of collecting the innumerable small quantities of mechanical or electrical energy, which are, or can be made available wherever fuel is consumed for heating purposes. Of the hundred millions tons of coal, which are annually consumed for heating purposes, most is used as steam heat. Suppose then, we generate the steam at high pressure—as is done already now in many cases for reasons of heating economy—and interpose between steam boiler and heating system some simple form of high pressure steam turbine, directly connected to an induction generator, and tie the latter into the general electrical power distribution system. Whenever the heating system is in operation, electric power is generated, as we may say as "by-products" of the heating plant, and fed into the electric system.

The power would not be generated continuously, but mainly in winter, and largely during the day and especially the evening. That is, the maximum power generation by such fuel power collecting plant essentially coincides with the lighting peak of the central station, thus occurs at the time of the day, and the season when power is most valuable. The effect of such fuel power collection on the central station should result in a material improvement of the station load factor, by cutting off the lighting peaks.

The only difference between such turbine induction generator stations, collecting the available fuel power scattered throughout the cities and towns, and the hydraulic induction generator stations collecting the powers of the streams throughout the country, is that in the steam turbine plant an excess speed cut-off must be provided, as the free running steam turbine speed is usually not limited to less than double speed, as is the case with the hydraulic turbine. Otherwise however, no speed governing is required. A further difference is, that the greater simplicity and therefore lower investment of the steam turbine plant would permit going down to smaller powers, a few kilowatts perhaps.

It is interesting to note, that even with a very inefficient steam turbine, the electric generation of such fuel power collecting plant interposed between boiler and heating system, takes place with practically 100 percent. efficiency, because whatever energy is wasted by the inefficiency of the steam turbine plant, remains as heat in the steam, and the only loss is the radiation from turbine and generator, and even this in most cases is useful in heating the place where the plant is located. The only advantage of a highly efficient turbine, is that larger amounts of electric power can be recovered from the fuel, and the question thus is that between the investment in the plant, and the value of the recovered power.

If then the total efficiency, from the chemical energy of the fuel to the electric power, were only 3 percent., it would mean that 3 percent. more coal would have to be burned, to feed the same heat units into the heating system. At an average energy value of 30,000 kj. per kg. of coal, this would give per ton of coal, 900,000 kj. or 250 kw-hr. At a bulk value of ½ cent per ky-hr. it would represent a power recovery value of $1.25 per ton of coal. This is quite considerable, more than sufficient to pay the interest on the investment in the very simple plant required.

At first, the steam turbine induction generator plant, proposed for the collection of fuel power, would appear similar to the isolated plant which, though often proved uneconomical, still has successfully maintained its hold in our northern latitudes, where heating is necessary through a considerable part of the year. However, the difference between the steam turbine induction generator plant and the isolated steam electric plants in our cities, is the same as that between the automatic hydroelectric induction generator station, and the present standard synchronous generator station: by getting rid of all the complexity and complication of the latter, the induction generator station becomes economically feasible in small sizes; but it does so only by ceasing to be an independent station, by turning over the functions of regulation and control to the central main station and so becoming an adjunct to the latter. But by this very feature, the turbo induction generator plant might afford to the central station, the public utility corporation, a very effective means of combatting the installation of isolated plants, by relieving the prospective owner of the isolated plant of all trouble, care and expense and incidental unreliability thereof, supplying central station power for lighting, but at the same time utilizing the potential power of the fuel burned for heating purposes. The simplest arrangement probably would be that the fuel power collecting plants scattered throughout the city would, as automatic stations, be taken care of by the public utility corporation, their power paid at its proper rates, those of uncontrolled bulk power, while the power used for lighting is bought from the central station at the proper lighting rates.

As this however means a new adjustment of the relation between customer and central station, and is not merely an engineering matter like the hydroelectric power collection, I have placed it in an appendix.

Discussion

We realize that our present method of using our coal resources is terribly inefficient. We know that in the conversion of the chemical energy of coal into mechanical or electrical energy, we have to pass through heat energy and thereby submit to the excessively low efficiency of transformation from the low grade heat energy to the high grade electrical energy. We get at best 10 to 20 percent. of the chemical energy of the coal as electrical energy; the remaining 80 to 90 percent. we throw away as heat in the condensing water, or worse still, have to pay for getting rid of it. At the same time we burn many millions of tons of coal to produce heat energy, and by degrading the chemical energy ino heat, waste the potential high grade energy which those millions of tons of coal could supply us.

It is an economic crime to burn coal for mere heating without first taking out as much high grade energy, mechanical or electrical, as is economically feasible. It is this feature, of using the available high grade energy of the coal, before using it for heating, which makes the isolated station successful, though it has every other feature against it. To a limited extent, combined electric and central steam heating plants have been installed, but their limitation is in the attempt to distribute heat energy, after producing it in bulk, from a central station. Here again we have the same rule; to do it efficiently, do it electrically. In the efficiency of distribution or its reverse, collection, no other form of energy can compete with electric energy, and the economic solution appears to be to burn the fuel wherever heating is required, but first take out its available high grade energy, and collect it electrically.

Assume we use 200,000,000 tons of coal per year for power, at an average total efficiency of 12 percent. giving us 24,000,000 kw. (referred to 24-hr. service) and use 200,000,000 tons of coal for heating purposes, wasting its potential power.

If then we could utilize the waste heat of the coal used for power generation, even if thereby the average total efficiency were reduced to 10 percent., we would require only 240,000,000 tons of coal, for producing the power, and would have left a heating equivalent of 216,000,000 tons of coal, or more than required for heating. That is, the coal consumption would be reduced from 400,000,000 to 240,000,000 tons, a saving of 160,000,000 tons of coal annually.

Or, if from the 200,000,000 tons of coal, which we degrade by burning it for fuel, we could first abstract the available high grade power, assuming even only 5 percent. efficiency, this would give us 10,000,000 kw. (24-hr. rate), at an additional coal consumption of 10,000,000 tons, while the production of the 10,000,000 kw. now requires 100,000,000 tons of coal, more or less, thus getting a saving of 90,000,000 tons of coal; or putting it the other way, a gain of 9,000,000 kw.—12,000,000 hp.—24-hr. service, or 36,000,000 horse power for an 8-hr. working day.

It is obvious that we never could completely accomplish this but even if we recover only one-quarter, or even only one-tenth of this waste, it would be a vast increase in our national efficiency.

Thus the solution of the coal problem, that is, the more economic use of fuel energy, is not only the increase of the thermodynamic efficiency of the heat engine, in which a radical advance is limited by formidable difficulties; but is the recovery of the potential energy of all the fuel, by electric collection.

Turbo Induction Generator

Assume then that wherever fuel is burned to produce steam for heating purposes, instead of a low-pressure boiler giving a few pounds over-pressure only, we generate the steam at high pressure, at six atmospheres (90 lbs.) or, in larger plants, even at 15 atmospheres (225 lb.) passing the steam through a high pressure turbine wheel directly connected to an induction generator tied into the electric supply system, and then exhaust the steam at 1.25 atmospheres (19 lb.) into the steam heating system, or at 0.48 atmospheres (7 lb.) into a vacuum heating system.

Per ton of coal: Chemical energy, 30×10^6 kj: Heat energy of steam from boiler, at 75 percent. boiler efficiency, 22.5×10^6 kj.											
	Boiler press		Dist press		Carnot-efficiency percent.	Output at 50 percent. efficiency		Value of power at ½c per kw-hr. $----	Avg. kw, assuming 25% time of use	Tons of coal per kw.	Size of induction generator, per 100 tons coal annually
	atm.	lb.	atm.	lb.		kj × 1000	kw-hr.				
Steam Heating	6	90	1.25	19	12.3	1380	385	1.92	0 176	5.7	25 kw.
	15	220	1.25	19	19.8	2230	620	3.10	0.283	3.5	45 kw.
Vacuum Heating	6	90	0.48	7	18.1	2030	565	2.82	0.258	3.9	40 kw.
	15	2.0	0.48	7	25.0	2820	810	4.05	0.37	2.7	55 kw.

der the assumption, that the use of the heating plant is equivalent to full capacity during one quarter of the time, and the turbine induction generator plant 50 percent. larger, to take care of maximum loads. As seen, the volume of the recovered power would be a substantial percentage of the fuel cost.

With 100,000,000 tons of coal used for heating purposes annually, assuming an average recovery of 600 kw-hr. per ton, this gives a total of 60,000,000,000 kw-hr. per year. One-quarter of this is more electric power than is now produced at Niagara, Chicago, New York and a few other of the biggest electric systems together.

At a fuel value of the coal of 30,000 kj. per kg. we have (see table)

From this it would follow that the average magnitude of the steam turbine induction generator plant for power collection from fuel in heating plants, would be about one-quarter to one-half kw. per ton of coal burned annually, under the assumption, that the use of the heating plant is equivalent to full capacity during one quarter of the time.

SAVE THE TIN

As a result of comparatively recent developments of the war, the supply of pig tin imported into the United States has been seriously restricted. The shortage of shipping in service to the Orient has prevented receipt of the large proportion of tin formerly obtained from the Dutch East Indies.

The War Service Committee of the Electrical Manufacturing Industry makes a strong plea for the conservation of tin in the use of babbitt metal, alloy castings and in tinning and soldering. They suggest the following measures:

The use of lead-base babbitt, or the reduction of tin-content in tin-base babbitt where its use is absolutely necessary.

The use of the thinnest section of babbitt metal consistent with a satisfactory bearing.

The reduction of the percentage of tin in alloy castings.

The use of a mixture of lead and tin for solder with a proportion of 55, 60 or even 70 percent. lead.

PATENT OFFICE NEEDS HELP

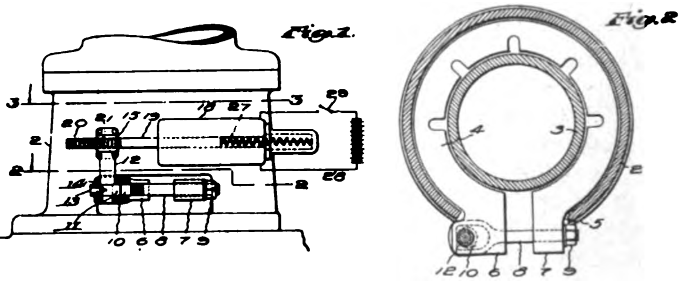
The United States Patent Office at Washington, D. C. is in need of technically trained help. Men or women are desired who have a scientific education, particularly in higher mathematics, chemistry, physics, and French or German, and who are not subject to the draft for military service. Engineering or teaching experience in addition to the above is valued. The entrance salary is $1500.

Examinations for the pasition of assistant examiner are held frequently by the Civil Service Commission at many points in the United States. One is announced for August 21 and 22, 1918. Details of the examination, places of holding the same, etc., may be had upon application to the Civil Service Commission, Washington, D. C., or to the United States Patent Office, Washington.

Should the necessity therefore arise, temporary appointments of qualified persons may be made pending their taking the Civil Service Examination. Application for such appointment should be made to the Patent Office at Washington.

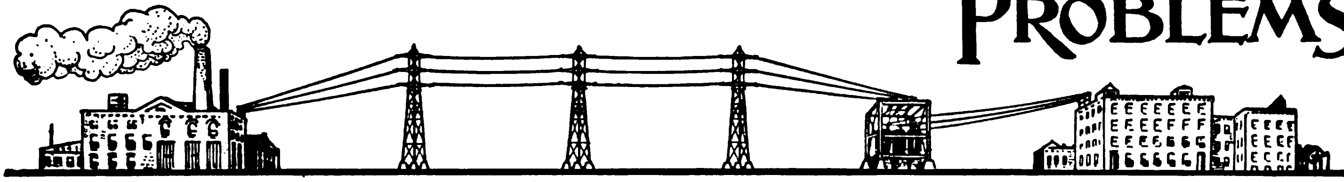
MACHINE TOOL CONTROL

The certainty and promptness, as well as the ability to place the control point at the most convenient spot, which characterizes the electrical control of machine tools, is taken advantage of to control and secure the adjustment of the standard or column of a radical drill and for similar uses according to a patent recently granted to Mr. Willard T. Sears, Philadelphia, Pa. His



device is well shown in the cuts wherein the column 3 is surrounded by a clamping ring 4 in the bed plate 2. The ends of the ring are connected by bolt 8 and cam 11 draws the clamping ring together. The cam is operated by pinion 21 driven by a rack 20 which is the plunger of the electromagnet 18. The drill arm may be released and adjusted to any desired position and may be locked in position by simply opening or closing the switch 29 which may be located at the most convenient point about the machine. Patent No. 1,185, 839.

POWER PLANT, LINE AND DISTRIBUTION PROBLEMS



A Record of Successful Practice and Actual Experiences of Practical Men

HOW TO WIND A MAGNET

By T. Schutter

In winding a magnet, it must be borne in mind that the winding is usually intended to occupy a given space. For this reason it is sometimes necessary to predetermine the amount of wire required, its resistance and its operating temperature.

These factors can be easily determined by means of a few simple equations. These equations are given below. The symbols which will be used and their meaning are:

a = Number of turns per layer.
b = Number of layers.
c = Number of turns on entire coil.
d = Diameter of bare wire in mils (1/1000 of an inch).
h = Allowable winding space (round coils only).
i = Thickness of insulation on both sides of wire.
l = Length of spool or distance between heads.
m = Length of average turn in inches (round coils).
t = Thickness of coil (rectangular coil only).
B = Breadth of pole piece or core.
D = Diameter of pole piece or core.
E = Operating voltage of coil.
F = Length of wire used on coil, in feet.
H = Height of pole piece or core.
I = Current taken by coil in amperes.
K = Specific resistance, 10.8 ohms cold, 12.8 ohms hot.
L = Length of pole piece or core.
K = Resistance of coil.
S = Radiating surface of coil.
T = Room temperature.
T° = Temperature of coil above room temperature when in operation.
W = Watts absorbed by coil.
M = Length of an average turn. (rectangular coils).

The calculations will be divided into two parts—round coils and rectangular coils. The formulas for round coil calculations are as follows:

(1) $a = \dfrac{l}{d + i}$

(2) $b = \dfrac{h}{d + i}$

(3) $c = a \times b.$

(4) $m = \dfrac{(2\,D \times 2\,h) \times \pi}{2}$

(5) $F = \dfrac{m \times c}{12}$

(6) $R = \dfrac{F \times K}{d^2}$

(7) $I = \dfrac{E}{R}$

(8) $W = I^2 \times R \text{ or } E \times I$

(9) $T^\circ = \dfrac{T \times W}{S}$

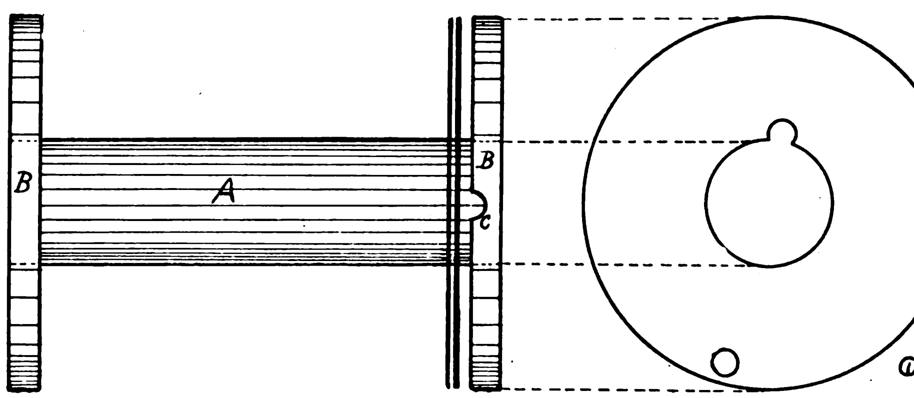


Fig. 1

The calculation and formulas for rectangular coils are as follows:

(1) $A = \dfrac{H}{d + i}$

(2) $b = \dfrac{t}{d + i}$

(3) $C = a \times b.$

(4) $M = 2\,B + 2\,L + 4\,t$

$$(5)\quad F = \frac{M \times C}{12}$$

$$(6)\quad R = \frac{F \times K}{d^2}$$

$$(7)\quad I = \frac{E}{R}$$

$$(8)\quad W = I^2 \times R \text{ or } E \times I$$

$$(9)\quad T^\circ = \frac{T \times W}{S}$$

Before taking up details and working out some problems, it were advisable to dwell a while on the precautions that should be taken in preparing, insulating and winding field coils or magnet coils. These general observations will be found helpful later on.

Electromagnet coils are usually wound directly on the core. Fibre ends or heads are usually placed so as to prevent the windings from slipping off the ends of the core. The core and fibre ends give the complete unit the shape of a spool, as shown in Fig. 1.

The core *A* should be insulated either with several turns of sheet fibre about .007 of an inch in thickness, (the thickness of the insulation around the core will depend entirely on the operating voltage of the coil), and one end or head should be drilled so

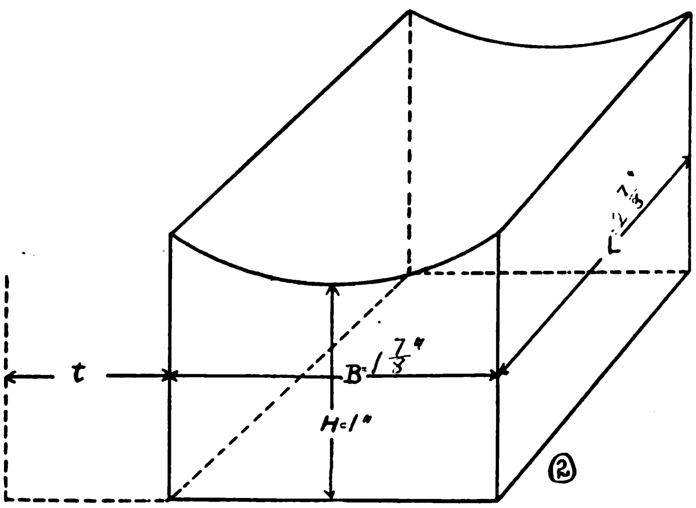


Fig. 2

as to allow the leads to come out through the ends or heads, or it can be arranged as shown at *B* Fig. 1, where the end or head has been gouged out so as to allow the lead to lay in flush, then a thin fibre washer is placed as at *C* Fig. 1.

The leads should be reinforced by splicing a piece of No. 18 B & S gauge flexible wire on both the beginning and ending of the winding. This flexible lead should take at least one turn around the coil, at the beginning as well as at the end, before being brought out from the coil for line connection.

The windings on all magnet coils should be wound in layers as close together as possible. When a small size of wire is being used, a sheet of some very thin insulating material, (usually wax paper is used for this purpose) should be placed between every four or five layers, but when heavier wires are used a sheet of wax paper is placed between every layer. These sheets of wax paper should be snuggly fitted so that they cover the end-turns of a layer as well as the center ones, as in many cases the difference in potential between the end-turns of two succeeding layers may be large, resulting in the liklihood of a breakdown of the insulation on the wires. This would cause a short circuit.

To illustrate this, assume a magnet wound with but two layers. Here the difference in potential between the first turn on the bottom and the last turn on the top layer, (which will be directly over one another) would be equal to the full line potential. If the insulation between two turns should break down, it would cause a dead short circuit.

On some magnets each layer is painted with shellac to reinforce the cotton insulation. On the more modern magnets the wire is coated with enamel, and in some cases a single covering of cotton is placed over this. The enameled wire gives better service when required to work under a heavy load, as it can stand more heat without being in danger of burning out.

When cotton insulation is subject of a temperature of about 180 degrees F. it will begin to char and gradually burn; but enamel insulation can stand a much higher temperature without that danger.

The winding of field coils is somewhat different from the winding of magnets. Field coils are wound over a form, then they are tapped, dipped into an insulating compound, and baked.

A pole piece for which a field coil is to be wound is shown in Fig. 2. The meanings of the lettered dimensions will be found in the previously printed list. When a pole piece is to be measured up for making a winding form as shown in Fig. 3, a certain amount of allowance must be made for insulation when taking the dimensions of *B* and *L*, Fig. 2. This amount of allowance depends entirely on the kind of insulation material that is to be used and also the amount to be employed.

On small field coils and on coils used on low voltages, about 1/16 of an inch on all sides is sufficient. This distance is increased as the sizes of coil and the voltages are increased.

When making a form the dimensions are taken as follows: *H* will be the thickness of the form, and is measured from the lowest part of the pole arc to the base of the pole, *B* and *L* plus the allowance for insulation. When the form is completed it must be perfectly square. Then drill a hole through the center parallel to the dimension *H*, through which a spindle will be placed for winding. The form should be cut in two parts as shown by the line *C*, Fig. 3.

The form is now divided into two parts, *A* and A^1. These two sections are fastened to the side pieces, *B* and B^1, as shown in Fig. 3.

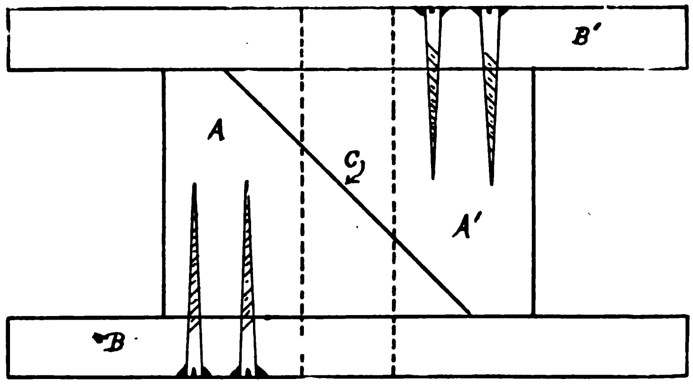


Fig. 3

The following data involves a practical problem of magnet winding, and the dimensions of which are as given in Fig. 4.

The magnet under construction will be of the round type, and it will be wound with No. 29 B & S gauge, single cotton-covered wire. The diameter of the bare wire is 11.3 mils or .0113 of an inch; the thickness of the insulation on both sides of the wire is 3.7 mils or .0037 of an inch. This will make a total of 15 mils, or .015 of an inch as the outside diameter of the wire.

The winding of the magnet will be placed in layers, and the first steps will be to find the number of turns per layer, the number of layers, and the number of turns on the entire coil. We have then:

$$A = \frac{l}{d + i} = \frac{3 \text{ in.}}{.0113 \text{ in.} + .0037 \text{ in.}} \text{ in.} = \frac{3000}{15} = 200$$

turns per layer.

$$b = \frac{h}{d + i} = \frac{1 \text{ in.}}{.0113 \text{ in.} + .0037 \text{ in.}} = \frac{1000}{15} = 66$$

layers.

$c = a \times b = 200 \times 66 = 13{,}200$ turns on the entire coil.

The next step is to determine the length of the average or mean turn, which is to turn midway between the inside or first layer and the outside or last layer of the winding. In Fig. 4a the inner circle (1) shows the diameter of the first layer, while the outer circle (3) shows the diameter of the top layer. Circle (2)

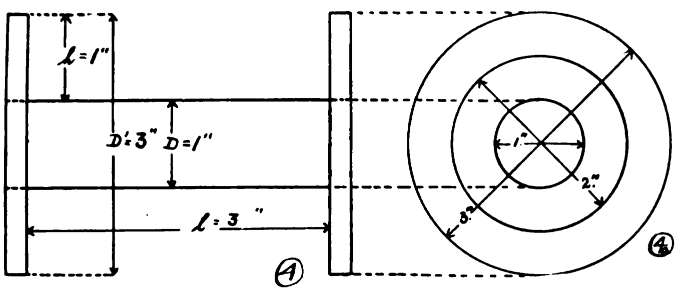


Fig. 4

is placed midway between the outer and inner circles and shows the diameter of the average or mean turn. Then its length in inches may be found as follows:

$$m = \frac{(\overset{2}{2\,D} + 2\,h) \times \pi}{2} = \frac{\overset{2}{2 \times 1} + 2 \times 1) \times 3.1416}{1}$$

$= 6.2832$ inches.

The next step is to determine the number of feet of wire used on the coil, and its resistance.

$$F = \frac{m \times c}{12} = \frac{6.2832 \times 13200}{12} = 6911.52 \text{ ft. of wire}$$

used to wind the coil. Then

$$R = \frac{F \times R}{dz^2} = \frac{6911.25 \times 10.8}{11.3 \times 11.3} = 584.5$$

ohms as the resistance of the coil.

The next steps are to find the current this coil will consume when operated on a 110-volt supply circuit, and the energy absorbed by the coil.

$$I = \frac{E}{R} = \frac{110}{584.5} = .17 \text{ amperes; then the energy absorbed}$$

will be.

$W = I^2 R$ or $.17^2 \times 584.5 = 16.9$ watts.

When a magnet coil is put into operation it will heat up, and the rise in temperature will depend on the amount of surface over which the heat can be radiated. On a stationary coil an allowance of .5 of a watt per inch of radiating surface is considered as satisfactory. The radiating surface of this coil will be:

$$S = (D^1 \times \pi\, l) + (D^{12} \times .7854 \times 2) =$$
$$(3 \times 3.1416 \times 3) + 3 \times 3 \times .7854 \times 2 = 42.4$$

square inches of radiating surface. This includes the cylindrical area plus the area of both ends.

Assuming that the temperature of the room in which this coil is operated is 75° F; then to find the number of degrees that the coil will heat above the room temperature proceed as follows:

$$T^\circ = \frac{T \times W}{S} = \frac{75 \times 16.9}{42.4} = 30^\circ \text{ F approximately.}$$

This temperature rise is satisfactory, as cotton insulation will stand 160° F without serious damage. It begins to char very slowly at 168° F. Since the total temperature of this coil is 75° + 30° = 105° F, it will be seen that the conditions are then entirely satisfactory.

The foregoing explanation and calculation was for a round field or magnet coil. The calculation for rectangular coils are somewhat different, and are as follows:

By taking the pole piece, shown in Fig. 2, for example, and substituting the following dimensions for the different letters: $B = 1\tfrac{7}{8}$ in.; $H = 1$ in.; $L = 2\tfrac{7}{8}$ in.; $t = 1$ in.

This style of coil is wound on a form, as shown in Fig. 3. In taking the dimensions for this form, an allowance is made for taping on B and L of about ⅛ in. This will make a winding form of 2 in. by 3 in. by 1 in. For the winding, the same size of wire will be used as that used for the round coil (No. 29 B & S gauge wire) where $d = .0113$ in. or 11.3 mils and $i = .0037$ in. or 3.7 mils.

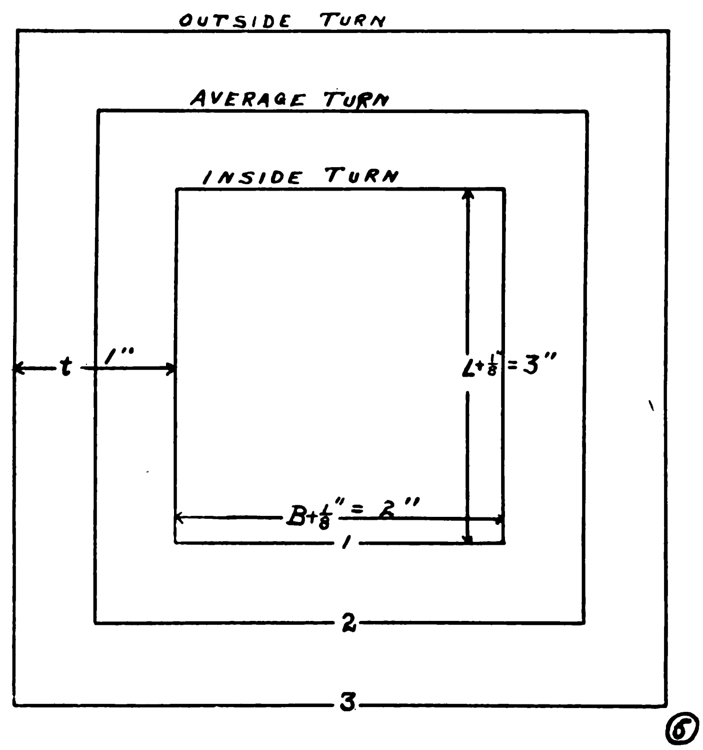


Fig. 5

The first steps are to determine the number of turns per layer, the number of layers and the number of turns on the entire coil. Then we have:

$$a = \frac{H}{d + i} = \frac{1 \text{ in.}}{.0113 + .0037} = \frac{1000}{15} = 66 \text{ turns per}$$

per layer.

$$b = \frac{t}{d + i} = \frac{1 \text{ in.}}{..0113 + .0037} = \frac{1000}{15} = 66 \text{ layers.}$$

$c = a \times b = 66 \times 66 = 4356$ turns on entire coil.

The next step is to determine the length of the average or mean turn, the length of wire used on entire coil in feet, and its resistance.

$M = 2\,B + 2\,H + 4\,t. = 2 \times 2$ in. $+ 2 \times 3$ in. $+ 4$ in. = in. length of average or mean turn.

$$F = \frac{M \times C}{12} = \frac{14 \times 4356}{12} = 5082 \text{ ft. of wire used}$$

on entire coil.

$$R = \frac{E \times K}{d^2} = \frac{5082 \times 10.8}{11.3 \times 11.3} = 427 \text{ ohms.}$$

The next step is to find the number of square innches of exposed surface over which the heat produced due to operation can be radiated, current drawn when operated on a 110-volt supply line, power absorbed and temperature rise above room temperature.

$$I = \frac{E}{R} = \frac{110}{427} = .26 \text{ amperes approximately.}$$

$W = I^2 \times R = .26^2 \times 427 = 28.8$ watts.

S for upper exposed side $= M \times t = 14$ in. $\times$ 1 in. 14 sq. in

S for outside of coil $= (B + L + 4\,t) \times 2 =$
$(2 + 3 + 4) \times 2 = 18$ sq. in.

This would make $14 + 18$ sq. in. $= 32$ sq. inches as the total exposed surface.

$$T^\circ = \frac{T \times W}{S} = \frac{75 \times 28}{32} = 70^\circ \text{ F.}$$

rise above room temperature, which would make a total of $75^\circ + 70^\circ = 145^\circ$ F as the operating temperature of the coil.

U. S. DIVISION OF ENGINEERING

The record for last month of the Division of Engineering offers testimony of the amount of work it has done in a very short time. During the past month alone, the division has received 468 applications for help from employers; 1314 applications for help from workers; has referred out 1063 applications, and actually located 483.

The privileges of the Division of Engineers are open, free of charge, to all engineers and technical men. For service, all they need to do is to apply to the local branch of the United States Employment Service in New York and they will at once obtain the help they need. For additional information and application blanks, they may apply to the central department, Division of Engineering, United States Employment Service, Chicago, Illinois. Whether he is in need of war work or not, every engineer and technical man should apply at once to these offices for registration blanks, so that he may put a record of his ability on file with the Government and may thereby at any future date secure a position, without any charge whatever.

ELECTRICAL TRADE WITH CHILE

Of all the countries on the west coast of South America, Chile offers the best opportunity for the immediate sale of electrical goods, and the prospects for the future are bright. Germany dominated the market before the war, but according to a report issued to-day by the Bureau of Foreign and Domestic Commerce, Department of Commerce, American goods have recently made big gains. German goods had entered the market in the wake of German capital.

Chile is a country where the natural resources and the will of the people make for progressive development along industrial and manufacturing lines, which means a steadily growing demand for power. Special Agent Philip S. Smith, author of the Government's report, asserts that this should and will be furnished by harnessing the many waterfalls of the Cordillera of the Andes to electric generators and sending the current to all parts of the central section of the republic.

One of the things that should not be overlooked in contemplating Chile as a future commercial field is the opportunity of uniting a safe investment with a profitable business. If advantage is taken of this situation the relations already existing between the two countries can be strengthened to their mutual profit.

The report analyses every phase of the electrical-goods business in both Chile and Boliva and is designed to assist American firms in their efforts to build up and maintain business with the two countries. Under the tital "Electrical Goods in Boliva and Chile," Special Agents Series No. 167, it is sold at the nominal price of 20 cents by the superintendent of Documents, Washington, D. C., and by all the district and cooperative offices of the Bureau of Foreign and Domestic Commerce.

HOW MUCH MONEY DOES A SOOT CLEANER SAVE?

Some interesting computations have recently been made available by the Vulcan Soot Cleaner Co., of Du Bois, Pa. They show that a soot cleaner saves much more money during its lifetime than is generally supposed. Just at this time, when we are all trying to save as much fuel as possible, these figures are of especial value.

The computations have been simplified to savings per foot of pipe. Thus they find that each foot of pipe used in connection with a permanently installed soot cleaner saves approximately 18.3 tons of coal during the lifetime of the cleaner. In addition to that each foot of pipe saves one man's labor for one day. This makes it a simple matter for the reader to compute the savings that can be expected from each foot of pipe after the installation of the cleaner.

Since the average water tube boiler requires about 200 ft. of pipe, it is not difficult to compute the total money saved, or the money saved by the reduction of labor cost alone. In some cases it is found that the computed labor saving alone pays for the cleaners. The money saving due to the lower coal consumption is, of course, many times larger.

Wages at the present time are high, but if we assume that boiler room labor can be secured at \$2 per day, the labor saving with the average cleaner is \$2 $\times$ 200 is \$400 for the lifetime of the cleaner.

As for coal saving, if we assume the price of coal to be \$4 per ton and 200 ft. of pipe per cleaner, the money saving for the lifetime of the cleaner will be, in round numbers

$$\$4.00 \times 18.3 \times 200 = \$14{,}600$$

Add this to the \$400 obtained above and we get a total saving of \$15,000. These figures vary of course with labor and coal cost, but can be easily adjusted by the reader to fit his own conditions and thus determine whether or not a permanently installed soot cleaner would be profitable in his plant. These figures are based on boilers operated at 140 percent. capacity, average coal consumption 4 lb. per b.h.p. per hour, boilers operating 24 hours per day, 325 days per year. The life of a cleaner is assumed to be seven years.

TELAUTOGRAPH HELPS SHIPBUILDERS

The Telautograph, an electrical device for automatically transmitting messages in writing, is now in operation in the lobby of the Corporation Building, and promises to be not only a great time-saver for officials, but a means of preventing strangers, without proper credentials, from wandering into the office floors of the building.

The master machine, consisting of a sending, and three receiving machines, is located on the first floor, at the information counter, with connections on each of the floors above, from which messages may be received or sent. Under this system, when a visitor comes into the building to see an official or employee, he will state his name and business to the operator in the lobby.

She will write it on the machine, and at the same time machines on upper floors will reproduce the message in her handwriting. The second message will be delivered to the person to whom it is addressed, and he will send his reply. If he wishes to see the caller, that fact will be communicated by the machine on his floor to the one on the first floor. The return message is to be stamped by the operator and will constitute a pass permitting a vistor to enter the elevator.

THE TRADE IN PRINT

What The Industry is Doing in a Literary Way

Beardslee Chandelier Manufacturing Company, Chicago, has just issued under the title "Business Building Bulletin" a 25x38-inch broadside illustrating 36 types of popular-priced direct and indirect lighting fixtures for all purposes. This broadside offers a 24-hour service on all orders for standard lighting fixtures. A new scale of discounts is also announced by this company.

✦ ✦ ✦

Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has just issued a two-color folder (publication No. 252), illustrating and emphasizing the convenience of the Seventy Fifty switch. The Seventy Fifty switch is extensively used with electric irons, toasters, and other appliances as well as on the cords of electric tools for the home, office and shop.

✦ ✦ ✦

The Insulating of Commutators is the title of a 16-page booklet now being distributed by the Mica Insulator Co., 68 Church Street, New York. "A few facts relative to an important subject" is the opening sentence of an article that tells why and how mica is used for insulating commutator segments from one another and from the shaft. "Micanite," the trade name for one of this company's standard products, is considered at length in the latter part of the booklet.

✦ ✦ ✦

Leeds & Northup Company, 4901 Stenton avenue, Philadelphia, Pa., is distributing Cotalog No. 20 dealing with the moving coil galvanometer. The first section of this book is devoted to a complete discussion of the moving coil galvanometer and its uses and contains a large number of charts and tables of an explanatory nature. The second part of the catalog illustrates and describes in detail an extensive line of galvanometers, lamp and scales, galvanometer mirrors, accessories, etc.

✦ ✦ ✦

Holophane Glass Company, 340 Madison avenue, New York City, has issued booklet No. 163 entitled "Scientific Industrial Illumination." This is a book of 36 pages, very completely illustrated that gives, first, a series of pertinent reasons for the need of improved industrial illumination. Special attention is given to the following benefits resulting from it: Increased production, decreased spoilage, fewer accidents, better workmanship, 24-hour utilization of facilities and decreased labor turnover. Further discussion follows on the low cost of scientific illumination and the scientific principles of good illumination. The remainder of the book is devoted almost entirely to illustrated descriptions of Holophane reflectors and their advantages.

✦ ✦ ✦

The Lighting of Offices and Drafting Rooms, Bulletin 35, Engineering Department, National Lamp Works of G. E. Co. This is a comprehensive treatment of the subject, devoted to a discussion of the methods by which the best lighting may be obtained in either old or new buildings. Confusing technicalities have been carefully avoided, with a view to making the bulletin of a practical nature. The subject is discussed under the following sub-divisions: Quantity of light, quality of light and choice of units, utilization of light, location and number of units, and illumination calculations. Other topics treated are the effect of color on quantity of light, shadow, and a comparison of the suitability of the various lighting equipments for use in buildings of this type. The solution of an illustrative problem is provided. The generous use of charts and pictures to illustrate the text makes this a desirable pamphlet for those interested in the subject.

✦ ✦ ✦

"Centrifugal Boiler Feed Pumps," is the title of a pamphlet just issued by the De Laval Steam Turbine Co., Trenton, N. J. It describes the De Laval combined steam turbine and centrifugal boiler feed pump. Centrifugal pumps have been used for feeding high-pressure steam boilers for a number of years, but the machine here described differs from those previously used in that the steam turbine rotor and the pump impellers are mounted upon one shaft with only two bearings and are enclosed within one housing. The combined turbine pump casting is split horizontally, and by lifting the cover all internal and working parts are exposed. The steam and water connections are in the lower part of the casing and are thus not disturbed when the pump is opened. The turbine is of the velocity-stage type and the pump contains either two or three impellers, according to the boiler pressure.

One of the features is the small size and weight of this type of pump. A pump for 3,000 boiler horse power occupies a floor space of only two by three feet as against about eight times that space for an ordinary duplex pump.

✦ ✦ ✦

Wiring Devices and Circuit Breakers, Catalogue 1-B, wiring devices and carbon circuit breaker, is now being distributed by the Westinghouse Electric & Mfg. Co. It contains 224 pages, and lists fuses, knife switches, service switches, and boxes, solderless connectors, disconnecting switches, instrument switches, safety switches, safety panel boards, safety floor boxes, and carbon circuit-breakers, part of which have previously been listed in the old sectional 3001 catalogue of the Westinghouse Company. An entirely new and complete line of knife switches of the company's own manufacture, both front and rear-connected, the types A and C, occupy 49 pages

of this catalogue. A new line of disconnecting switches, known as types P and R, are listed in this catalogue for the first time. In listing the carbon circuit-breakers, the Westinghouse Company has made a departure from its previous practice. The carbon circuit-breakers are listed in this catalogue according to what they will accomplish; that is, according to the method of operation, method of mounting, and their capacity, the types designated being the secondary consideration in the table of listings.

DID YOU KNOW THAT—

BITS OF GOSSIP FROM THE TRADE

The Okonite Company, 501 Fifth Avenue, New York, announces that James B. Olson joined its staff on August 1. Mr. Olson is well known in the insulated wire industry, having been identified with it for many years.

✦ ✦ ✦

National Acme Company, of Windsor, Vermont, manufacturers of automatic screw lathes, are contemplating moving their Cleveland plant to Windsor if a suitable site can be produced and conditions are favorable. At the present time The Colonial Power & Light Company furnishes them with from 250,000 to 300,000 kw. h per month.

✦ ✦ ✦

PURELY PERSONAL

W. A. Layman, president of the Wagner Electric Manufacturing Company, has been chosen to serve on the board of directors of Washington University.

✦ ✦ ✦

J. Franklin Stevens has been appointed District Chairman for South-eastern Pennsylvania in charge of Conservation Division and Power and Light Division of the Federal Fuel Administration for Pennsylvania.

✦ ✦ ✦

F. H. Rickeman, for several years connected with the Interstate Light & Power Company (Northern States Power Company), Galena-Illinois, has been appointed general manager of the company, succeeding W. R. Miller, resigned.

✦ ✦ ✦

C. J. Peterson, who has been connected with the Stillwater, Minn., division of the Northern States Power Company, for eight years as hydro electric superintendent, has been appointed general superintendent, succeeding C. J. Clarey.

✦ ✦ ✦

N. I. Garrison, manager of the El Reno, Okla., division of the Oklahoma Gas & Electric Company, has been elected vice-chairman of the Canadian County Chapter of the Red Cross.

✦ ✦ ✦

Lewis S. Maxfield, formerly in the motive power department of the Interborough Rapid Transit and New York Railways companies, has resigned to become assistant engineer with the Nate-Earle Co., Engineering Contractors of New York.

✦ ✦ ✦

Edgar A. Wilhelmi, export manager of The Robbins & Myers Co., Springfield, O., has recently returned from a four-months trip to the Far East, including the Hawaiian Islands, Japan, China, and the Phillipines. Mr. Wilhelmi states that in general the industries of these countries are experiencing the same prosperity as those in this country, due to the war demands. The only adverse conditions affecting business are the uncertainity of receiving goods and the high freight rates.

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H. H. Hermes, manager of the New Business Department of the Oklahoma Gas & Electric Company, Oklahoma City, Okla., has been appointed illuminating engineering administrator for the State of Oklahoma.

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George J. Roberts, of East Orange, New Jersey, vice-president and general manager of the Public Service Corporation of New Jersey, was recently appointed as Ordnance District Chief of the New York District, and will have his office in the Albemarle Building, Broadway at 24th St.

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J. N. Mahoney, for 12 years a member of the engineering department, has resigned from the Westinghouse Electric & Mfg. Company.. to open consulting offices in New York. For the last 8 years, Mr. Mahoney has been in charge of designing switches, fuses, and circuit breakers for the Westinghouse company.

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David D. Gibson, Jr., electrical engineer with the Carborundum Co., of Niagara Falls, N. Y., is at present located in Shawinigan Falls, Que., testing and putting into service the 60,000-volt transformer station and electric furnaces at the Canadian Aloxite Company's plant.

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Capt. Fulton Mandeville, formerly of the commercial department of the Louisville Gas & Electric Co., Louisville, Ky., has been promoted from the rank of lieutenant in the 327th Machine Gun Battalion of the Lincoln Division. Capt. Mandeville graduated from the officers training camp at Fort Benjamin Harrison last year and received a commission as first lieutenant.

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C. A. Graves, president of the Graves Engineering Co., has been appointed assistant administrative engineer of the Fuel Administration for the State of New York. At one time he was associated with the Brooklyn Edison Co.

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J. H. Fenton, of the Los Angeles office of the Westinghouse Electric & Mfg. Company, has recently been appointed manager of the industrial division of that office, which includes jurisdiction over the Tucson and El Paso offices.

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T. E. Keating, manager of the turbine section of the power sales department of the Westinghouse Electric & Mfg. Co., at East Pittsburgh, has been commissioned as Lieutenant, Senior Grade, United States Navy, and has been assigned to the United States Navy, Steam Engineering School at Stevens Institute as Instructor to the Junior Engineering Officers in modern turbine and condenser practice.

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E. P. Dillon, manager of power division, New York office of the Westinghouse Electric & Mfg. Co., has resigned to become general manager of the Research Corporation of New York. Mr. Dillon was with the Westinghouse company from 1909, having been previously connected with various mining and electrical companies in Colorado. In 1917 he was transferred to the New York office as manager of the railway and power divisions.

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OBITUARY

Lieut. Warren G. Harries, youngest son of Brig. Gen. Geo. H. Harries, formerly vice-president of H. M. Byllesby & Co., was recently killed in an automobile accident in France.

Capt. Howard C. McCall, son of Joseph B. McCall, president of the Philadelphia Electric Co., was killed in action in France on July 20. He was graduated at the University of Pennsylvania in 1909.

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First Lieut. Edward T. Hathaway, son of F. B. Hathaway of the Southwestern General Electric Co., Houston, Texas, died in France last month as the result of an aeroplane accident.

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Abbott S. Cooke, president of the Cooke-Wilson Electrical Supply Co., of Pittsburgh, died at his home in that place on July 25. He was an old timer in the electrical business.

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Edgar Marburgh, professor of civil engineering in the University of Pennsylvania, secretary-treasurer of the American Society for Testing Materials, died in Philadelphia, June 27, 1918, as a result of a nervous breakdown of more than a year ago.

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ASSOCIATIONS AND SOCIETIES

American Gear Manufacturers Association will hold its next semi-annual meeting at the Onondaga Hotel, Syracuse, N. Y., Setpember 19, 20, and 21.

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Jovian Convention will be held at Dallas, Texas, October 24-26, 1918.

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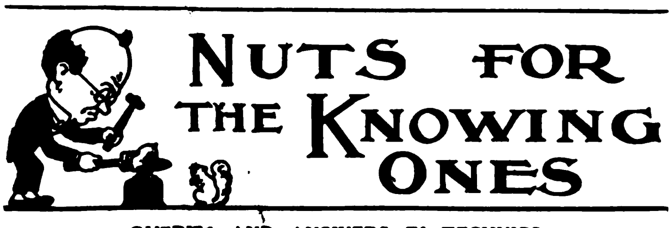
American Association of Engineers, 29 South La Salle St., Chicago, Ill., announces the engagement of C. E. Drayer, of Cleveland, Ohio, at national secretary. Mr. Drayer was formerly secretary of the Cleveland Engineering Society.



QUERIES AND ANSWERS IN TECHNICS

The core of a 450-kw. 10,000-volt alternating current generator becomes almost as hot at no load as it does at full load. Is this due to eddy currents, or to poor insulation of the stator windings which are about 6 years old? Assuming that it is caused by eddy currents in the stator core, what is the best cure and can it be repaired at the plant or must the stator be sent to the manufacturers?

M. Bowman, Michipicoten River, Ontario, Canada.

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Will you please give me the data on rewinding a small motor. The motor was formerly a series wound machine. I want to have it rewound for shunt service.

The name of motor is Fairbanks-Morse series wound, 4 pole No. 16128y. Type T. R., 220 volts D. C., 475 rev. per min. I wish to convert it to a shunt wound motor of approximately 1500 rev. per. min. to develop as much horse power as possible.

The size of the armature is as follows:

No. of slots, 30.
Length or slots, 3-3/4 in.
Width of slots, 3/8 in.
Diameter or armature, 6½ in.
Field core, 1½ in. X 3½ in.

C. E. COLLIER,
Eddyville, Ky.

BRIEF TIDINGS FOR THE BUSY MAN

The Arkansas Valley Railway, Light & Power Company is considering the electrification of the water works which supplies the northern part of the city. Approximately 800 horsepower will be required.

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What is said to be the largest polyphase regulator in kilovolt-ampere capacity ever built has just been completed for the Hartford Electric Light Company, Hartford, Conn. Its rating is 1,000 kilovolt-amperes, three phase, 60 cycles, and provides 10 percent. regulation on a 10,000-kilovolt-ampere, 11,000-volt, three-phase, 526-ampere circuit. The regulator is an oil-immersed, forced-oil-cooled type, which is a new but very successful departure in the method of cooling regulators.

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Since September 1, 1917, increased rates for utility service have become effective at 297 communities served by the following properties managed by H. M. Byllesby & Company: Fort Smith Light & Traction Company, Mobile Electric Company, Northern States Power Company, Oklahoma Gas & Electric Company, Ottumwa Railway & Light Company, Puget Sound Gas Company, San Diego Consolidated Gas & Electric Company, Tacoma Gas Company, and Western States Gas & Electric Company.

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When we burn wood or coal we draw upon the oxygen that has been set free into the air when some tree grew, and we combine or burn it with the carbon and hydrogen which is in the wood or coal, to carbonic acid gas and water again. White smoke is mostly steam and carbonic acid gas. Black smoke is mostly carbon that got frozen out in the fire or couldn't find oxygen enough to combine to carbonic acid gas again. The desert of Sahara alone receives every day in solar energy the equivalent of six billion tons of coal.

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The National Research Council, acting as the department of science and research of the council of National Defense, has appointed a committee to investigate the fatigue phenomena of Metals. Professor H. F. Moore, of the Engineering Experiment Station of the University of Illinois is chairman. The committee is charged with the responsibility of developing a knowledge of the strength and durability of metals subjected to repeated stresses, such as ship structures, crank shafts of aircraft engines, and heavy ordnance. It is expected that much of the experimentation required will be done in the laboratories of the University of Illinois at Urbana under the personal direction of Professor Moore.

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In a paper recently read before the Canadian Society of Civil Engineers, Lieut.-Col. R. W. Leonard explained the utilization of Sudbury ores, to produce steel of high strength. In these ores there is a large content of copper and nickel in combination with the iron. The new steel was found to give results under test that were fully equal to those of nickel steel. It showed an ultimate strength of 70,000 to more than 100,000 pounds per square inch, with a yield point of 60,000 to 80,000 pounds per square inch, and showed properties which would make it a very satisfactory material for use in the manufacture of ordnance and bridges. New material is not yet on the market but its cost should be very low. Direct use of nickel-bearing iron ores is not new, but heretofore instead of trying to use nickel-copper iron ores direct in the smelter, efforts have been made to get

rid of the copper. The Canadian experiments, however, show that a very satisfactory result can be obtained by a special treatment of the ores without making any effort to eliminate the copper content.

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According to the *Scientific American,* for the last two years of war the biplane type has been in practically universal use, although during the last year the British have employed a few squadrons of Sopwith triplanes with excellent results. However, at present there are many indications that designers are again swinging back to the monoplane in search of greater speed, better climbing ability, and greater maneuvering power. In a recent British official statement it is admitted that excellent results are being obtained at the front with a new monoplane. On the other hand, the Germans are now trying their hand at triplanes, and it is reported that they are rapidly increasing the number of this type flying at the front.

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The chief parts of a Tungar rectifier are a bulb, a compensator, a reactance. The bulb looks much like an incandescent lamp. In addition to the low-voltage filament it has another electrode, the "anode." In the bulb is an inert gas—argon. The combination of the heated filament and the gas makes it possible for current to flow in but one direction—from anode to cathode. Therefore, only uni-directional or direct current can flow from the rectifier. The efficiency of the 6-ampere, 75-volt Tungar rectifier is about 75 percent. at full load.

This rectifier is primarily intended for use by public garages and battery service stations which care for starting and lighting batteries used in gasoline-driven automobiles.

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The Franklin Institute of the State of Pennsylvania, one department of which has since 1824 annually reported upon inventions with a view of making awards, has so far found but 1,700 inventions worth reporting upon, or an average of 18 a year, though the number of patents granted each year runs into the hundreds of thousands! The Institute is trustee of a number of funds for making awards for meritorious inventions, but has, since 1824, only been able to make such awards in 400 cases, or at the rate of just over four a year, while the interest on one of the funds—the John Scott Legacy Medal and Premium, has accumulated to several thousands of dollars!

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Measured in terms of average labor, copper, wire, car equipment, machinery, coal, and in fact all supplies which it uses in providing public service, the purchasing power of a nickel, as compared with the pre-war period, varies slightly from 2½ cents. If 5 cents was ever a proper rate of fare, the present rate should approximate 10 cents. What business law operates differently for the seller of street car transportation and the seller of pie, hardware, shoes, clothing and everything else? Think for a moment that the nickel is in reality only 2½ cents, and it will be clear that you cannot fairly purchase with it street car rides costing more than 5 cents.

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GOVERNMENT EXHIBIT OF FOREIGN ELECTRICAL GOODS

There is on display at the local district office of the Bureau of Foreign and Domestic Commerce, in room 734 of the New York Customhouse, at Battery Place, a large technical collection of samples of electrical goods used in foreign countries. The exhibit is made up of a comprehensive selection of the goods most employed in electrical work in various foreign countries and includes wiring devices, heating appliances, electrical porcelains, dry cells, flash lights, electric bells, conduit and conduit fittings, insulating wire, etc.

These samples have been forwarded mainly in connection with the special investigations undertaken in South America by P. S. Smith, and in Australia, New Zealand, China, Japan, and Eastern Siberia by R. A. Lundquist, special agent of the bureau. Complete data accompany each article on exhibit, giving country of origin, where obtained, how used, selling price, etc.

There are several hundred items in the exhibit, and these have been specially arranged by T. O. Klath, commercial agent in charge of the bureau's exhibit room, for inspection by electrical manufacturers and exporters in order that they may make a personal study of the classes of goods with which their products come into competition abroad.

These samples of foreign goods available through the efforts of the Bureau of Foreign and Domestic Commerce, are being made broad use of by the manufacturers of the United States. An interesting case was recently learned of, where an electrical manufacturer immediately visited the sample room upon learning of the arrival of a shipment of goods from a foreign market, and carefully studied certain items in which he was interested. Returning to his plant, he developed a similar line of superior design, cabled quotations and data to his agents in the market, and began selling a new line which has rapidly grown to large volume.

There is a wide field abroad for standard American electrical goods, as well as for adaptions of American designs to foreign requirements, and when our electrical manufacturers study the types of goods now in use in such market, they can obtain a grasp of the standards and of the conditions existing that can be secured in no other way except by a personal visit to the field, and this knowledge will enable them to push the sale of their goods with the best possible efficiency.

R. A. Lundquist, himself a consulting engineer, who conducted the investigations in Australia, New Zealand, and the Far East, will be in the city for a time, and will discuss with visitors the uses of the various items in the exhibit and the electrical practices in the different countres from which the samples have been secured.

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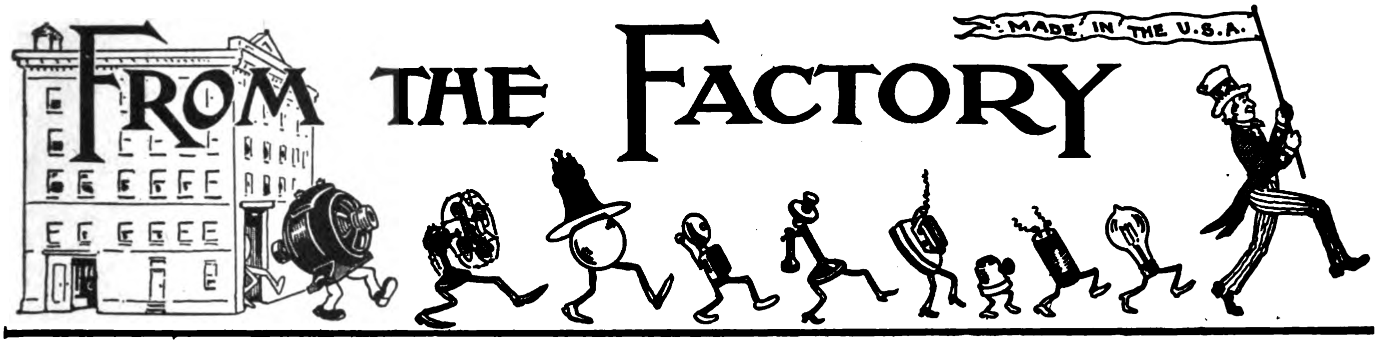
FOREIGN TRADE AFTER THE WAR

Edward N. Hurley, chairman of the United States Shipping Board, says we are rapidly building the mechanical equipment for regular steamship lines all over the world. The fast troop ship can be converted for combined passenger and cargo service and placed on regular lines, reaching the whole of Central America, South America, the Pacific, and the British Colonies. We shall undoubtedly have our own liners to Great Britain, European, and Mediterranean ports. Our refrigerator ships, now carrying meat and dairy products to feed the allies, will carry meat, fruit, butter, eggs, and perishables to other countries. Our cargo ships can be organized on the triangular system, which has made British and German shipping profitable. That is, a British ship left Wales with a cargo of coal for South America, picked up a cargo of nitrates for the United States, and returned with a cargo of wheat to England. Thus British export and import trade were both facilitated, and on the third leg of the triangle the British ship did a delivery job for a foreign nation, thus adding to tonnage and revenue. If 25,000,000 tons of American shipping can be kept busy in our own export and import trade, then the development of this third leg in the triangle will keep 30,000,000 to 35,000,000 tons of American shipping employed

To keep this great new merchant marine busy we must have a radical change in American business thinking. Every manufacturer and trader in the United States, every banker, farmer, miner, and consumer must begin to think now about American merchant ships as a great modern international delivery service.



Short Stories About Electrical Goods Offered By Manufacturers

INTERCHANGEABLE CONNECTING BLOCK, ROSETTE AND RECEPTACLE

The Bryant Electric Co. of Bridgeport, Conn., has just placed on the market a new connecting block. This block consists of two pieces of poreclain fastened together from the exterior by means of two screws, which are retained by fibre washers in their holes in the top piece, even when the two parts of the block are separated. These screws also form the current-carrying contacts between the top and base. The base of the block, as will be noted in illustration, Fig. 1, has a substantial recess for the two firmly fixed binding plates, each of which has four binding screws, to permit of ready connection of wires for additional circuits as may be needed. Thus, it is unnecessary to

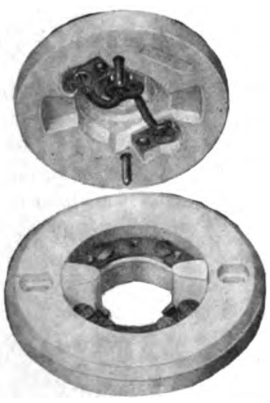


Fig. 1

Fig. 2

Fig. 3

Interchangeable connecting block, rosette, and receptacle. Bryant Electric Co., Bridgeport, Conn.

remove the fitting or awkardly splice and solder the wires as required, because there is ample room for handling the wires through the round opening in the base.

Fig. 2 shows a small film or "knock-out" of porcelain in the center of the cap. A light blow will serve to knock this out, transforming the "block" into a rosette. Wires can be passed through this opening and fastened at the binding screws as shown in the upper view of Fig. 1, so that drop light or switch fixture can be attached.

Another interchangeable feature of this block is that to this same style base a porcelain lamp receptacle (as shown in Fig. 3) can be attached. The heavy lugs shown in base fit into the recesses moulded into both the top piece of the block or rosette and the lamp receptacle base and insure the correct relative position of the parts so that the fastening screws (which also serve as current connections) can be easily and properly fastenend.

These devices, designated as List No. 566 for the rosette-connecting block, and No. 4122 for the receptacle, are designed for attachment to standard 3¼ in. outlet boxes and to No. 700 Adapti boxes. They are National Electrical Code approved.

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STANDARD DOME REFLECTORS

The Reflector Commttee of the Associated Manufacturers of Electrical Supplies has given encouraging evidence of progress through its announcement of the adoption of standard designs for porcelain-lined metal dome reflectors suitable principally for industrial lighting. The specifications standardized and recommended by the representatives of reflector and lamp manufacturers, after a thorough and exhaustive consideration of requirements, are for reflectors of the dome type for direct lighting to accommodate mazda C lamps ranging from 75 watts to 1000 watts, inclusive.

The trade designation adopted for reflectors made according to the specifications of the Reflector Committee is "R-L-M Standard," an abbreviation of "Reflector and Lamp Manufacturers' Standard." A copyrighted mark of identification for R-L-M standard reflectors to be used by all Association Manufacturers is in course of preparation.

The announcement of a standard industrial lighting reflector is only the beginning of a very necessary and desirable work toward standardization and elimination of waste and inefficiency in lighting apparatus, which the Reflector Committee as a unit and the Association Manufacturers of Electrical Supplies are organized and equipped to accomplish.

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NON-GLARE LAMP SHIELD

The Benjamin Electric Mfg. Co., 128 South Sangamon St., Chicago, Ill., is manufacturing a new device for eliminating the glare from high power gas-filled lamps. It is composed of glass or metal, is bowl-shaped, and hangs under the lamp bulb. It is easily removed for cleaning.

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IMPROVED ARC LAMP CARBON HOLDER

An important improvement is announced in the Kliegl arc lamp carbon holders for Kliegl universal hand feed arc lamps as manufactured by the Universal Electric Stage Lighting Co., 240 West 50th St., New York City.

Heretofore the bottom holders were not made for a wide range of carbon sizes, whereas as now made for 70 ampere lamps, the holder is adjustable and will take with equal ease ¾ inch or 5/16 inch carbons or any intermediate sizes. The photograph distinctly shows how this is accomplished without need of explaining the mechanical details. It shows a ¾ inch carbon in the top holder and a ⅜ inch. carbon in the bottom holder.

A smaller carbon holder is made for 35 ampere lamps and is adjustable in the same way to take any carbon diameter from ⅝ inch to 5/16 inch. inclusive.

It will be noted that the carbons can be adjusted sideways as well as vertically thus maintaining perfect alignment and constantly focusing in the center of the lens.

A special arrangement has been made for fastening lugs with asbestos wire. A carbon drop, of course, is always provided on all carbon holders.

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PORTABLE LAMP

A portable lamp is being manufactured by the Anderson Electric Specialty Company, 118 South Clinton Street, Chicago, Ill. This lamp consists of an Adapt-a-Lite extension unit, 10 ft. of cord and socket, an adjustable shade and a bracket base.

The bracket base combines a base for use as a table lamp, means for hanging on a wall, a clamp for attaching to the frame of a bed or edge of a desk or table. The socket may be detached from the bracket base and wound up to the reel when desired.

The shade is quickly adjusted to direct the light rays in any direction. The device can be attached to any lamp socket.

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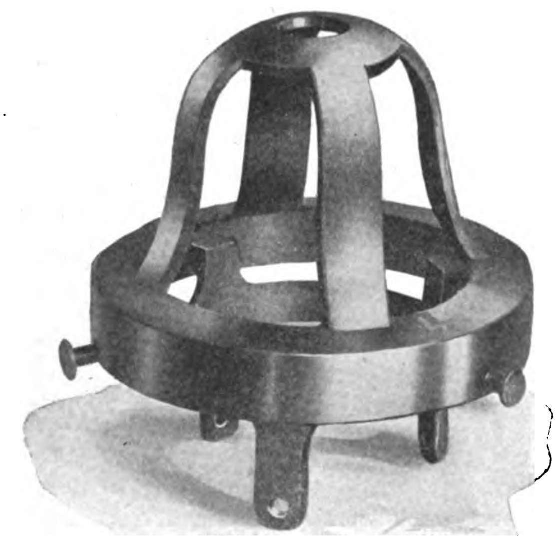
KWIKFIT HOLDER

This is a combination reflector and bowl holder, recently put on the market by Fensterer & Ruhe, 37 Murray Street, New York. Designed for use with large two-piece units, it is said to be both simple and labor saving. It is made of cast metal and holds both glassware and socket. It's design is such as to eliminate holes in reflectors; it also eliminates rosettes and hooks.



Kwikfit holder, Fensterer & Ruhe, 37 Murray Street, New York.

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FLEXIBLE CHARGING OUTFIT

A commutating rectifier for charging batteries without overheating them is being manufactured by the Stahl Rectifier Company, 1401 West Jackson Boulevard, Chicago. Three rectifying commutators with one-quarter of the sections dead produce pulsating currents, which, the manufacturers claim, allows charging at a high rate without overheating the batteries. Because of an independent regulator for each circuit these three circuits can be charged at any rate from 4 amperes to 12 amperes. One circuit can be charging one line of batteries at a rate of 10 amperes, another circuit can be charging at a rate of only 5 amperes, and a third circuit can be charging at an entirely different rate—all three operating at the same time.

MAKING TEMPERATURE TRIP THE CIRCUIT-BREAKER

The oldest form of overload protection is electro-magnetic, cutting off the current if it reaches a value deemed dangerous. The fact that most electrical apparatus can withstand momentary overloads without danger has gradually led operators to push up the current values at which electromagnetic protective devices will operate, or to dispense with them entirely, rather than undergo the inconvenience of having them disconnect the machinery on momentary peaks.

A method of visual protection on the basis of temperature was the next step. Exploring coils were built into the apparatus and used to indicate the temperature of hot spots by means of electrical instruments.

The latest step is a relay, the type CT, built by the Westinghouse Electric & Mfg. Co., which automatically trips the circuit-breaker when the temperature reaches the danger point under excessive current. It may be used to protect any alternating-current apparatus from excessive heating if the apparatus is so arranged that exploring coils can be installed.

The relay is intended to protect apparatus against overheating from sustained overloads. To afford this protection with the least interruption of service, the breaker should be tripped through the direct effect of the temperature of the apparatus. The relay should be so arranged that it prevents the breaker from tripping if the overload is of such short duration that the temperature does not rise to a dangerous value; while if the overload apparatus persists the breaker must be tripped out as soon as the temperature rises beyond the critical value. The type CT temperature relay operates on the wheatstone bridge principle. The construction of the exploring coils will vary, depending on the kind of apparatus with which they are to be used.

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TRANSFER RELAY

Protective relays that operate by closing a separate direct-current tripping circuit, which in turn trips the circuit-breaker, have proved more serviceable than "shunt-trip" relays and have come into general use. In some cases, however, a separate direct-current tripping circuit is not available and other means must be sought. The use of "transfer" relays in the best solution so far obtained, for they energize the trip coil off the circuit-breaker through current transformers. The type BT relay can be applied to any make of circuit-closing relay with similar characteristics.

The breaker operates solely through the current transformer and the relays. When there is no fault on the line, the trip coil of the breaker is mechanically and electrically isolated from the circuit, avoiding liklihood of tripping due to imperfection in the relay contacts ordinarily shunting the trip coil.

The relay contains two series coils—an upper or operating coil and a lower or holding coil. The holding coil holds down the armature core, until a third coil, wound on the same magnetic circuit and known as the releasing coil is short-circuited by the protective relay. The releasing coil acts as the secondary of a transformer and when short-circuited, a current flows through it, demagnetizing the core. The holding coil, therefore, allows the operating coil to raise the core which operates the transfer switch, thus closing the trip coil circuit.

The transfer switch and other current carrying parts of the relay are designed to carry 5 amperes continuously, but during times of short circuit the switch may be called on to handle as much as 100 or 200 amperes.

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PROTECTION AGAINST REVERSED PHASES

If a three-phase motor is disconnected from a circuit and the phases reversed when it is reconnected, it will naturally run backward. Such a reversal may occur and has occurred when the motor is disconnected for repairs, through an error in reconnecting leads at the power house, or substation, or from a number of other causes.

In many cases the reversal of rotation of a motor, aside from the inconveniences it causes, is not a serious matter as the error can be corrected at the motor terminals. In other cases, however, serious consequences may result. The reversal of an elevator motor, for instance, might result in wrecking the machinery and loss of life.

To protect motors against phase reversal where such protection is necessary, the Westinghouse Electric & Mfg. Co. has developed a reverse-phase relay. If a phase is reversed, or if a phase fails, or if the voltage drops below 75 percent. of normal, the relay contacts close and trip the circuit-breaker, either through a shut-trip coil or by short-circuiting an under voltage trip coil having a series reverse resistor.

The relay operates on the induction principle. When properly connected the torque holds the contacts open against the restraint of a spiral spring. On low voltage the torgue diminishes and the spring closes the contacts. On reversal of phase connections the reversed torque assists the spring in closing the contacts.

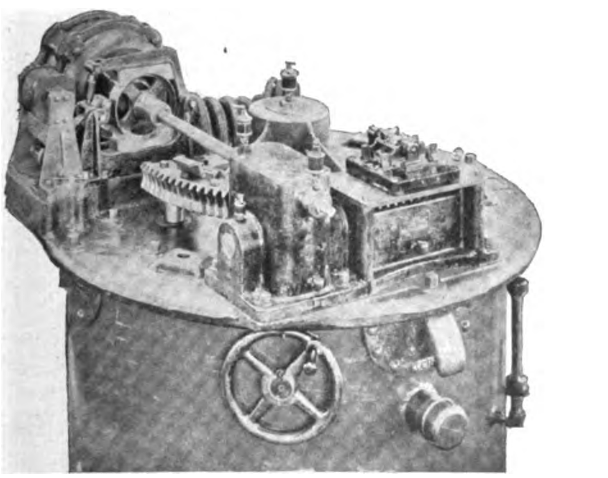
The contacts will close 5 amperes at 250 volts or less.

POLYPHASE INDUCTION REGULATORS

The largest kva capacity polyphase regulator ever built has just been completed for the Hartford Electric Light and Power Company of Hartford, Conn.

The rating is 1000 kva., three-phase, 60 cycles and provides 100 percent. regulation on a 10,000 kva., 11,000 volt, three-phase, 526 ampere circuit. The regulator is an oil immersed, forced-oil-cooled type, which is a new but very successful departure in the method of cooling regulators.

In this method of cooling, the cold oil is forced in at the bottom of the regulators through the lower portion of the windings, which extend below the core, and which are especially spaced so as to give a free passage for the oil. As



Three-phase, oil-immersed forced oil regulator. General Electric Co., Schenectady, N. Y.

the oil passes upward it is forced through three separate and distinct passages, each passage being of such size as to allow a flow of oil in proportion to the heat generated.

One oil passage is inside the motor shaft, one outside the stator iron between the regulator and the tank, and the third through the gap between the shunt and series windings. After passing through the upper portion of the windings, which are spaced in the same manner as the lower portion, the oil overflows into a channel along the inside of the tank. In order that the flow into the channel be uniform from all directions a special distributor is provided. From the channel the oil is conducted by gravity through a series of cooling coils to a storage tank and from the storage tank is again forced through the regulator.

The regulator is of the skeleton frame design with a sturdy mechanical construction.

The conductors of the windings are heavily insulated and the insulation on the outside of the coils is in proportion. The strand insulation of the shunt winding is exceptionally strong and additional insulation is used between layers. The series coils are of one turn per layer and the turns are insulated from each other with insulation which will withstand a potential greater than the full line voltage.

In order to allow free passage of the oil through the coil insulation into the coil, each coil is provided with a vent at the bottom. In addition the complete machine is given a vacuum oil treatment to remove any air pockets that may exist in the coils.

The parts of the coils which extend above and below the core are provided with mechanical reinforcing to withstand the strains due to short circuits. The shunt coils are banded to an iron support and around the series coils is placed a heavy iron ring, properly insulated to which each coil is coded securely.

The regulator is motor operated and will travel from one limit to the other limit in 40 seconds.

The dimensions of the regulator are 4 ft. 6 in. at the base, with a height overall of 10 ft. 3½ in. The weight is approximately 23,000 lbs.

METERS FOR WIRELESS AND HIGH-FREQUENCY WORK

A high grade hot wire measuring instrument designed particularly for wireless and other high-frequency work, depending for its operation upon the expansion of a metal strip which is heated by the current to be measured, has been developed by the Westinghouse Electric & Mfg. Co. The slight sag in this conducting strip is magnified several hundred times on the scale by means of a combination of wires and a deflecting spring.

The conducting strip is made of special non-corrosive material. The separating posts have the same temperature coefficient of expansion as the conductng strip, so that the changes in room temperature do not cause an error in the reading of the instrument.

The instruments are furnished in two forms, for flush mounting and portable. Similar instruments for switchboard mounting are also supplied. The flush-mounting form, known as type EH is of the round open-face type. The face is 3 in. in diameter, and the diameter outside the flange is 3¼ in. It has a black rubberoid case and rim, with white dial.

The portable form known as type PH, is mounted in a morocco-leather-covered wooden case with heavy glass over the dial. The case is 3¾ in. by 4⅜ in. by 2 in. thick.

The scale plate is made of metal, and the scale subtends an arc of 90 degrees, being 2⅜ in. long.

SPHERE-GAP LIGHTING ARRESTER

A sphere-gap lightning arrester now being manufactured by the Electrical Engineers' Equipment Company of Chicago consists essentially of a sphere gap and a horn gap in series with resistance to ground. This construction has been adopted by the company since it has been shown that a sphere gap will handle high-frequency surges more rapidly than a horn gap. The horn gap is used to dissipate the arc which results from the surge, as this arc will follow up the horns and extinguish itself. The resistance tube is placed in series with the horn gap and affords a straight path to ground

DUPLEX INSTRUMENTS

In its new catalogue on instruments and relays, just published, the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., announces two new duplex instruments for battery charging, marine, dental, telegraph, telephone, farm lighting, and other compact instrument panels where direct-current is involved.

These duplex instruments consist of any two standard Westinghouse type AW or type FW instruments desired, mounted in an attractive dull-black metal case. The type AW instruments have round open faces, 3 in. diameter, with glass cover and rear mounting studs; the type FW have 5-in. faces.

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ILLUMINATED FUSE TESTER

An appliance designed to do away with waste of time and money to discover a blown fuse is announced, and is being marketed by R. S. Blake, 230 So. La Salle Street, Chicago, Ill. It consists of a device to test fuses in place with safety, while the back of fuse is illuminated by the light from a dry cell flash lamp. The tester is held in one hand, the light flashed on, and the necessary contacts are made by means of the two contact points which are suitably placed—one a stiff heavy rubber insulated wire—and the other a rubber insulated flexible wire. The result of the test is immediately apparent by the lighting or remaining dark of the two test lamps arranged in series.

The sockets in the Blake fuse tester are standard Edison base sockets, and any standard lamps may be used in them. Any voltage up to 500 may be tested. In making tests on 500 volts, it is necessary to use two 220-volt lamps. In making tests 110-220-volt circuits two 110-volt lamps are used.

The device is practically indestructible, and is marketed with or without the flash light, thus if the electrician is provided with his own lamp, only the tester proper need be purchased.

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HEAVY DUTY MOMENTARY CONTACT SWITCH

The Hart Manufacturing Co., Hartford, Conn., is in the market with what is known as a heavy duty momentary contact switch.

These switches are furnished in combinations of from two to eight gangs, mounted in separate cast iron boxes, with cast covers enclosing the push buttons themselves. This type of switch was brought out by this concern to meet Government specifications.

On the ordinary type of momentary contact switch, this company has found that, especially when subjected to hard use, the composition button breaks off, rendering the switch inoperative. With this type of switch it is so arranged that the buttons cannot be broken off as there is a protecting casting around each separate button.

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PISTON VACUUM MACHINE

This piston vacuum machine, used by canners and preservers, combines a tumbler sealing machine and a vacuum pump in one simple unit requiring only a ¾ hp. Westinghouse motor to operate it.

It is claimed that an ordinary operator can seal as many as 50 tumblers a minute with this machine with less effort than formerly because of the construction which enables him to perform the work of unloading and loading one pocket while the machine removes the air from the other pocket, and seals it. The degree of vacuum desired in each package can be regulated instantly. Broken tumblers are reduced to a minimum, since the sealing strain is applied through compensating springs which seal each jar alike, although one may be larger than the other. The variation is taken up in the spring. Changes from one size to another can be made easily in two or three minutes.

This machine is made in two types, for sealing tumblers, from 2½ to 6 in. in height, by the Anchor Cap and Closure Corp., Brooklyn, N. Y. The two-pocket type is used for dry or pastry products, and the four-pocket type for liquid or semi-liquid products which are apt to spill or splash. Either type is arranged to give three speeds, as desired.

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MOTOR-DRIVEN ROTARY BLOWER

A complete motor-driven rotary blower mounted as a unit on a base is being manufactured by the Anderson Electric Specialty Company, 118 South Clinton Street, Chicago, Ill. The device consists of a rotary blower direct connected to the motor. Current consumption is said to be only that of a 40-watt lamp, which drives the blower at a rate of 1500 r.p.m. The blower is made for varying voltages for either direct or alternating currents.

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PACKAGE TYING MACHINE

Neater and more uniform packages can be tied, in the same time, it is claimed, by the Bunn package tying machine, made by B. H. Bunn & Company, Chicago, Ill., than can be done by five men. The United States Post Office Department has adopted it for tying letter mail.

The package tier is simple and compact occupying a space only one foot square. The motive power is a little Westinghouse motor located in the lower part of the machine. It can be attached to an electric light socket and uses but little current.

Each bundle is tied securely in the same way every time. A non-slip knot prevents the string from slipping and allowing the package to become loose. One wrapping only of the twine each way eliminates the waste of twine where several wrappings by hand process were ordinarily made. Thus much saving of labor and economy is effected by the use of this machine.

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JOHNSON GROUND CLAMP

This clamp is provided with sufficient holes to make it adjustable to any size of pipe from ⅜ to 3 in., inclusive. In addition, a non-separable lug is provided, which makes it possible to connect two or more of these clamps through the same ground wire by soldering the wire to the clamps, either before or after they are installed. After the clamp is placed around the pipe, a tight connection can be easily made by screwing up the set screw provided for that purpose. It is made by the Cap-Swivel-Set Co., Warren, Ohio.

◆ ◆ ◆

SPRAGUE SINGLE STRIP CABLE

The universal use of interior wiring for light and power was originated and developed by the Sprague Electric Works of General Electric Co. The first paper tube for carrying the wires was later improved by covering with a brass armor. This was superseded by an insulated rigid iron pipe. Then came the flexible steel conduit, and later the flexible steel armored conductor, better known as BX cable. This term was originated and adopted as a trade mark by the Sprague Electric Works and therefore cannot properly be used to designate armored conductors of any other manufacturer.

This company has recently brought out a new type. The armor instead of being formed of double strips of steel, as in the BX, is made with a single strip of galvanized steel interlocked and gasketed, the whole armor covering the new code standard No. 14 B. & S. wire. It is light in weight and very flexible.

Sprague S. S. type is recommended for wiring existing buildings. It is practically watertight, has all the flexibility of the regular BX and can be installed with ease in finished buildings without defacing the walls or decorations.

Sprague S. S. flexible cable for the present will be manufactured only in the No. 14—two wire size. Later, as the demand warrants, three-wire and other sizes will be supplied.

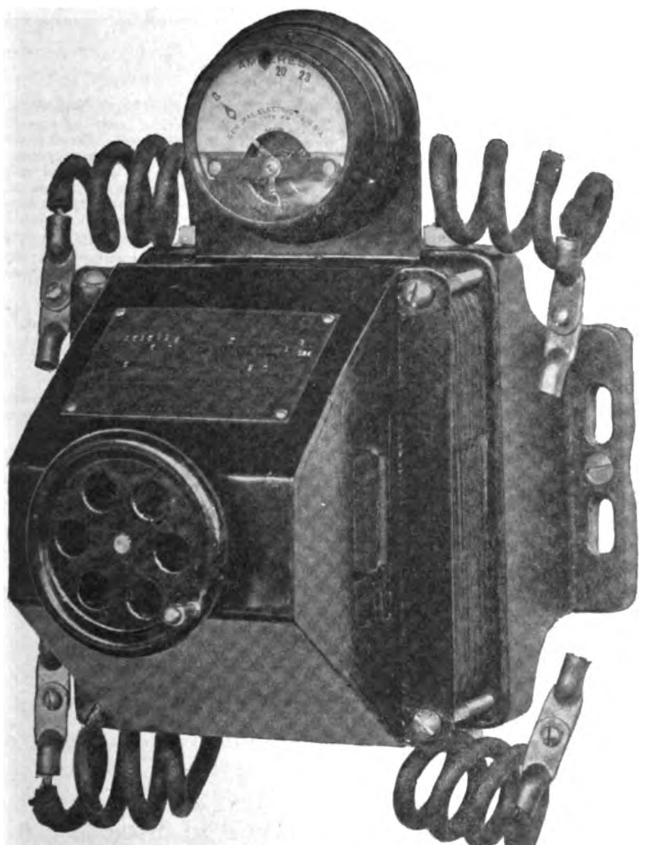
SEAL FOR CONDUIT

A conduit seal for closing the ends of exposed conduits is now being marketed by Barnes & Irving, Inc., Syracuse, N. Y. It is said to be especially useful in concrete buildings because it prevents conduit pipes from becoming plugged with concrete. It consists of a disc of paraffined cardboard, and comes in assorted sizes.

COMPENSARC FOR MOTION PICTURE PROJECTION

To give the close regulation of current essential for mazda motion picture projection lamps, the General Electric Company has developed a new compensarc, the Type 1, Form B. Protection is afforded against over current, and regulation to within 1/10 ampere is obtained.

It operates on the reactance principle and is furnished for standard alternating voltages and frequencies in ratings of 20

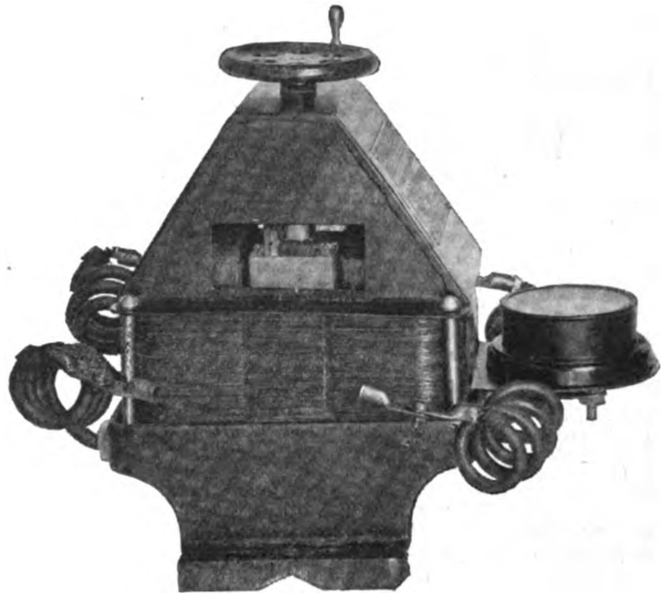


Form B reactance type compensarc. General Electric Co., Schenectady, N. Y.

and 30 amperes, corresponding to the mazda lamps now on the market for this purpose.

The compensarc may be installed convenient to the operator who can watch the ammeter and control the current by the hand wheel shown in the illustration.

This compensarc is made up of a two-coil autotransformer stacked with standard transformer punchings within a raw hide housing, the complete wiring of which forms the line side with the lamp terminals tapped across one coil. The coils are stacked so that room is left between them from an iron leakage plug on each side of the magnetic circuit. Turning a hand wheel on the shaft of the iron plug moves it in and out between the two coils, giving a very close adjust-



Form B reactance type compensarc. General Electric Co., Schenectady, N. Y.

ment for the lamp. Maximum reactance is obtained when the plug is all the way in. The only noise is a slight humming when the plugs are being withdrawn; this ceases when they come to rest.

Net weight is 32 lb. overall dimensions are 8 3/16 in. wide; 11 7/16 in. high and 10 7/8 in. deep.

STOPPING THE LEAKS

A leading telephone company has as part of its war-time program, brought to the attention of the installers the importance of eliminating waste of material. In this connection it has prepared a striking display of the various materials used, with the price of each; thus, small tacks are shown at 70 cents per 1,000, toggle bolts at 3 cents each, wire at 1¼ cents per foot, insulating tape at 18 cents per roll, angle pieces at 7 cents each, porcelain insulators at 1¼ cents each, and so on. This graphic lesson on the cost of material serves to encourage men to save in these times of economy.

SAVING THE CORDS

Injury to connecting cords is quite frequent with such electrical devices as irons, toasters, percolators, and so on, because of the practice of making and breaking the circuit with the plug. Each time the plug is pulled away from the contacts, an arc results, and it is evident that the great heat of this arc must in time burn the insulation and melt or make brittle the copper wire. At some future time the connecting cord generally gives out, causing much inconvenience. To obviate this trouble an electrical manufacturer has now come forward with a switch which is designed to be inserted in the connecting cord, thus taking away from the plug the duty of making and breaking the circuit. Equipped with large contacts and designed for a quick break, the switch handles the current without injury to the cord; also, it is more convenient than the usual method.

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Electrical Engineering

Treating of the Theory and Practice of Electrical Generation and Transmission, and the Utilization of Electrical Energy.

Frank A. Lent, New York

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DEVELOPMENT OF THE ELECTRIC TRAVELING CRANE

The claim is sometimes made that the steel plant developed the electric traveling crane, but with equal force and justice it can be safely stated that the electric traveling crane developed the steel plant, said the author at a recent meeting of the Cleveland Engineering Society, from whose *journal* this article is abstracted. While as at present constituted, the modern steel plant could not exist without the modern crane, the crane could exist without the modern steel plant, the electric traveling crane being a vital factor of economy in modern manufacturing methods, not only in the steel plant but in the iron and steel foundry, machine shop, stone and lumber industries, electric light and power plants, shipbuilding and the railroads whose glistening tracks span the earth. In each case, the electric traveling crane has been developed to suit the particular condition, to increase the output and to supply the most rapid and efficient method of handling material, and every day there is a new demand that taxes the experience and ingenuity of the crane engineer.

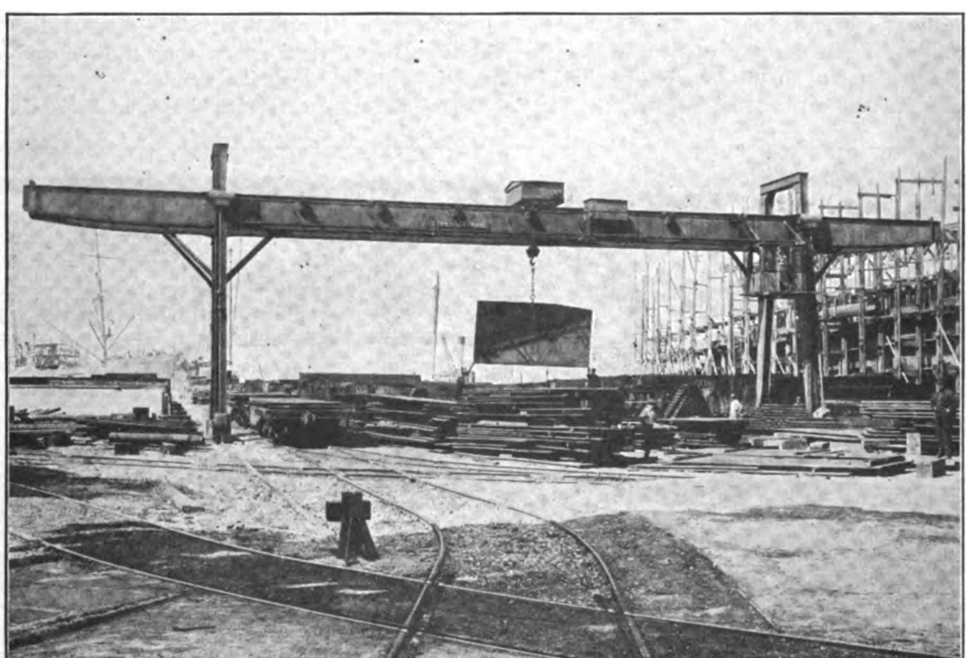

Fig. 1. 40-Ton Electric Traveling Crane

Let us enumerate a few of the essential points demanded of the modern electric traveling crane and after that we can briefly analyze some of the methods adopted to attain them.

One of the first principles of its design must be safety; that is, to be able to handle a load up to its rated capacity with a large margin of reserve strength to compensate for wear, use and abuse, so as not to endanger the life and limb of the operator or the men working beneath the crane by failure of the component parts of inadequate protection of the operator, and we may further add provision should be made to safeguard the man or men engaged in repairs.

Second. The crane should be quick-acting, responding immediately the current is turned on, so that all movements of the crane can be used simultaneously, obviating lost time in the prompt handling of materials.

Third. The crane should be efficient in that if called upon to operate continuously for a long period of time it should be able to stand up to the work with the minimum delay for repairs or attention, secured only by proper lubrication and generous wearing parts carefully protected from dust and mechanical injury.

The regulation or control of the various movements of the crane should be such that the desired work can be performed with exactitude and ease, the load being quickly transported to its desired location, leaving the crane free in the shortest possible space of time to do such other duties as it is called upon to perform.

position, and they are now lifting the girder intact with the bridge drive mechanism.

Fig. 2 shows the generally approved type of crane girders in America which is the box section type. Each girder is composed of two web plates, universal mill top and bottom cover plates, and four chord angles running the entire length of the girder without splice.

The webb plates, you will note, are connected together at frequent intervals by diaphragm plates to prevent buckling and distortion of the girders by the bridge drive motor or gears. The

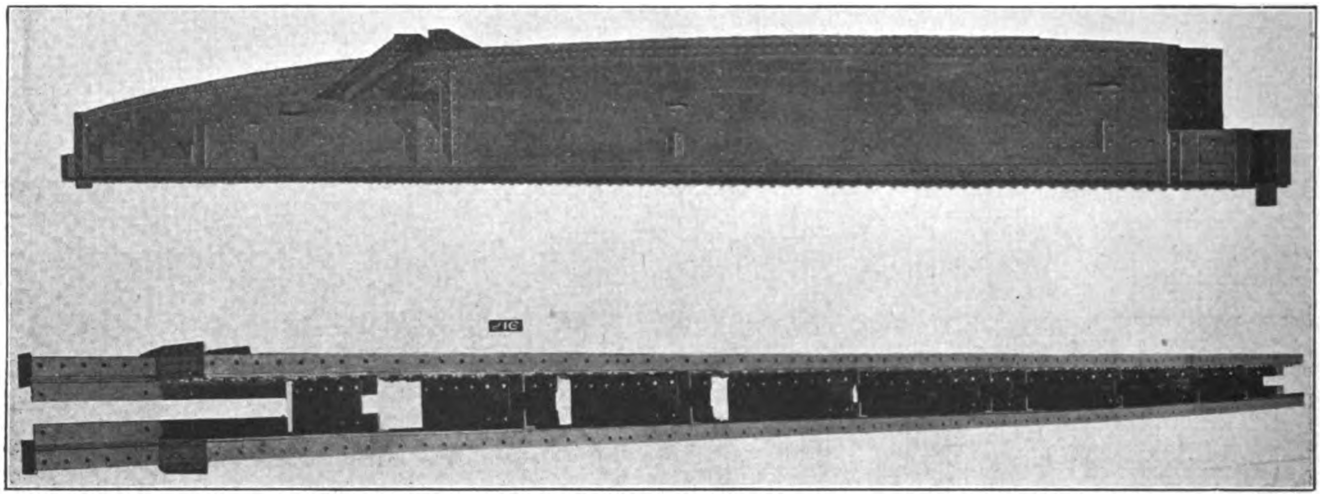

Fig. 2. Box-Section Type of Girder

All parts of the crane should be accessible for examination or repair, and each distinctive part readily removable when necessary. These parts should be compact, so as to be easily handled. To meet the foregoing demands different principles of construction have been utilized, varying with the individuality of the designer, and it frequently happens that a crane built to comply with the specifications of one department of a plant will not be accepted by another department of the same plant, though the work to be performed is identical.

time was when some builders made these separators of cast iron.

Fig. 3 shows another design of girder which has proven extremely satisfactory in use, and is known as the auxiliary braced girder. For long spans an additional vertical auxiliary brace is provided, which also serves as a hand rail for the platform, the auxiliary brace forming an ideal support for the bridge drive shafting, motors and gears, thus making active use of all the material without excessive weight.

The lattice type of girder shown in Fig. 4 is desirable in long

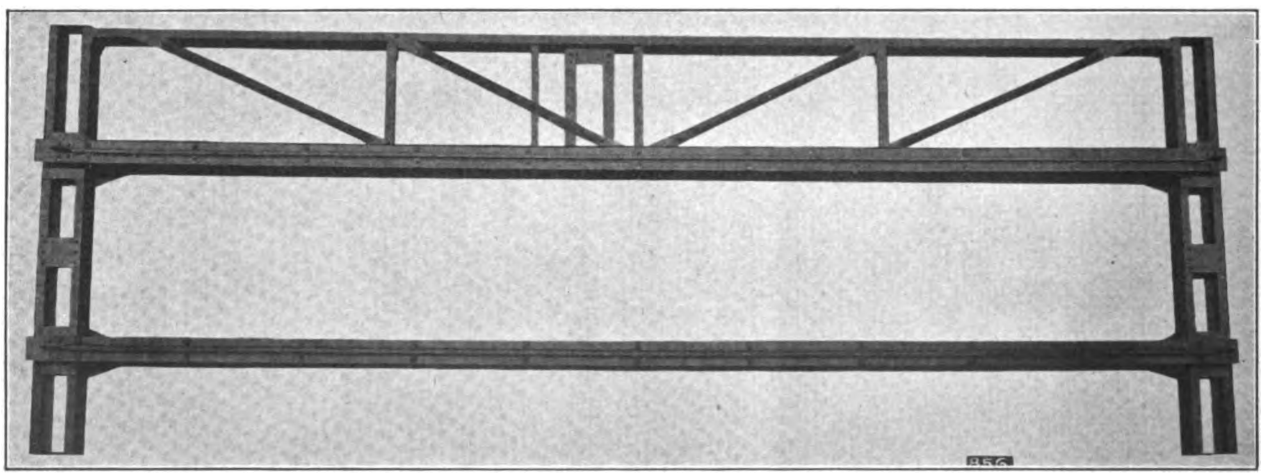

Fig. 3. Auxiliary-Braced Girder

While the construction of cranes in the different countries of Europe and the United States varies widely, the two most radically different specifications are found in the practice of some of the steel mills of America and the government of France; the one, to illustrate, specifying a battleship, the other a Ford.

Fig. 1 shows a recent installation in the new freight yards of the Pennsylvania railroad, foot of Washington avenue, Philadelphia, of a 40-ton electric traveling crane. To erect this crane a 150-ton capacity locomotive crane was used. The two bridge ends or trucks have been placed on the runway and lashed in

span cranes and makes a rigid, stiff construction, light in weight but high in labor construction cost, which has doubtless been one of the reasons why it has not become more popular in America, although introduced in this country a number of years ago. The first installation was at the American Car & Foundry Co., Detroit.

In these days of economy, conservation of power and "safety first" advocates, it would be well to pause a moment and ascertain whether the greater number of accidents are caused by the failure of the component parts of the crane in operation, or when the crane is laid up undergoing repairs. In other words, should not the scientific light weight of a crane, a moving object, receive the same careful consideration as an automobile. Does not a 6-inch angle iron toe-guard along the footwalk of a crane, specified by some users, cause more accidents than it prevents, due to the extra weight which causes wear and tear and increased repairs on the crane, thereby multiplying the possibility of accidents?

In Fig. 5 we see the reproduction of a sketch drawing showing a crane of 40-ton capacity, 152-foot span, 140-foot lift of hook. These girders are about 11 feet deep, a competitive design with box section girders, requiring a depth of about 25 feet, showing a saving of 14 feet in the height of the building for same lift of hook. In a building several hundred feet long these cranes save in the building cost alone more than the increased labor construction cost of the crane.

An entirely new feature has been introduced in the design of this crane in that all parts of the girders are active members. In the ordinary lattice girder, the inner member carries the entire weight of the trolley and its suspended load, the outer members forming an auxiliary brace. In this design, the trolley and load are carried in the center of the girder and all members bear an equal strain. These girders rest upon and should be securely fastened to bridge ends. We recommend wide gusset plate to prevent the girders from getting out of square and turned bolts in reamed holes for connecting these parts. Bridge ends are made of cast iron, steel castings or structural steel.

Originally I suppose crane manufacturers had a whaling big iron foundry, but were not so well equipped for fabricating structural steel, hence the original cast iron bridge ends with the consequent risk of failure through defective castings, due to shifting of cores, shrinkage cracks or other causes. The steel casting bridge end is an attempt to overcome these defects which are inherent in a casting of this kind and are still present in the steel casting, besides the useless excess weight that increases the wear on the motors, gears and bearings.

The cast iron bridge end allows the introduction of the M. C. B. type of truck wheel bearings, which makes a good appearance, but is of doubtful utility. In the structural steel ends, the engineer knows exactly what he has and all chance is eliminated. Failure is only possible by mistake in calculation. The dead weight is reduced to the safe minimum and the strain on the wearing parts reduced by that much. The truck wheel is held rigidly in line and cannot twist as may be possible with the M. C. B. type of bearing, due to uneven track and a larger axle bearing surface can be obtained.

The electric brake, either direct or alternating current, is similar in construction excepting the solenoids. Fig 6 shows a mechanical load brake of the double disc type with hard bronze wearing surfaces. This brake with the intermediate gears forms a self-contained unit, the parts running in oil. Where direct current is available, dynamic braking is often a desirable feature, eliminating the mechanical load brake, thereby reducing the number of wearing parts. The bottom block is of steel. The hook revolves on ball bearings. The sheaves are bronze bushed and turned to fit the rope. The bottom block is prevented from being hoisted up into the trolley by the application of a limit switch, which cuts off the current from the motor when the hook reaches the dangerous position.

The various types of limit switches are too numerous to mention, apparently having taken the place of the car coupler, of which several hundred types were brought out some 40 years ago, as any railroad master mechanic can tell you. But after all, the best limit switch is the careful, competent, conscientious crane operator.

Careful, not reckless.

Competent in that he knows how.

Conscientious in that he does not neglect his duties.

This kind of man will save dollars in maintenance by keeping the crane properly adjusted, clean and well oiled.

The engineer of maintenance in a large ship building plant called my attention to a crane the other day that had been in-

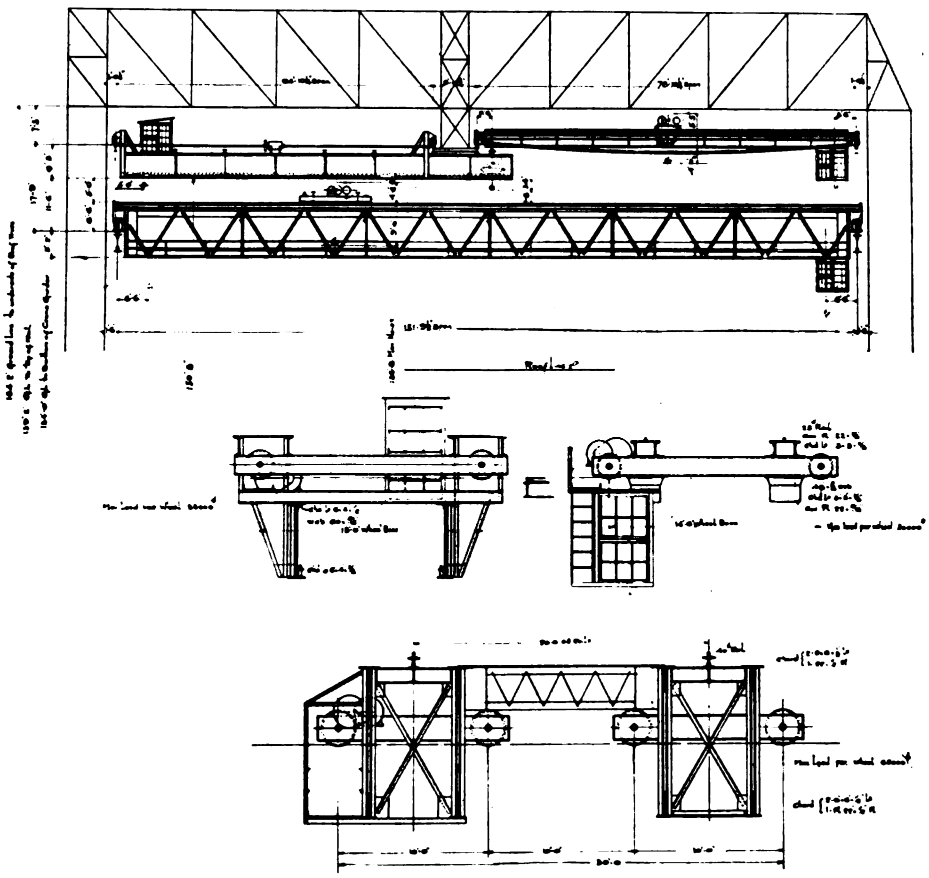

Fig. 4. Lattice Type Girder
Fig. 5. Sketch Drawing of 40-Ton, 152-Ft. Crane

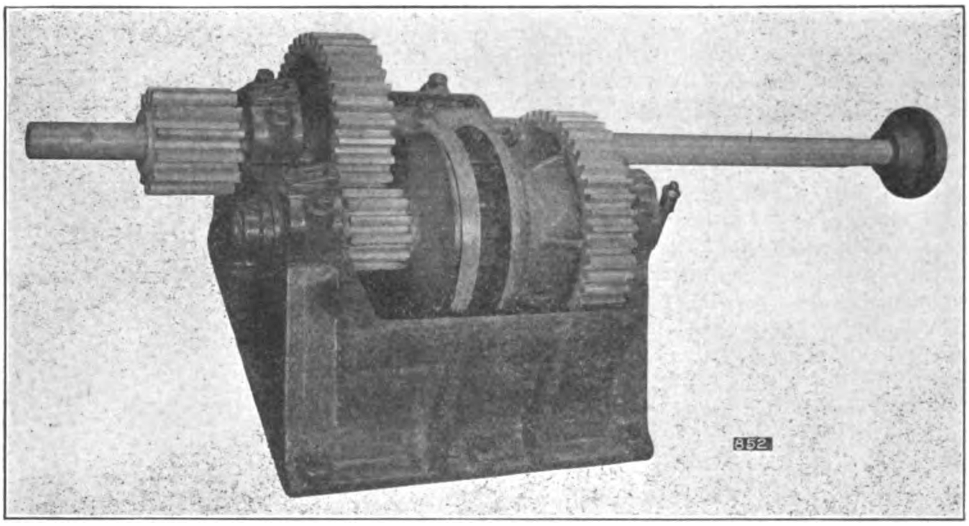

Fig. 6. Double Disc Mechanical Brake

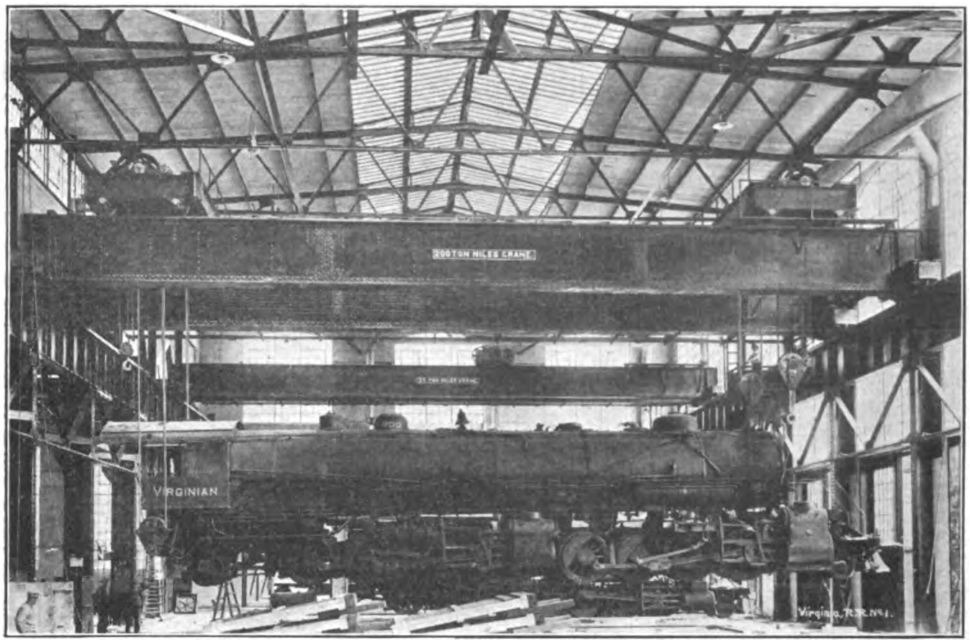

Fig. 7. Showing Cranes Operated by Alternating Current Motors

Fig. 7-A. Outdoor traveling crane

service for years—the repairs being but one hoisting rope and one motor bushing, due undoubtedly to the fact that the crane had never been neglected.

Fig. 7 is a picture of the Robbins Dry Dock, Brooklyn. These cranes are operated by alternating current motors. I would call your attention to a novel method this company uses to get variable speed on machine tools with alternating current motors. Each tool is operated by its own independent motor, coupled to a jack shaft with cone pulley, corresponding to the cone pulley on the machine tool.

Fig. 8 shows a gantry crane in the Brooklyn navy yard with 25-foot cantilever extension on each end. The vertical shafts are carried in universal thrust bearings to prevent the gears from getting out of line.

Fig. 9 shows a 540,000-pound locomotive being lifted with a 200-ton crane in the shops of the Virginian Railroad Company.

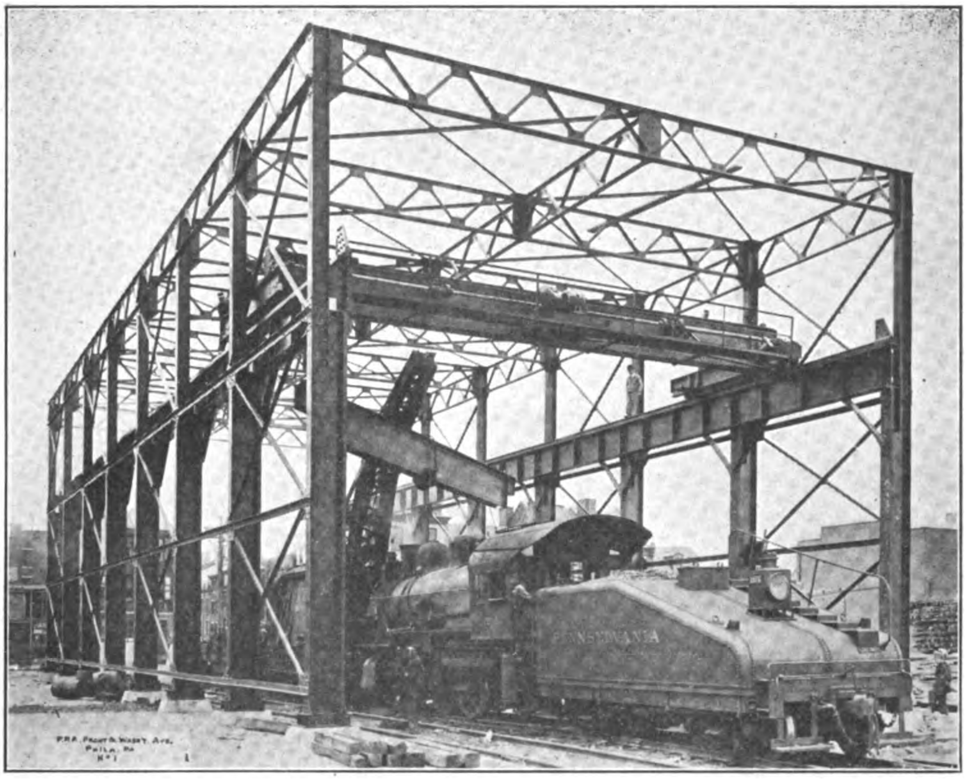

Fig. 9. 200-Ton Crane and Load

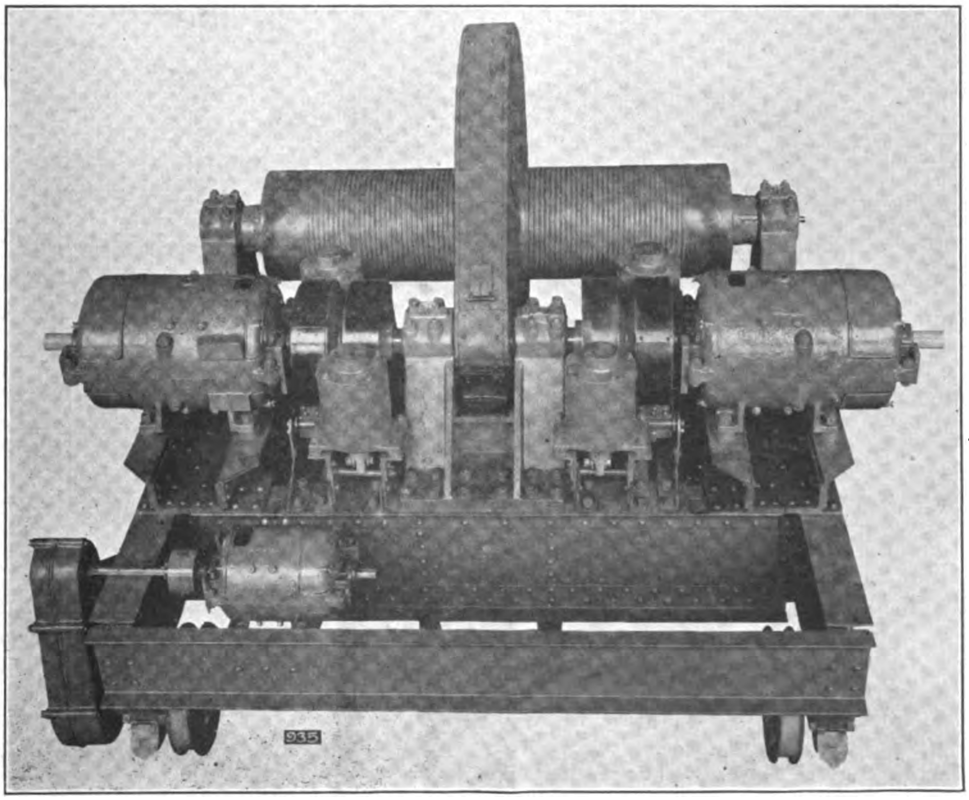

Fig. 10. Trolley for Gun-Dipping Crane

This is a special locomotive crane with 4-point suspension. Ropes lead down to the lifting beams; one for the rear end and one for the front, are fitted with a sling engaging the boiler. The trolley is of the double drum type, one trolley having an auxiliary hoist. This locomotive is advertised as being the most powerful locomotive in the world and is of the type used in hauling coal from the Virginian mountains to the coast for the U. S. Government.

Fig. 10 shows a novel trolley for a gun-dipping crane. Note the simplicity of design. The framing is of structural steel; the hoist is operated by two 100-horsepower motors, geared direct to the drum; the gear is enclosed in a welded steel case. The load is sustained by four electric brakes and controlled by dynamic braking. The steel gear is about 12 feet in diameter. This trolley is of 60,000 pounds capacity and lowers the gun forging into the oil bath under complete control at a speed of 180 feet per minute.

The electric brake is of the solenoid type. The holding power is obtained by the weight of the plunger, which is inside the magnet coil. This plunger is attached to the far end of the brake lever. On the opposite end of the brake lever, adjacent to the fulcrum, is attached a lined steel brake band which nearly surrounds the entire circumference of the turned steel brake wheel, and the holding power is the friction or grip of the band on the wheel.

For all practical purposes no differences can be observed in the operation of the crane, whether alternating current or direct current is used.

The regulation of the speed on the alternating current crane has been perfected to such an extent that it can be satisfactorily used in all classes of work, including setting cores, lifting the copes or pouring hot metal in a foundry.

The main difference between the direct current and alternating current crane is that the direct current motor is series wound and the speed of the crane increases with the decrease of the load, while with the alternating current crane the maximum speed is constant. For example, take a 10-ton crane with direct current motors, geared to lift the full load at a speed of 20 feet per minute. The speed of the empty hook would be approximately 40 feet per minute. The regulation of the speed is between zero and full speed in either case. On the same crane operated by alternating current motors, the maximum speed would be 20 feet per minute with full load or empty hook and the regulation would be between zero and this maximum speed. You will note, therefore, that it is possible to operate the direct current crane with light loads at a higher speed than is the case, with alternating current motors. This, however, is seldom required as the maximum speed is rarely used in ordinary operations.

The alternating current crane has one inherent safety feature not found in the crane with direct current motors, in that the motor is built with a pre-determined fixed torque and a heavier load than this maximum tornque will handle cannot be lifted, whereas, with the series would direct current motor there is no limit to the load it will attempt to lift and if excessively overloaded the motor will burn out provided some part of the hoisting mechanism does not fail.

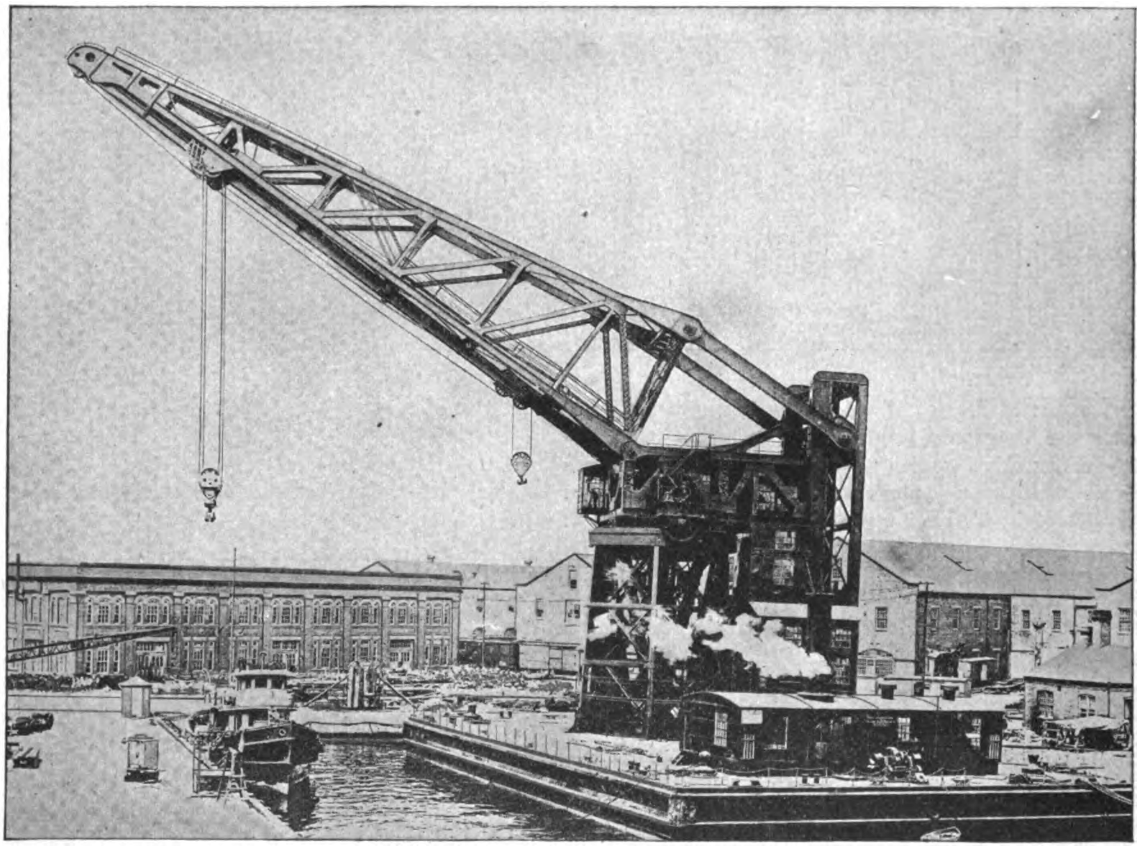

Fig. 8. Gantry Crane

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SAVING FUEL

Manufacturers of incandescent electric lights, by agreeing to limit the production of lights having carbon filaments, have made possible a saving of 1,000,000 tons of coal annually, the Fuel Administration has announced.

More efficient types with metallic filaments, will be substituted, except for a few services where the old-style product is made necessary by the conditions. In this respect, however, war tim econditions only accentuate a state of affairs that has been apparent to all electrical men for the last 10 years.

ELEMENTS *of* ILLUMINATING ENGINEERING

This installment, says the General Electric Review, by courtesy of whom this series has been republished, which concludes the series, shows how the principles and data of the previous installments are applied to the solution of actual lighting installations. Four problems are worked out, covering the lighting requirements of four different kinds of establishments. A careful study of the series should enable the engineer to design a lighting system for almost any service that will provide satisfactory illumination and accord with the best practice.

Problem 1—Office Lighting

It is desired to install a modern lighting system in a large general office of which the floor plan is shown in Fig. 1. It will be noted that a row of columns 10½ feet apart extends lengthwise down the center of the room. The problem is to be solved on the basis of the following data:

Dimensions:

Width	29 feet
Length	105 feet
Ceiling height	15 feet

Color of ceiling—very light cream
Color of walls—greenish grey, medium

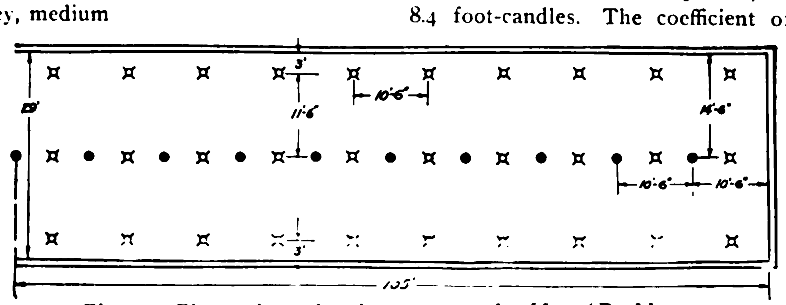

Fig. 1. Floor plan of a large, general office (Problem 1.

It will be noted that the room is long with respect to its height and a large number of the persons occupying the room will, therefore, be forced to have lighting units within the visual field a greater part of the time. For this reason the lamp filaments must be completely screened from view. This conclusion together with the light cream ceiling and greenish-grey walls at once suggests the use of indirect or semi-indirect units. Totally indirect units possess the advantage that their use in their office would insure an almost complete avoidance of glare. On the other hand, *dense* semi-indirect units are equally satisfactory and were chosen for this particular office.

Table I gives 4-8 foot-candles as satisfactory intensities for office lighting. In view of the fact that in this office lighting is required for a considerable portion of the day, an intensity of 7 foot-candles will be used as the basis for solution. This intensity, however, must be increased somewhat to offset the decrease due to lamp depreciation and dust collection on the units. A depreciation factor of 1.20 can be used satisfactorily in this case; the installation must provde, therefore, an initial intensity of 8.4 foot-candles. The coefficient of utilization for dense opal semi-indirect units used in the office in question is found from Table II[2] as follows:

$$\text{Ratio, } \frac{\text{Room width}}{\text{Ceiling height}} = \frac{29}{15} = 1.93 \text{ (Use 2)}$$

Example of a well-lighted store

Coefficient of Utilization = 0.31.

$$\text{Ratio, } \frac{\text{Room length}}{\text{Ceiling height}} = \frac{105}{15} = 7 \text{ (Use 5)}$$

Coefficient of utilization = 0.42.

Hence, not less than two rows of 10 units each, spaced 10½ feet lengthwise, of the room, are required. Since the units must furnish 75,200 lumens, each of the 20 units must supply 3,760 lumens, and reference to Table IV shows that the 300-watt Mazda C lamp is required. An alternate spacing plan which suggests

Another example of a well-lighted store

Final coefficient = 0.31 + 1/3 (0.42—0.34 (+)

The total number of lumens which must be supplied is now to be

$$\frac{8.4 \times 29 \times 105}{0.34} = 75,200$$

By use of the spacing ratio given for semi-indirect units in

itself is to use three rows of units spaced 12½ feet apart lengthwise and 11 to 12 feet crosswise of the office. This calls for 30 units, and if 200-watt lamps are used the power requirement will be the same as with the previous arrangement. Notwithstanding the fact that the installation of the 30 units necessitated a greater cost of installation, this arrangement was adopted, first, because it brings the outlets more nearly in squares, and second,

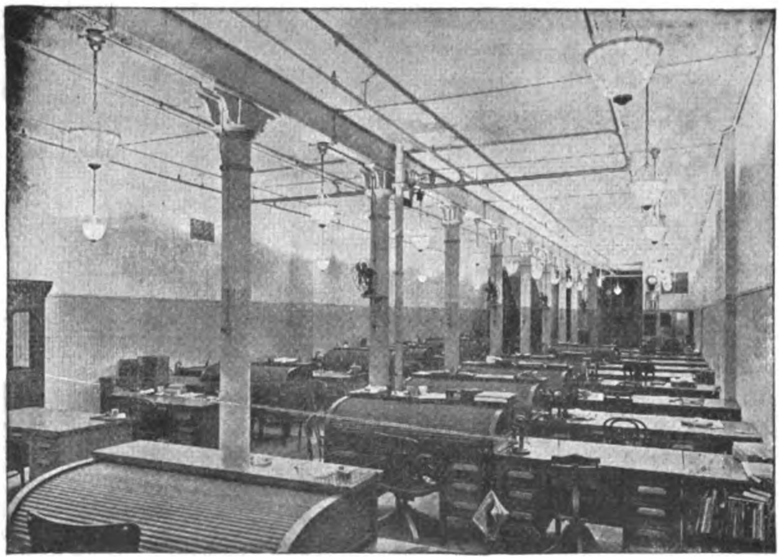

Fig. 2. Solution to office lighting problem (Problem 1.)

Table III, the maximum allowable spacing is found to be 18¾ feet. As has been pointed out, it is always advisable in placing outlets to consider the location of columns with respect to the possible future subdivision of the area. In this office it was thought very desirable to have the installation symmetrical with the columns, at least in the direction lengthwise of the room.

because of the fact that the brightness of the semi-indirect bowl selected—and hence the liability of eyestrain—is considerable less with the 200-watt lamps. The outlets were located as shown in Fig. 1.

This example illustrates the points previously brought out, that permissible spacing distances as calculated from Table

III should be regarded as maximum spacing distances and that closer spacings do not detract from the uniformity of illumination and can frequently be used to advantage.

The distance at which the units should be suspended from the ceiling is determined by the appearance of the ceiling; spotty effects should in general be avoided. Usually a suspension distance equal to from one fourth to one third the spacing distance is satisfactory.

Fig. 2 shows the ligting system described in operation.

Problem 2—Store Lighting

It is desired to light the main floor of a large clothing store located in the principal business section of a large city. The floor plan of the store is shown in Fig. 3. A mezzanine floor extends around the entire main floor and for their reason and for the reason that high cases line the walls, little of the light striking the walls will assist in illuminating the store proper. Although the walls are finished in a light color they must, therefore, be considered "dark" for purposes of calculation. The basic data are as follows:

Front portion of store
- Width 60 feet
- Length 78 feet

Rear portion of store
- Width 55 feet
- Average length 55 feet
- Ceiling height 16 feet
- Color of ceiling—light cream
- Color of walls—"dark"

For this installation the store management has been favorably impressed with the appearance of opal enclosing units of ornamental design, and such units are accordingly chosen, bearing in mind the importance of securing an opal which while "light" as regards absorption, will diffuse the light thoroughly.

By reference to Table I it is seen that the intensity suitable between 7 and 10 foot-candles. A value of 8 will be taken as a desirable working value. This value multiplied by a depreciation factor of 1.20 gives 9.6 foot-candles as a desirable initial value. The coefficient of utilization is found in the usual way to be approximately 0.38. The total area of the store is 7,705 square feet; hence the total lumens which must be generated initially are

$$\frac{9.6 \times 7{,}705}{0.38} = 194{,}600.$$

It will be noted from the floor plan shown that the ceiling is divided by beams into 21 bays. A desirable location of units would be a single unit at the center of each of these bays with perhaps no unit in the one small triangular bay formed by the angle of the building. The bays average approximately 20 feet square, hence the spacing of the units would be about 20 feet. It is seen from Table III that a 20-foot spacing of totally enclosing units calls for a mounting height of 12 feet for uniform illumination. The distance between the ceiling and the working plane is in this store 13 feet and enclosing units can therefore be used.

Since 20 units are to supply 194,600 lumens, each unit must generate 9,730 lumens—more than the 500-watt lamp will sup-

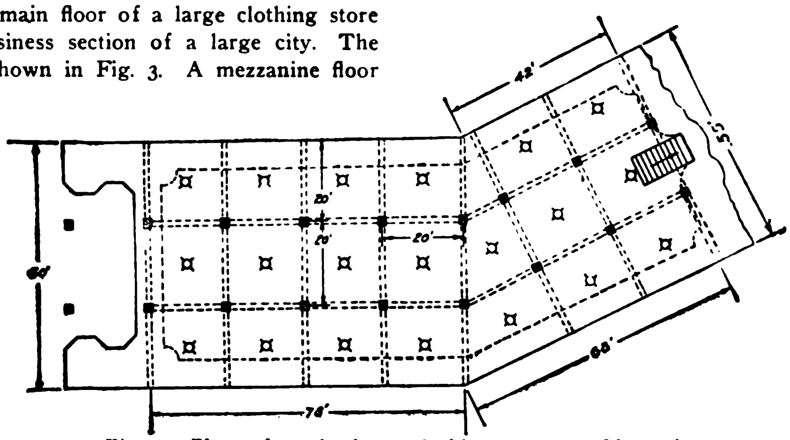

Fig. 3. Floor plan of a large clothing store (problem 2.)

Fig. 4. A well-lighted clothing store (problem 2.)

ply and less than the 750-watt lamp will furnish. From the standpoint of good vision it is unquestionably true that 500-watt lamps would provide sufficient illumination (about 6.6 foot-candles) and would ordinarily be used, but in this case the management attached very decided importance to the advertising value of a high intensity and installed 750-watt Mazda C lamps.

The installation discussed is shown in Fig. 4. It will be noted that the units were, from considerations of appearance, dropped a somewhat greater distance from the ceiling than the calculation called for. Although this mounting involved a sacrifice in uniformity, the fact that a high intensity was used gave assurance that at all points the illumination would be adequate. It will be noted from the photograph that the units are of very large size and hence their brightness is of a sufficiently low order so that it does not interfere with good vision.

Problem 3—Industrial Lighting

It is desired to light furniture factory. The greater part of the work can be classed as fine woodwork. Fig. 5 shows the floor plan. It will be noted that work benches line three sides of the room.

For this installation the dome-shaped procelain-enameled steel

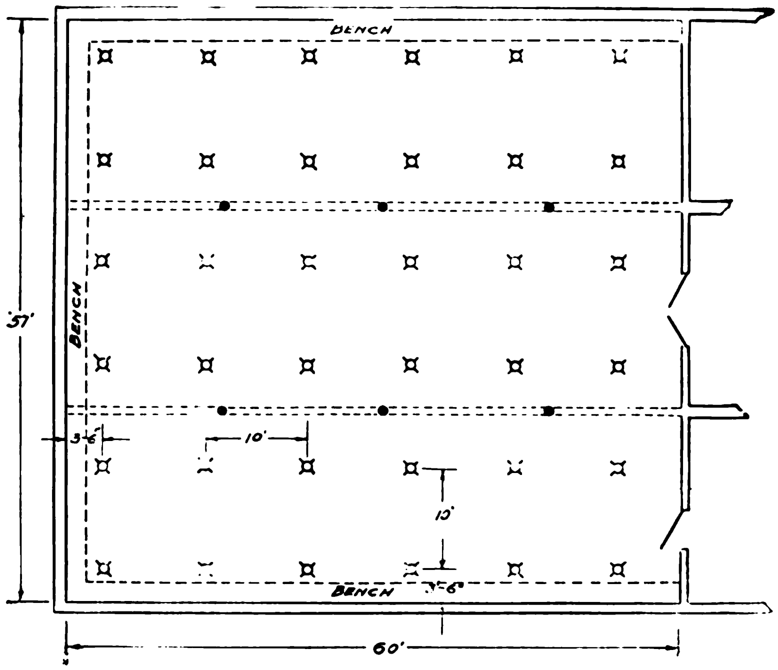

Fig. 5. Floor plan of a furniture factory (problem 3.)

reflector is selected, for it is efficient, durable, and provides a desirable distribution of light. The diffusion of light which it affords is entirely satisfactory for a woodworking plant. The following data are to be used as a working basis:

Fig. 6. Lighting installation over benches (problem 3.)

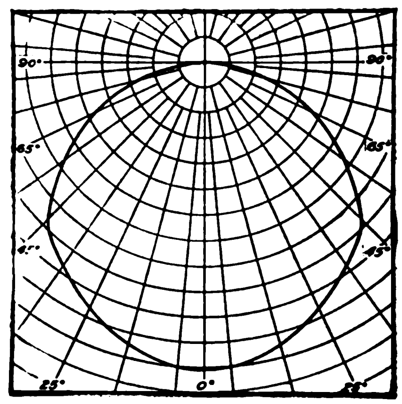

Fig. 8. Distribution curve of metal-cap diffusing unit. (problem 3)

Dimensions:
- Width 57 feet
- Length 60 feet
- Ceiling height 12 feet

Coloring of ceiling—white
Color of walls—white

Table I gives 4-8 foot-candles as satisfactory intensities for fine work. In contrast with the metal trades, the surfaces work-

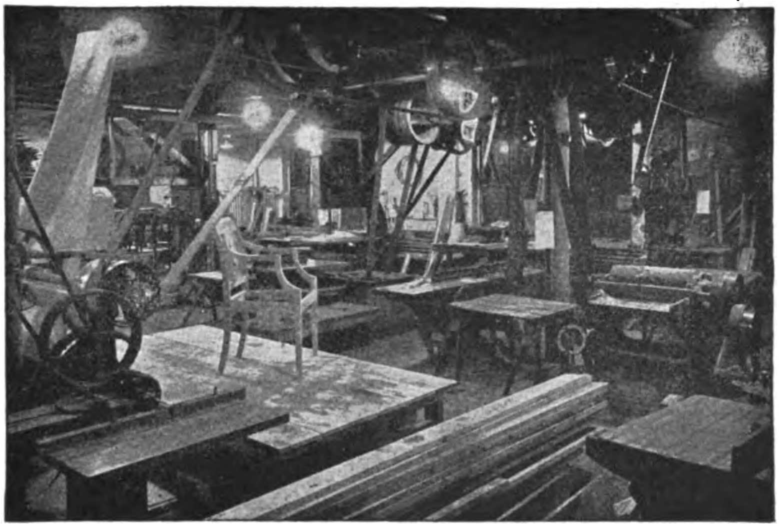

Fig. 7. Illumination of woodworking plant (problem 3)

ed upon have for the most part of a fairly good reflection factor, and therefore should appear sufficiently light under an intensity of 5 foot-candles. Particles of sawdust are carried about by the air in woodworking shops and although light in color collect rather heavily on the lighting units. For this reason the desirable intensity is multiplied by a depreciation factor of 1.30 to insure that the average intensity will not fall below the desired value. This gives an initial working intensity of 6.5 foot-candles. The coefficient of utilization for dome-shaped porcelain-enameled steel reflectors for this particular room is found from Table II to be 0.69. The total generated lumens necessary to produce an initial intensity of 6.5 foot-candles on the working plane are

$$\frac{6.5 \times 60 \times 57}{0.69} = 32{,}200 \text{ lumens.}$$

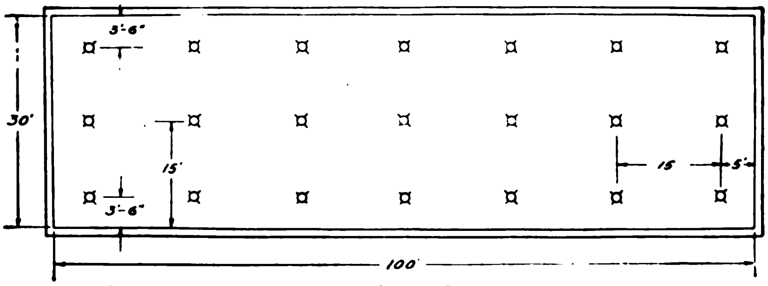

Fig. 9. Floor plan of metal-working plant (problem 4)

Table III gives 1 2/3 as the maximum spacing ratio for dome-shaped steel reflectors. In this problem the maximum mounting height above the working plane is about 8 feet. The maximum allowable spacing distance is, therefore, 13.3. The dimen-

Fig. 10. Installation of metal-working plant (problem 4)

sions of the room allow a symmetrical arrangement of 5 rows of 5 units each spaced on approximately 12-foot centers. However, since it is desirable to provide a system more nearly symmetrical with respect to the bays, and since a row of units should be provided over each of the benches which line three sides of the room, it will be better practice to install 6 rows of 6 units each, locating one row 3½ feet from each of the three walls along which the benches are placed, as shown in Fig. 5, and spacing the remaining units at 10-foot intervals in rows 10 feet apart. With this arrangement 36 units are required. If 36 units are to generate 32,200 lumens, each Reference to Table IV shows that the 75-watt Mazda C lamp will supply 865 lumens and should insure adequate illumination. Bowl-frosted lamps are necessary to minimize glare.

The photographs reproduced in Figs. 6 and 7 show the installation described in this problem

Problem 4—Industrial Lighting

It is desired to light an industrial plant manufacturing tools and other similar metal parts. In order that glare shall be avoided, and that shadows shall not be objectionable, the metal-cap diffusing unit shown in Fig. 10, in the September issue, will be used. Since this unit is only available for use with 75, 100, 150, 200 and 300-watt Mazda C lamps, the choice of lamp size is limited to a cetrain extent.

The following data are given as a working basis:

Dimensions:

Length	100 feet
Width	30 feet
Ceiling height	15 feet

Color of ceiling—light

Color of walls—medium

Table I gives 4—8 foot-candles as satisfactory intensities for metal-working plants. In this case an intensity of at least 6 foot-candles is desirable. This value is multiplied by a depreciation factor of 1.25 to offset the decrease in illumination certain to result from lamp depreciation and dust collection, and the initial desirable intensity becomes 7.5 foot-candles.

This metal-cap diffusing units is a special rather than a general type, and hence it is not listed in Table II. However, it gives about the same proportion of the total light—60 percent.—in the lower hemisphere as does the semi-enclosing unit, and as may be seen from Fig. 8 its distribution curve is, in general, similar to that of the semi-enclosing unit below the horizontal, although the latter unit gives higher candle-power values near the horizontal. Since with dark walls and ceiling light given off near the horizontal and above has, in industrial plants, little effect on the illumination of the working plane, the coefficient of utilization applying to semi-enclosing units for rooms with dark ceiling and walls can always be used safely for the metal-cap diffusing unit. The spacing ratios applying to the semi-enclosing unit can also be used. From the data given in Table II, the coefficient of utilization to be used is found in the usual way to be 0.38. The total generated lumens required are then

$$\frac{7.5 \times 30 \times 100}{0.38} = 59{,}200 \text{ lumens.}$$

The maximum allowable spacing distance is found from Table III to be 1½ times the hanging height. The maximum height at which units can be mounted above the working plane is about 11 feet. Hence, the maximum allowable spacing distance is 16.5 feet. The dimensions of the room permit the use of two rows of 6 units each or a total of 12 units, but 12,300-watt Mazda C lamps—the largest size which can be used with available metal-cap diffusing units—will not give a sufficiently high intensity of illumination. Morever, the location of work benches along the side walls makes desirable the location of a row of units over each of the benches at a distance of 3½ feet from the walls. If two rows of units were so located, the distance between the rows would exceed the allowable spacing distance; hence it is desirable to install three rows of units, one over the two rows of work benches at a distance of 3½ feet from the center of the room. Such an arrangement calls for a distance of 11½ feet between rows. Since in this problem the distance between units in a row lengthwise of the room is limited only by the allowable spacing distance, a spacing of approximately 15 feet will provide uniform illumination and will provide an arrangement of units reasonably near square Such spacing will require 7 units per row or a total of 21 units in all, as shown in Fig. 9. To provide 59,200 lumens, each unit must provide 2,820 lumens. Reference to Table IV shows that the 200-watt Mazda C lamp supplies 2,920 lumens, and will therefore provide adequate light for the problem at hand. The installation is shown in Fig. 10.

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INSULL ON DAYLIGHT SAVING

The seven months daylight saving schedule means a saving of about 300,000 tons of coal, said Samuel Insull at a recent meeting of the Electrical Development League of San Francisco. He then went on to say that the chances are that the all-the-year-around daylight saving schedule would not save much more coal, probably not more than 100,000 to 125,000 tons more.

The annual loss in gross income to the electric companies under the present law is upwards of nine and a half million dollars and the saving in fuel, being the only saving, is about $900,000. The net loss to the companies is somewhere around eight and a half million dollars. Now, if the change in time were made continuous all the year around, upwards of 400,000 kilowatts of capacity would be released, and somewhere around 150 to 200 millions of dollars of capital now employed would be ,so to speak, released because, on the whole, the 400,000 kilowatts released by the change in the winter peak could be sold for supplying energy to aboslutely necessary industries. The saving in the fixed charge, if a very large amount of additional business could be taken on without increased capital investment, would be from eight to ten million dollars.

Such a scheme put into effect would distinctly conserve between 150 and 200 millions of dollars and would immediately place at the disposal of the Government 400,000 kilowatts of capacity which cannot be found at this time in any other way.

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THE TONNAGE PUZZLE

The use of election drive to propel ships is a reminder that but few electrical men know what is meant by "tonnage." A contemporary discussing this subject says that deadweight tonnage is what the vessel actually can carry in tons of heavy cargo, plus stores and bunker coal. Gross tonnage is based on the cubic contents of the hull, with certain arbitrary spaces deducted; accordingly it has little bearing upon the cargo-carrying capacity. Net registered tonnage is gross tonnage with further deductions on account of crew space and machinery space, and again has little bearing upon the dead-weight figures. Finally, the displacement is the total weight of the vessel when full of cargo, and accordingly represents the weight of her hull plus her deadweight tonnage. These two itms can at least be made to appear reasonable to the most hopelessly non-technical mind by thinking of the hull—the ship herself—as live tonnage; displacement is then live tonnage plus the dead tonnage which can be piled onto the vessel.

In round numbers a ship of 9,000 tons deadweight would have a gross tonnage of 5,000 and a net registered tonnage of 3,000; she would displace 12,000 tons of water when fully loaded, so that figure represents her displacement.

ELECTRIC POWER FOR NITROGEN FIXATION

By E. Kilburn Scott

Method of Making Nitric Acid

One method of producing nitric acid from air which I call the *indirect* method, said the author of this article at the recent convention of the American Institute of Electrical Engineers, is first to make carbide of calcium, then treat it with nitrogen to form calcium cyanamid, from which ammonia and in turn nitric acid are obtained.

Another method is the *direct* which, consists in combining nitrogen and oxygen of the air directly in the electric arc to form nitric acid.

Those interested in the indirect method have drawn comparisons between it and the direct electric arc process, with the object of showing that the indirect is the better. A tabular comparison of the operations involved in the two processes should thus prove of interest, since it is the only way in which a fair comparison can be made.

It is frequently stated that the amount of electric energy required for a given quantity of nitric acid produced by the indirect process, is less than that required by the direct, and this is put forward as a strong argument in favor of the indirect method. The only way to compare two operations is to take into account *all* the factors which go to make up the total cost, and appraise each one at its proper value.

	INDIRECT METHOD Employing Calcium Cyanamid to Make Ammonia and Oxidising the Ammonia to Acid by a Catalyst	DIRECT METHOD Employing the Arc Flame Furnace Only
Factories	1. To make calcium carbide.	1. To make nitric acid.
	2. To make cyanamid.	
	3. To make nitic acid.	
Operations	1. Burning limestone.	1. Blowing air through electric arc flame to produce nitrous gases.
	2. Grinding lime.	2. Absorption of gases in towers to produce acid.
	3. Grinding coke or anthracite.	
	4. Mixing lime and carbon in correct proportions.	
	5. Making calcium carbide in electric furnaces.	
	6. Grinding carbide to fine powder in neutral atmospheres.	
	7. Making liquid air to produce nitrogen.	
	8. Packing calcium carbide into retorts.	
	9. Making calcium cyanamid by adding nitrogen and by use of electric resistors.	
	10. Emptying cyanamid from retorts.	
	11. Grinding cyanamid to a fine powder.	
	12. Hydrating cyanamid to rid it of carbide.	
	13. Making superheated steam.	
	14. Treatment of cyanamid with steam in autoclaves to produce ammonia.	
	15. Oxidation of ammonia to produce weak nitrous gases by means of a catalyst.	
	16. Absorption of gases in towers to produce acid.	
	INDIRECT METHOD	DIRECT METHOD
Raw Materials	1. Lime	1. Air.
	2. Coke	2. Metal electrodes
	3. Carbon electrodes in carbide furnaces.	3. Water.
	4. Carbon resistors in cyanamid retorts.	
	5. Pure nitrogen.	
	6. Superheated steam.	
	7. Air.	
	8. Water.	
Electric Energy for	1. Carbide furnaces.	1. Arc flame furnaces.
	2. Grinding carbide.	
	3. Cyanamid retorts.	
	4. Grinding cyanamid.	
	5. Heating catalyst. naces.	
	6. Motors for power, etc., including several cranes.	
Skilled Labor for	1. Carbide furnaces.	1. Arc flame furnace.
	2. Cyanamid retorts.	2. Absorption plant.
	3. Packing cyanamid.	
	4. Grinding machinery.	
	5. Making pure nitrogen.	
	6. Making ammonia.	
	7. Catalytic process.	
	8. Absorption plant.	

If two processes are to be compared as regards one factor only, then it may with equal justice be claimed that the electric energy represented by a few motors and lights required for a plant making acid from sodium nitrate, is less than the electric energy required by all other processes for making acid. Such a statement does not prove anything, and yet it is similar to the one put forward by the advocates of the *indirect* process.

Obviously the cost of plant using the indirect method, will be very much greater than that in the case of the direct, for if we assume that the cost of a carbide furnace and its accessories is about the same as that of an air nitrate furnace with its accessories, then, the indirect process embraces in addition:

1. A complete plant for making cyanamid.
2. A liquid air plant for making pure nitrogen.
3. Powerful machinery for grinding the carbide and the cyanamid.
4. Steam boilers and autoclaves for making ammonia.
5. A complete catalytic plant for oxidizing the ammonia to nitric acid.

n the indirect method it is essential to have all the materials, gasses, etc., absolutely pure, for example at the cyanamid works at Odda in Norway it was necessary to carry a pipe up the mountain side so as to ensure supply of pure air to the liquid air plant.

When carbide is converted into cyanamid some of the former remains, unchanged, and in order to obviate danger of explosion a special treatment of the mixture is necessary to ensure a total decomposition of the remaining carbide.

Platinum is usually employed and in order to "reactivate" it., it is necessary to subject it to an acid treatment and eventually to remelt, in which process it is impossible to avoid loss of this expensive metal.

Russia is almost the sole source of platinum and whilst our Ally, could be depended upon, today with Germany practically controlling that country,- the position is serious. The various allied Governments have had to commandeer platinum as it is essential for several war purposes. With utmost deliberation and foresight the Germans are working to control the world's storehouse of platinum in the Ural Mountains, and any processes which depend upon this rare metal are going to be very seriously handicapped. I consider that those who have had a hand in starting new processes dependent on platinum are very blameworthy. Politicians cannot be expected to know these things, but those who do not know should inform them.

By the direct method the cost of air is nil, and the cost of water is practically that of pumping. On the other hand, the materials required in the indirect method are very expensive and especially difficult to obtain at the present time. Over three fourths of the cost of working the indirect process is represented in materials liable to price fluctuation. These are now much higher than before the war, and will remain at the higher level after the war.

In the direct method less than one-fifth of the total cost is represented in materials dependent on market rates, and the principal item of cost, namely electric power, will, if anything, tend to come down in price.

The direct method is very simple to operate, whilst the indirect requires much skilled and unskilled labor, and some of the operations are dangerous to health. Therefore, the more labor demands increase, the more will the indirect method be handicapped in this respect. There are many separate links involving exact operating, to make the whole run smoothly and the slightest hitch in connection with any one link necessarily holds up the whole system.

The manufacture of cyanamid has to be carried out in retorts of relatively small size involving much labor to set up, etc. This is to enable the nitrogen gas to penetrate to all parts of the contain carbide. The times of the reaction and the cooling down, etc., are definitely fixed and it is quite impossible to work the process with off-peak power; also should there be an accident or failure of current for a time there is every chance of ruining both the cyanamid retorts and the carbide furnaces.

All nitrate processes have a military bearing as regards preparedness, in which is involved the question of transportation. The heavy and bulky raw materials necessary for the indirect process places it at a serious disadvantage from this point of view. Especially at the present time when the railways are so congested; with the direct process there is no carriage of raw materials.

The indirect process has been strongly advocated in that after the war, cyanamid will be much used as a fertilizer. On the other hand a large number of objections have been voiced against such use, as witness the following extract from a book by Dr. Brion.

"Cyanamid cannot be used with a large number of soils such as very sandy or moor soils, or with such soils as tend to become acid. Further it cannot be used for growing tobacco nor for some kinds of fodder. It is useless as a top dressing and can be applied only in dry weather when it must be plowed in at once. Cyanamid attacks the eyes of men handling it."

Whilst some of these objections may have been overcome by making the cyanamid granular, and probably also some of them are over-emphasized, it still remains true that cyanamid is by no means as good a fertilizer as nitrate.

The effect of the calcium in calcium cyanamid in the presence of moisture is to cause the revision of phosphoric acid and therefore it can only be used in limited quantities in a combined fertilizer.

In a legal action in the State of Maine between the Armour Fertilizer works and Ellis Logan, in April, 1916, there was sworn testimony that calcium cyanamid destroyed a crop of potatoes and that not more than 60 to 70 lbs. of it should be used per ton of fertilizer. I believe that is only one specific instance of the general situation.

Electric Power

As a basic load for a power house the direct are process presents the advantage that it can be established anywhere, because the raw materials being only air and water, considerations of transportation do not enter into the situation.

It is particularly suitable for off-peak or off-season loads, for there is no fused material to solidify, and little to deteriorate in case of stoppage. Some of the furnaces can be switched on and off like an arc lamp, without detriment to brickwork or structural details, or to the process of manufacture.

As there seems to be some doubt as to the possibility of running arc furnaces intermittently on a commercial scale, I would mention that about seven years ago a nitric acid factory was built at Legano, Italy to utilize 10,000 horse power, especially during the night. Of course this plant has been considerably extended, especially since the war. I am also credibly informed that in Germany there is very large arc process plant working with off-peak power. At any rate there is no difficulty in doing it, whereas it is impossible to work intermittently with any other method of fixing atmospheric introgen.

In some ways, it is an advantage to run a plant for 8000 or less hours per year, instead of the full number, because the spare time can be conveniently used for renewals and repairs. Less spare plant is thus required and the plant can be operated by two shifts of men.

Because the plants in Norway are very large and only use hydroelectric power, a mythology has grown up, that the arc flame process can only be worked commercially on a very large scale, and with water power. As a matter of fact it is well worth while to build plants of 10,000 kw.

As a matter of fact hydroelectric power may be a disadvantage because of its distance from industrial centers for either the factory has to be placed in an out of the way position or else the power has to be transmitted over a long transmission line. I am of the opinion that electrochemical factories should be placed near the power supply, and the ideal position is alongside the power house especially if off-peak power is used.

In a national emergency it is surely better to bring into immediate use all the surplus equipment that already exists, than to start building new power houses, whether hydraulic or steam, and seeing that the direct-arc flame process is suitable for working with off-peak, I suggest that a number of nitrate plants be forthwith erected at existing power houses.

By erecting say, ten or more nitrate plants of say 10,000 kw. each at power houses in places near where nitrates are required there would be considerable saving in transportation; early deliveries of nitrate could be made. Further there would be less risk of temporary interruption of supply in case of accident or sabotage.

As a matter of fact there are power houses which could easily spare more than 10,000 kw. for over 20 hours a day and through the week end. Also there are power houses fully equipped with steam plant which are now standing idle. In the present crisis they might just as well as brought into use even if the cost of generation is high.

In some power houses the load factor might be doubled and this would have the immediate effect of reducing costs but there has been far too much shilly shallying consideration given to questions of cost. With U-boats on the high seas trying to stop supplies of Chil enitrate, the railways congested with traffic and electrical engineering works marking ammunitions, what is the use of discussing power costs. The thing to do is to jump in and make full use of plants already installed.

Recently much has been heard of the suitability of Muscles Shoals, Alabama, as a site for the manufacture of nitrates because of the water power which is being developed there, but it will take at least four years to complete these hydraulic works. In the meantime a large steam power house is being built in order that the cynamid process may be put in to early operation. This includes a 60,000-kw. turbo generator and should anything happen to it the nitrate plant would be stopped as the various steps of the indirect cyanamid process are so interlocked.

Viewed from this standpoint it would seem to be better in every way to have the manufacture of indispensable materials for explosives manufactured in a number of smaller plants, in widespread centers and by other processes than the indirect.

Coke Oven and Nitrate Plants

At the present time ammonium nitrate is required in very large quantities for burster charges for shells, torpedoes, mines, grenades, etc. This is made from two components, viz., nitric acid and ammonia, both of which are difficult to transport, the first because it is a corrosive acid and the second because in every ton of aqua ammonia there are about 2½ tons of water. An industrial process capable of furnishing electric energy as well as a supply of ammonia would be ideal, and it so happens that this is the case with a regenerative coke oven plant Half the total gas made is available and this can be easily turned into electric energy whilst at the same time the nitrogen contained in the coal provides the right amount of ammonia necessary to combine with the nitric-acid made from the electric energy by the arc flame process.

In order to show what can be done with a coke oven plant the following particulars will be of interest. I take a Koppers type of oven as being the best known.

Quality of Coal	Ton per charge	Hours coking time
Low volatile coal	13½	18
Mixture containing 80 percent. high volatile 20 percent. low volatile	12½	16½
High volatile coal	11½	15

A battery of ovens varies in size but we may as well take a round number of 100 for which the average yields are as follows:

Number of ovens	100
Tons of coal per oven	12½
Hours coking time	16
Total yield of coke	72 per cent
Yield small coal and breeze	5 per cent
Net yield good coke	67 per cent
Ammonium sulphate per ton of coal	25 lb.
Reckoned as ammonia per ton of coal	6½ lb.
Tar per ton of coal	9 gal.
Light oil per ton of coal	3 gal.
Total gas per ton, of coal	11,000 cu. ft.
British thermal units	550 per cu. ft.
Surplus gas	55 per cent
Surplus gas per ton of coal	6,000 cu. ft.

Such a battery of ovens, each of which distils 12½ tons of coal in 16 hours, will deal with

$$\frac{100 \times 12.5 \times 24}{16} = 1{,}900 \text{ tons per day}$$

Assuming 6000 cu. ft. of surplus gas per ton of coal and 550 B.t.u. per cu. ft. the total heat value per hour will be

$$\frac{1900 \times 6000 \times 550}{24} = 260{,}000{,}000 \text{ B.t.u.}$$

If employed in gas engines using 13,000 B.t.u. h.p-hr. the power will be

$$\frac{260{,}000{,}000}{13{,}000} = 20{,}000 \text{ h. p., or say, } 14{,}000 \text{ kw.}$$

If steam boilers and turbines are used instead of gas engines the power will be less so to be on the safe side, we will take the round figure of 10,000 kw.

We will also assume that electric furnaces utilizing 10,000 kw. for a whole year, can produce 6,3000 tons of 100 percent. acid. Nitric acid capable of furnishing theoretically 8000 tons of ammonium nitrite as indicated below:—

	NH_3 +	HNO_3 =	NH_4NO_3
Molecular weights	17	63	80
In short tons	1700	6300	8000

Allowing 24 lbs. of sulphate of ammonia or 6½ lb. of ammonia per ton of coal, a total consumption of 1900 tons of coal per day should give.

$$\frac{1900 \times 365 \times 6.5}{20{,}000} = 2250 \text{ tons per annum}$$

It will thus be seen that there is plenty of ammonia to combine with the acid made by the surplus gas, even if a higher yield of acid is allowed per kw-yr. and more power is generated.

I purposely leave out of discussion, questions as to types of nitrogen fixation furnaces and of yields obtained. I may say, however, that it is not right to assume that yields are limited to those usually obtained from certain well known furnaces which must of necessity work with single-phase current.

The amount of ammonium nitrate will be less than the theoretical figure because the efficiency of the reaction is not 100 percent., also it is usual to convert a certain amount of the gas into sodium nitrate-nitrite. A safe figure would be 7000 tons and at this rate it can be shown that with electric energy at 5 mils per kw-hr. and ammonia at 13c. a pound, the ammonium nitrite can be made at less than half the price the Government is now paying.

In order to show how large a business the nitrogen industry has become, the following figures (compiled by Dr. Jaul J. Fox) give the nitrogen balance sheet for the United States for 1917.

IMPORTED SUPPLIES

	Tons of 2,000 lb.	Tons of Nitrogen
Chile Saltpetre 95 percent. $NaNO_3$	1,742,540	272,880
Ordinary saltpetre, potassium nitrate	4,609	645
Ordinary saltpetre and gunpowder containing 75 percent. KNO_3	1,500	210
Ammonium sulphate	8,135	1,725
Ammonium chloride	1,073	280

Domestic Supplies

Coke oven ammonia—NH_3..........	113,760	93,625
Gas works ammonia—NH_3..........	12,500	10,288
Calcium cyanamid percent trogen	12,800	10,534

Nitrogen Exported

	Tons of 2,000 lb.	Tons of Nitrogen
Nitric Acid, 15 percent. nitrogen....	486	73
Picric Acid, 18 percent. nitrogen....	26,610	4,790
Dynamite, 12 percent. nitrogen......	8,962	1,255
Gunpowder and smokeless powder, 13 percent. nitrogen...........	223,270	29,025
Ordinary saltpetre.................	875	123

In addition to the above, there are also about 8800 tons represented nitrogen in the following items which are the figure for 1917.

	Value
Loaded cartridges	$42,000,000
Fuses	34,000,000
Shells and projectiles	74,000,000
All other	202,000,000
Total	253,000,000

It will be noticed that ammonia nitrate is not included in these figures, but I assure it would be about 50,000 tons for 1917.

In Great Britain the consumption of ammonium nitrate is now probably 400,000 tons a year, and the production here will have to be at least as much. To make this, the theoretical proportion of ammonia required is about 85,000 tons and of nitric about 315,000 tons.

It will thus be seen that the coke oven plants in the country could supply all the ammonium nitrate required if they were put onto the job.

Until recently most coke oven ammonia was converted into sulphate, but owing to the war demand for nitrate, more and more of it is being made into aqua-ammonia of about 29 percent. strength. In some cases this is being transported many hundreds of miles prior to conversion into ammonium nitrate and since each ton of ammonia necessitates the transportation of about 2½ tons of water, the bearing of this, on the present railway congestion is at once apparent. Tank cars have to be used and they must return empty, so the freight on the actual ammonia carried is extremely high.

Concluding Observations

There are many coke ovens of the wasteful bee-hive type in operation, which do not recover by-product and the replacement of these by modern coke-ovens would be a great immediate economic gain and meet the war conditions better than the building of large dams for water power.

In the present emergency coke ovens are of great value because they give coke for making steel, gas for power purposes, ammonia for nitrate manufacture, and toluol and benzol for explosives.

After the war ammonium nitrate will be in demand for fertilizer as well as for safty explosives and other explosives. The high percentage of nitrogen which it contains viz., 35 percent. and the ease with which it can be converted into other compounds makes it especially useful for conveying nitrogen in the fixed form over considerable distances.

It is more profitable to make nitrate than sulphate, because pound for pound, the nitrate contains nearly twice as much fixed nitrogen and the nitrogen commands a higher price per unit when in the form of ammonium nitrate.

PLACING THE ENGINEER

When is an engineer not an engineer? asks a writer in monad. This question, apparently nonsensical, has a real significance, one that concerns the welfare of the individual engineer and, at the same time, concerns the conduct of the war.

The engineer himself has just become conscious of this significance. Previously he has been singuarly indifferent to his own interests. Through proud of his profession, he has failed in a measure to guard it with sufficient care, and as a result his importance has been obscured, his ideals slighted, and his progress retarded.

These and similar facts have become evident through the recent establishment in Chicago of the Division of Engineering, a department of the United States Employment Service. This department has made many interesting discoveries with regard to the engineering profession. It has found, for instance, that the public does not understand the status of the engineer and that it is unfamiliar with his actual accomplishments. The professional engineer has been confused with the mechanic, and technical and professional profficiency. Similar misconceptions have flourished with regard to credit, rank, and compensaiton.

Yet the engineer is the most powerful figure in the world today. He is the active force which makes the winning of the war possible. He designs the impedimenta of the battle field, the air, and the water; h dviss sanitation systms; h tetaeatoetaoshrdleta and the water; he devises sanitation systems; he constructs armaments and builds highways. He is at once a scientist and a soldier, a patriot whose picturesque accomplishments are comparable to those of the heroes of romantic fiction.

He is to be neglected no longer, for the United States, enforcing one of its noblest democratic prerogatives, by means of the Division of Engineering, will register and classify engineers and technical men with a view to conserving them, economically distributing them, and sympathetically directing them. This means that the engineer is to become a still more powerful force in the present war because his services will be intelligently utilized. It means also that, perhaps unconsciously, the Government is tending toward universal service—placing the right man in the right place, considering the needs of the nation as they relate to the ability of the individual.

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WHY YOU SHOULD SAVE PAPER

Sulphur is used in the manufacture of practically all kinds of paper.

It is used in the form of SO_2, or Sulphur Dioxide.

Our Government needs great quantities of sulphur for war munitions.

Much of this is used in the manufacture of gas to be used in warfare.

Germany began the use of poison gas in warfare.

It is necessary to fight back with the same weapon.

Otherwise our soldiers will be needlessly sacrificed.

Our Government has beaten Germany at her own game.

We make a better gas, one that is deadlier and drives back the enemy more efficiently than any gas they have.

There must be no shortage of sulphur because every pound of it made into gas saves our own men and helps speed up our final victory.

Every piece of paper contains a certain amount of sulphur.

There are only two sulphur mines in America.

There is not enough sulphur for both the great quantities of gas needed and the tons of paper that we thoughtlessly waste.

Every sheet of paper, every bag, every bit of wrapping paper, every sheet of letter paper we save by not needlessly using or by not thoughtlessly wasting allows just so much more of the precious sulphur for our war use. Save the paper and help choke the fiendish Hun at his own choking game.

EDITORIAL

BUY, BUY LIBERTY BONDS

Again the Government is appealing to you, reader, to invest all your spare earning and saving capacity in its securities. It goes without saying that the will to respond is countrywide, though the means may be lacking here and there to buy in any amount for cash. Scarcity of cash is no excuse for not subscribing to the Fourth Liberty Loan; for what the Government wants is timely funds to carry on the war, as they are needed to buy munitions and the many forms of supplies required for home and foreign service. All these munitions and supplies will not be needed at once, but from time to time as the necessity for them arises at the front. This gives all who have any earning capacity ample time in which to pay their subscriptions. To pay for the bonds in this way is just what the Government wishes and urges. What it needs is the money to be sure, but the last thing it wishes is that the money to pay for the bonds be got by raiding the savings banks. Let the savings account alone, as that money is needed to finance the war industries, and pay for the bonds out of current earnings, with money that represents a lot of unnecessaries unbought. In other words, buy your bonds on the installment plan with money that spells self-denial. In this way the Government will get the loan of your money as it needs it, and in this way you will learn the wisdom of the old saying that nothing pays better or surer dividends than self-denial. You will then appreciate the value of your bonds to he full, and not be inclined to sell them or to exchange them for a piece of paper issued by dealers in what are known as cat and dog securities. If your bonds represent many days of hard labor plus a lot of doing without, they will be bonds worth the having. You will find yourself, then, the owner of the safest security in the world bought on the installment plan with money that might have been spent for things that you don't need; that show how you pitched in and helped out in time of need; with bonds that will pay interest money every six months, and with bonds that you will be able to turn back into hard cash, perhaps just at the time you will need it most. There is, you see, every reason in the world why you should buy the new Liberty Bonds to the limit of your earning and saving capacity. It is your duty to buy them, your privilege to be allowed to buy them on such favorable terms; and who knows but that the shell bought with he money loaned by you will be the very shell that will settle the Hun's hash forever. Take a chance on it; subscribe to the Fourth Liberty Loan as you never subscribed before—and pray that the good angels will lend their wings to guide the shell bought with your savings and turn it into the shell that will end the war. Now then, over the top with a dash and a cheer for the Fourth Liberty Loan!

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EARLY CHRISTMAS SHOPPING

The Government requests that you do your Christmas shopping now and prevent the congestion sure to result from last moment shopping in places where man power and woman power are at low ebb due to the demands of the war. It were well to remember that a large part of the real manhood and womanhood of the nation are pegging away at war work here or in France, and the shops consequently operated inefficiently compared with pre-war days. This is as true in the electrical industry as in others. Besides, due to priority restrictions recently promulgated, electrical manufacturers are pledged to see that their products are to be used for purposes that will directly help win the war. In some cases retailers of electrical apparatus are expected to exercise the best judgment they can muster in the matter of the real needs of the customer. With their purchases censored in this way, it is likely that the retailers will be less freehanded in stocking up this year, and it is advisable therefore that those who expect to make useful electrical presents this year begin to think about their Christmas shopping early in October. Now is the time.

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A LITTLE KNOWLEDGE

'Tis a dangerous thing to have a little knowledge, says the ancient adage. Everyone finds this out for himself a few times before he becomes cautious for himself and suspicious of others. We had an experience a short time ago that recalled this old wise saw, an experience that bespeaks a suitable amount of caution and suspicion for at least the immediate future. Here is the tale, unvarnished. A well known technical writer made some statements in a Government publication that usually carries the weight of Government

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Patriotic citizens by the thousands are subscribing to the war savings stamps issued by the United States Government. An average of $20 per capita—$20 for each man, woman and child in America—is asked during 1918 from this source. The putting across of this splendid scheme is most helpful to the government at this critical period in our national life, and at the same time it is the most remarkable plan for encouragement of thrift among the young and old ever initiated. Are you doing your part? Are you saving your pennies, nickels and dimes?

authority. He was writing on the electrical welding of ships. We took him at his word and published an extract from his article. An engineer whose experience has been along electrical welding lines, took exception to some of the statements in the extract. They were at direct variance with his knowledge of the subject. Upon investigation we found that the engineer was right and the technical writer was wrong. Not being accredited authorities on that particular phase of electrical activity, and satisfied that Government authority was back of it, we assumed that no faux pas would be committed in publishing that extract. Maybe the technical writer's stenographer or the printer's compositor or copyholder or proofreader was at fault. Be that as it may, the upshot of it all is that the engineer took us to task, and duty bound we were compelled to make amends for taking the technical writer at his published word. The technical writer said that spot welding is done with electrodes of the same metal as the plates to be joined—steel electrodes for steel ships—and arc welding with copper electrodes which do not fuse. Maybe he is a boche spy, hoping in this way to hold back the ship program. If he is it is our duty and our pleasure to agree with our correspondent and to give as wide publicity as we can to the fact that copper electrodes are always used in spot welding, and that in arc welding one pure iron electrode is used, as it fuses and help to fill the joint. Boche cupidity or carelessness, or ignorance, whichever it be, the shipbuilding program must not be jeopardized by even so apparently slight a thing as an error in the use of electrodes for welding.

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IN TIME OF WAR

If it is good business in time of peace to prepare for war none the less is it good busines in time of war to prepare for peace. Remote as it seems to-day, the dove of peace will eventually alight in a world tired of strife and bloodshed and ready for the friendly contests of business that make life worth the living to men of red blood and action. Farsighted men are preparing for this time, for a time when the trains and the ships will not be burdened with roops and munitions, but with the thousand and one things that will be needed to repair the ravages of mines, shrapnel, and high explosive shells of past years. Unlike the shiftless wag who entertained the Arkansaw Traveler, these farsighted men will not be passively philosophied. They are not disposed, as the Arkansaw Traveler's host was, when asked why he did not mend his roof to say, "Why bother about it? I can't fix the roof when it rains; and when the sun's out, what's the use?"

These men are fixing their roofs now, rain or shine. Simply because there are such things as priorities and essential industries, and their factories going day and night with war orders, and advertising brings little or no new business, business that they could not possibly take care of because there are such things do not cease to keep their names and their wares before the prospective buying public by curtailing their advertising in the trade papers. By continuing to advertise they are investing in business insurance for the future. When the Kaiser and his crowd of freebooters are winded and over the ropes, those who advertise now will not have to build up good will all over again. There will be no lost motion on this account. Their names will still be household words, and their products will not, like the Mammoth Cave, be seldom seen and little thought of because they ceased to advertise. Nobody goes to see the Mammoth Cave nowadays. Why? just because the folk that run it, have stopped advertising it. But few of the rising generation ever hear of it. Why don't people eat "Force?" The answer is easy, because "Sunny Jim" has disappeared from the papers and the bill boards. What happened to the Mammoth Cave and to Sunny Jim will happen to all those who, beset with mistaken ideas about the value of advertising, insist in withdrawing their names and their wares from the advertising pages of the trade papers. If, as has recently been said, there ever was a time when it was necessary to build and to hold good will, that time is now.

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ELECTRIC SERVICE IN FRANCE AFTER THE WAR IS OVER

The reconstitution of economic life in the invaded regions of France will not be possible without having recourse as largely as possible to electricity, says *Commerce Reports*. Electricity is the one thing capable, because of its flexibility and unlimited power of expansion, of handling the complex problems which will arise in connection with the reopening of workshops, factories, and mines, and the resumption of social life in general.

The directors and representatives of the large central power stations and electric-lighting plants situated in the invaded regions, banded together under the auspices of the Syndicat Professionnel des Producteurs et Distributeurs d'Energie Electrique, are already engaged in studying the problem of reconstructing their central power stations.

Those interested are agreed that since they will undoubtedly find themselves face to face with a clean state so far as the old plants are concerned, advantage should be taken of the opportunity for securing as largely as possible the standardization of new equipment and transmission systems. The adoption of the principle of standardization would make it possible for those interested to help one another most effectively, because the machinery available would be capable of being used in one place as another and could be transported from point to point.

A question to be answered is, how will the electric current be distributed? Will it be by the new units that are in contemplation or will it be by existing transmission systems that may eventually be recovered? The object, of course, will be to satisfy the collective needs of the liberated regions as effectively as possible. In spite of the uncertainty with regard to the conditions in which the liberation of the invaded territory will be brought about, it is absolutely necessary to provide for most effective distribution of current, no matter what locations may be chosen for the generation of the current. In this connection the electrical committee thinks it much better to leave out of consideration the old transmission lines, for the chances are that all the copper wire has been either destroyed or carried off by the enemy. Moreover, even if part of the old transmission system should be found intact, it would probably not be capable of use.

By the creation of a vast system of power generation and distribution established in accordance with a general plan carefully laid out and capable of realization by successive stages as the needs of the invaded regions may dictate, the committee hopes to achieve the maximum efficiency by avoiding the creation of numerous small private central stations.

ELECTRICALLY PROPELLED U.S.S. TENNESSEE

The development of the propulsive machinery for capital ships during the past few years, has been very rapid, says Wilfred Dykes in *The Electric Journal.* The reciprocating engine, which has held the field until recently, had been developed in the United States Navy to a high degree, but the obvious advantages of rotating machinery led to its being superseded by the direct-connected steam turbine. The direct turbine drive left a good deal to be desired from the standpoint of economy, especially at light loads, which is of particular importance as a battleship steams most of the time at cruising speed which requires only a small percentage of the power at full speed. The economy at cruising speed has been considerably improved by the addition of geared cruising turbines connected to the main turbines through a suitable clutch when running at cruising speeds.

A number of years ago the United States Navy determined to experiment with two new types of drive that seemed promising, but which had not been given practical tests, and two of the large colliers were equipped, one with geared turbines and the other one with electric propulsion. Both of these equipments have given satisfactory service and have shown that either arrangement would be feasible for battleship propulsion. In the meantime gearing had been developed very extensively for land installations and where the the problem is simply to reduce the speed of a high-speed of a high-speed turbine to the propeller speed, the geared drive have proven entirely satisfactory. By the use of a high-speed turbine with geared drive the weight may be reduced very materially and very good economies may be obtained, as the turbine is operated at speeds for which it is naturally best adapted. By the addition of a cruising turbine for lower speeds the water rate may be maintained practically constant over a large range. The tests made by the Navy Department together with experience gathered from outside sources led to the adoption of geared drive for the 90,000 h.p. scout cruisers.

The electrically driven collier has also given very satisfactory service, and the ease with which the ship can be maneuvered is very noticeable. The steam consumption of the geared and electrically driven colliers is approximately the same.

After due consideration of the results of various trials, it was decided that electric propulsion would be used for the newer battleships, and a contract was let for the equipment for battleship No. 40, the *New Mexico,* which has recently gone into commission. The well known advantage of electric drive, allowing of the disposition of the apparatus in the best locations, is of the greatest importance in the design of fighting ships. The full advantages of electric drive were not utilized in the case of the *New Mexico* but as the detailed design of the equipment developed they became obvious and when the contracts for the *Tennessee* and *California* were made, it was realized that the adoption of electric drive revolutionize the design of the ship, and that some of the features of this type of drive which were considered of such much importance when the decision was originally made, were actually secondary compared with the military advantages that were obtained by the utilization of the characteristics of the electric machinery.

In general it may be stated that the electric drive and the gear drive show approximately the same overall steam consumptions, both of which are very much superior to the older systems, so that a decision made on the basis of military advantages to use either one, does not entail any sacrifice in economy. The electric drive has provided a new tool for the naval constructor of great value when designing ships for modern conditions. The question of reliability of electric drive has not been seriously raised, as it was realized that in our central stations, steel mills and other large industries, the same units had already been utilized of equivalent power to those which it was proposed to install in the ship, and the only new condition was that the machinery would be in a ship instead of on dry land.

The *Tennessee* will be one of the most powerful fighting ships built, having displacement of over 32,000 tons, and a speed of 21 knots at full power. The equipment for propelling the ship will consist of four 3-phase induction motors, each driving one propeller, and two turbogenerators for supplying the motors with power. Each of the four motors will develop 7000 h.p. at a speed of about 180 r.p.m. and will be capable of working continuously at 8375 h.p. as an overload condition. The motors have two windings, of 24 and 36 poles, so that they have two normal speeds of 123 and 180 r.p.m. with full speed of the turbine. In this way it is possible to run the turbine at its most economical speed when steaming either at full power or cruising at 15 knots. Intermediate speeds are obtained by varying the speed of the turbine and the equipment is designed to maintain a low water rate over the full range of speed from ten knots up. When operating below 17 knots, only one generator is used, and this improves the economy, as the load on the unit is brought nearer to its full capacity. The turbogenerators supplying power to the main units each develop 13 500 k.v.a. at full speed and are capable of carrying 15000 k.v.a. continuously for the overload condition. The generators are two-pole machines and the unit runs at 2190 revolutions, corresponding to 36.5 cycles per second, with the motors running at 180 r.p.m. The maximum speed of the turbogenerator is 2270 r.p.m., corresponding to 37.9 cycles, equivalent to a motor speed of 186.5 r.p.m. which requires 8375 h.p. To obtain lower speeds, the turbine speed is reduced to about 1500 r.p.m. which corresponds to the change-over point from the 24 to the 36 pole connection of the motors. With the change-over of the motor connections, the speed of the generator is increased to 2270 revolutions, corresponding to 15 knots with the 36 pole connection. The motor speed combination is simply the equivalent of a variable ratio of gearing which in the case of the 24 pole connection is 12:1 and with the 36 pole connection 18:1. The direction of rotation of the machines is controlled by reversing switches which simply transpose two of the phases at the motors, the generator of course continuing to run in the same direction. The motors have two separate windings on the stator, one of the 24 pole and the other the 36 pole connection. The same results might have been obtained by use of one winding, but this would have entailed greater complication in the connections and would have restricted the design in other ways. The rotor has a single polar winding for 24 poles which is connected to the slip rings in the ordinary way, so that resistance can be inserted in the circuit during starting or reversing. When the machine is operating on the 36 pole connection, the rotor winding cross-connections act as short-circuiting connections for this pole combination. With the 24 pole combination, they act as equalizing connection between points of equal potential. On the 36 pole connection, the motor operates as a squirrel-cage machine and it is not intended that this winding should be used during the starting or reversing but only as a running winding. In this way, only one winding is used and one set of slip rings.

The speed of the turbine is varied by means of a unique hydraulically-operated governor. The loading of the governor is regulated by means of a variable pressure of oil system, the pressure of which is regulated with great accuracy by a pressure mechanism operated by the control handle. In this way, any mechanical connection through shafts or rods with the governor from the operating point, with the consequent danger of jamming where passing through bulkheads, is avoided. A unique feature of this arrangement is that the pressure is caused to pulsate slightly so that the whole of the regulating and governor mechanism is kept slightly in motion, and thereby prevented from sticking, thereby adding greatly to the sensitivity of the control, which is of great importance when ships are steaming in formation. The turbines are of the Westinghouse semi-double flow, impulse-reaction type. The high-pressure steam is expanded in suitable nozzles and passes through a two row impulse wheel, after which it passes through the first stage of the reaction expansion, which is single flow. The steam then divides and passes through the low-pressure stages of the turbine, which are double flow. The turbine is provided with an automatic stop to cut off steam in case the speed should exceed the maximum safe-operating value. The main hydraulically-operated governor maintains speed practically constant at anv value set by the control mechanism, independent of the load, so that in case the propellers should leave the water during rough weather there will be no racing.

The generators and motors are very carefully insulated for this service so as to prevent damage due to moisture or the accumulation of salt, and also due to the high temperatures which are liable to be encountered in this service. The principal material used for insulation of coils in the slots is mica, and the machines are capable of withstanding slot temperatures up to at least 150 degrees C. without injury. Ventilation of the generators is provided by fans supplying air to each engine room and the fans on the generator forcing the air through the machine and out through ducts. The motors each have two fans mounted directly above them which draw the air through the motor and force it out through the ventilating ducts. The generators are excited from the direct-current power circuit of the ship through boosters which are capable of raising the normal 240 volt supply to 320 volts or reducing it to zero.

The power supply from the turbogenerators is brought to a centrally located control room in which is mounted all the necessary switching apparatus for controlling and distributing the power to the motors. In this room is mounted the regulating apparatus for the main turbines, the field switch and rheostat for the turbogenerator excitation, and the liquid rheostats for the main motors. All necessary instruments for the operation of the equipment are mounted directly in front of the operators and full advantage is taken of the great facility with which electric power can be measured, inasmuch as it will assist in the operation of the ship. For starting and reversing the main motors, automatic liquid rheostats are used which are of a similar design to those used previously for industrial purposes. These liquid rheostats consist of two tank, the upper containing a series of fixed electrodes and the lower acting as a reservior. By means of a suitable pump, the electrolyte is caused to flow from the lower to the upper tank at the proper rate to cause the desired acceleration. When the bypass between the two tanks is open, the electrolyte is maintained within the electrode tank at the proper level to give the maximum resistance. When this bypass is closed, the electrolyte rises in the upper tank, thereby progressively short-circuiting the electrodes until the minimum resistance is reached at the overflow point, after which the liquid simply continues to circulate through the two tanks. A switch is provided so that this rheostat may be short-circuited.

The cables for connecting the turbogenerators and motors are of great importance, as the operation of the ship depends upon their reliability. A number of parallel circuits are used, each cable being of the three-core type, and the failure of any single cable would not seriously interfere with the operation of the ship. The main cables are of the same order of importance as the main steam pipes; hence the greatest care has been taken to insure that these cables should be the best type that is possible to manufacture for the service and to this end, a committee of the American Institute of Electrical Engineers assisted the Navy Department in preparing the specifications.

The main auxiliaries in the engine rooms are electrically driven. The main circulating pumps are driven by 235 h.p. direct-current motors, directly connected to centrifugal pumps, the speed of which can be varied to suit various conditions of operation. In this way, the power consumption can be reduced as the speed of the ship is reduced. The principal provision for maintaining vacuum in the condenser is th euse of LeBlanc air ejectors, which are novel for this class of ship. These air ejectors have already been successfully tried out by the Navy Department on other vessels with such satisfactory results as to justify their adoption for these vessels. The condensate from the condensers is handled by vertical electrically-driven centrifugal condensate pumps so that the whole of the essential auxiliary apparatus for the turbines is rotary and, based on the experience in land service as well as at sea, a greater reliability and lower maintenance can be anticipated for these equipments compared with past practice. The use of air ejectors enables the vacuum to be maintained at least as high, if not higher, than the older combination of reciprocatiny air pump and Parsons augmentor, and the space and weight are a very small fraction of that required with the older system.

While steam consumption is not of vital importance, on account of the other advantages of electric drive, yet the figures that can be obtained are very appreciably better than the direct connected turbine and are lower than any past practice. From 10 to 15 knots, only one generator is used, the motors being connected for 36 poles. From 15 to 17 knots, the motors are connected for 24 poles and one generator is used. From 17 knots to 21 knots, both generators are in operation, each machine supplying power to two motors, each side of the ship being independently operated.

In designing the equipment for the *Tennessee*, every effort has been made to avoid the introduction of experimental or risky constructions, and the design is such that the experience gained in other fields has been utilized to full advantage, and the design factors have been kept within well-developed practice. At the same time provisions have been made so that the full advantages of the characteristics of electric drive can be utilized in the operation of the ship.

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FACTS ABOUT GRAPHITE

Graphite, says the paper bearing the same name, is one of the three forms in which carbon exists, the three forms being as follows:

First—substances represented in a general way by coke, lampblack, charcoal, carbon from gas retorts and substances of this type, none of which has a specific gravity above 2.15. They have no unctuous qualities and are all amorphous; that is, have no crystalline structure.

Second—the second form is technically called graphite (or graphitic carbon). It is also commercially known as plumbago or black-lead and is that form having a specific gravity of approximately 2.25. Its peculiar and distinguishing characteristic is that of unctuousness; that is, its extreme smoothness and softness to the touch. This substance is also peculiar in that it exists in both the crystalline and amorphous conditions. The material is either natural or artificial, the artificial form always being amorphous. There is some question as to whether the so-called amorphous forms of natural graphite are really such or whether they have been changed from an earlier crystalline form, but they are practically amorphous for the reason that under any milling operation or pressure they invariably break down to a very fine condition, having no appearance of crystallization. Graphite, on rubbing, produces a high polish, black or dark gray in color.

Third—the third form is the diamond, a transparent crystal of very great hardness, having a specific gravity of about 3.45. It is as different in its physical properties from graphite as two substances can possibly be.

All forms of carbon are practically insoluble in all chemicals, but are consumed in the presence of oxygen at high temperatures.

AN EXPERIMENT IN CONSERVATION

By G. E. Quinan

In the fall of 1915 the Puget Sound Traction, Light & Power Company signed a 3-year contract for fuel oil at 75 cents per barrel. A number of other large contracts were signed at that time at about the same price. In the summer of 1916, oil had advanced to 90 cents; in the early months of 1917 the price was $1.10; then came the declaration of war and oil moved upward by jumps to $1.65, where it remained fairly steady through the fall and winter. The price to-day is close to the two-dollar mark and contracts for future delivery are not to be had at any price.

In the light of our experience with present day prices of all commodities there is nothing remarkable in the foregoing unless it be that the price did not go higher. Oil began to be used in the Northwest about 1900 and in ten years had come to be the predominating fuel oil on ships, railroads, steam boiler plants and the larger fuel burning installations of all kinds, at which time the mounting price and the refusal of the oil companies to take on further commitments began to have their effect and the larger users, including the railroads, turned for relief to the long neglected coal measures of the state. At the present time the change from oil to coal or in some cases to water-power-generated electricity, is general, with the prospect that oil will be practically unobtainable after November 1, except by war industries to whom its use is essential. That the vast coal measures of Washington are at last coming into their own, and permanently, cannot be questioned, as the increasing use of oil in California, which has no coal, an dthe decreasing production make dollar oil a thing of the past for us in the Northwest, barring the discovery of new fields in this vicinity.

As far back as the fall of 1916 it was becoming increasingly apparent to the officers of this company that we must look to coal for the future fuel. At that time we were burning oil at the Western Avenue steam heating plant and at the steam power plant at Georgetown with a total of about 10,000 boiler horse-power.

To equip these plants for burning coal would iost nearly half a million dollars and serious consideration was thehefore given to the kind of equipment to be used. Our experience with the Post Street plant inclined us to favor the use of chain grate stokers, but before reaching a decision it was felt that the possibilities of powdered coal ought to be looked into.

References to this method of burning coal were appearing frequently in the technical press and search through the library files developed an extensive literature on the subject extending back for 20 years. This proved to be as unsatisfying as it was voluminous, the outstanding facts being that while powdered coal was being used successfully in cement furnaces and in reverberatory furnace work it had not been successfully adapted to steam boiler practice. A number of small plants in the East were burning powdered coal, but the results, while partially successful, were not at all a character to justify the adoption of this method of firing on a large scale. As a result of this investigation the whole matter would have been dropped had not Mr. W. J. Santmyer, advisory steam engineer for the company, insisted on trying it out in a small way.

For this purpose a 300 h. p. B. & W. boiler at the Western Avenue steam heating station was equipped with at Dutch oven and the experiments began. Powdered coal was obtained from the briquette plant of the Pacific Coast Coal Company at Renton and brought to Seattle in a specially constructed closed car, from which it was delivered to an enclosed bunker by bucket elevator. From the bunker the coal was fed by air pressure through pipes and a locally designed burner to the furnace. Without going in detail into the various difficulties which were encountered it is enough to say that they were numerous, and considerable ingenuity was shown by Mr. Santmyer and his assistants in overcoming them. After about a month of experimentation, during which many changes were made in burners, air pressure, etc., real results began to be obtained. Sub-bituminous coals, which give an evaporation of about 6¼ lbs. of water per lb. of coal on chain grates, gave better than 8.5 lbs. evaporation per lb. of the pulverized product when burned in powdered form, corresponding to an increase of 20 percent. to 25 percent. in the evaporative performance of the raw coal.

Almost perfect control of the fire was possible by regulating the speed of the supply fan by means of a rheostat controlling a variable speed motor. The boiler was equipped with an indicating steam flow meter and its responses to changes in fan speed were almost like those of an ammeter on an electric generator. When fired with oil the setting of this boiler began to show distress at an overload of 50 percent., while under powdered coal, overloads of more than 100 percent. were carried without visibly affecting either the brick work or tubes.

One of the last difficulties to be cleared up was the formation of slag on the boiler tubes. This was due to insufficient space between the burners and the tubes with the result that combustion of the solid matter of the coal was not completed in the fire-box but was going on among the tubes, the steam of burning coal being from 12 to 14 feet long. Two means were found for correcting this, one by furnishing a longer path for the flame and the other by the use of steam introduced into the fire. The effect of this latter was quite remarkable resulting in a decrease in flame length of about 50 percent. the amount of steam required being less than that used for atomization with an oil burner of good design.

With the shortened flame length the fused portion of the ash is deposited on the furnace walls before reaching the tubes and flows down into the ash pit leaving a glazed coating about 1/16 in. thick on the brick work. Some difficulty was experienced due to the slag accumulating in the ash pit in a solid block requiring the use of bars to break it up. This was finally overcome by constructing the throat of the slag pit so that the molten slag was forced to drop from the furnace in semi-fluid masses, and by use of a water spray which prevented successive droppings from sticking together. Under this treatment the slag accumulates in the pit in chunks about the size of a large potato and is easily removed with a rake through the usual cleanout door.

After three months of operation, during which time all obtainable grades of coal were burned, from which grade bituminous coals to the poorest lignites, Mr. Santmyer demonstrated conclusively that coal of the character obtainable in this region could be successfully burned in powdered form under steam boilers and that the performance of all grades when burned in this way was superior to any other method of firing, the improvement in the case of the lower grades being relatively greater than for bituminous coal.

The Seattle experiments attracted wide interest among coal men and power plant operators in many parts of this country and in Canada, Japan and Australia. The Australian government evinced an especially keen interest as the enormous deposits of lignites in that country will become tremendously valuable if the new method of firing proves practicable.

That the use of powdered coal is entirely feasible from the the physical standpoint has been clearly demonstrated. Its economic feasibility depends upon the cost of coal of different grades in a given market. With low priced coals which can be successfully fired on mechanical stokers the cost of drying and pulverizing for powdered burning may more than offset improved performance. This cost has not yet been definitely ascertained but in large pulverizing plants will probably run from fifty cents to a dollar a ton, including all costs.

The field for powdered coal apparently lies in the utilization of the smaller "fines" from relatively high grade coals, and lignites when the better grades. Since the lignities are not suitable for domestic use, steam coal of this character must bear the full cost of mining and distribution, and will not therefore come into use until the demand for steam coal has absorbed the finer sizes of domestic coals which have for many years past been more or less of a drug on the market. There are hundreds of thousands of tons of sub-bituminous buckwheat and finer grades lying on the mine dumps and in the sludge piles of mines within forty miles of Seattle. With the passing of fuel oil in the Northwest, powdered coal will undoubtedly prove economically feasible in the reclaiming of these dumps and in the utilization of every pound of "fines" produced in the future.

The result of Mr. Santmyer's experiments was that it was decided to cancel orders already placed for chain grate stokers and equip the Western Avenue plant for powdered coal. The plans for Georgetown station were allowed to stand ond the instation of chain grates there is now nearly complete.

At Western Avenue station we have now 4,100 boiler h. p. in ten B. & W. units, used exclusively for steam heating. The station, though originally equipped for coal, was changed to oil and all coal equipment removed. It was therefore necessary to provide coal and ash handling equipment and storage facilities and to change the furnace design, as well as to supply the equipment required for drying and pulverizing the coal.

The pulverizing plant is housed in a new concrete building adjacent to the station on the south and coal is delivered through a tunnel under Western Avenue from bunkers of 500 tons capacity constructed on ground adjoining Union Street substation. The raw coal is brought in over our own tracks on Western Avenue and delivered by gravity to the bunkers.

From the bunkers it feeds by gravity onto a rubber belt conveyor which carries it to a crusher of the single roll type at the entrance to the tunnel. This crusher breaks the coal down to approximately one inch size and discharges on a 75-ton per hour belt conveyor running through the tunnel. This belt delivers the coal to a vertical elevator of the two-strand chain and bucket type just inside the pulverizing plant at the northeast corner of the building. The coal is elevated to the roof, and distributed to the crushing coal bunker by flight conveyor.

The crushed coal bunker extends the width of the building on the Western Avenue side and has a capacity of 300 tons. From two openings in the bottom of this bunker the coal is fed by apron type feeders to chutes communicating with the driers on the floor below. The spill from the apron feeders is picked up by screw conveyors and delivered to the chutes, which are so arranged that coal can be fed from either end of the bunker to either of the two driers.

The driers must reduce the moisture content of the coal from values as high as 25 percent. down to 4 percent. or less. They are simply steel cylinders 55 ft. long, one 5 ft., and the other 6 ft. in diameter. They are slightly inclined to the horizinal and are arranged for rotation about the longitudinal axis. Steel baffles are arranged longitudinally inside which successively raise the coal and drop it as the cylinder rotates, thus forcing the coal because of the pitch, to gradually pass through the drier.

Heat for drying is supplied by furnaces which enclose the driers for the greater part of their length, leaving only the ends projecting. The furnaces will be fired with powdered coal and the gases of combustion will pass into the driers at the discharge ends and be sucked through the shells together with the moisture and dust from the coal by fans at the opposite ends. These fans discharge into cyclone dust collectors installed on the roof.

The dry coal, at a temperature of about 400 deg. F., is discharged by the driers through chutes into the boot of a bucket elevator which carries it to the roof, where it is distributed to the dry coal bunker of 100 tons capacity by screw conveyors. In each of the chutes leading from the driers is a magnetic plate for separating small pieces of iron from the coal. Larger bodies are removed by means of a shaking screw before entering the tunnel.

From the dry coal bunker, which extends the width of the building on the Railroad Avenue end, the coal feeds through chutes to four pulverizing mills of five tons per hour capacity each. These mills were built by the Fuller Engineering Company and will grind the dry coal to a fineness permitting 95 percent. to pass a 100 mesh screen and 85 percent. to pass a 200 mesh screen. This is pretty nearly as fine as talcum powder.

The powdered coal is carried from the mills by screw conveyor to the north side of the building, raised to the roof by bucket elevator and distributed by screw conveyors to steel bins in the boiler plant. There is one of these bins of about 15 tons capacity for each boiler placed in front of and above the boiler top.

Dutch ovens have been constructed in front of each boiler and the floor cut away to provide the necessary furnace volume and slag pits. The clean-out doors for the slag pits are at the basement floor level under the boiler room, and slag will be handled in wheelbarrows to a bucket elevator which will raise it to the top of a concrete ash bunker constructed on the Railroad Avenue end of the boiler room. This bunker is arranged to discharge into railroad cars or auto trucks.

In the powdered coal installation perhaps the most important feature is the method of feeding the coal to the furnace. At Western Avenue station three types of "burners" will be tried out, one developed by Mr. Santmyer, one by the Stone & Webster Engineering Division and one by the Locomotive Pulverized Fuel Co. Santmyer's burner has proved quite satisfactory and the other types are to be tried out simply to see if they can show any improvement. The function of the burner is to thoroughly mix the powdered coal with air in the right proportions and deliver it into the furnace at a suitable pressure. The burner is installed in the front wall of the Dutch oven, or on top at an angle of about 45 deg., and is to the powdered coal furnace what the carbureter is to a gas engine.

In the Stone & Webster design, it is proposed to introduce all the air required for combustion through the burner. In the other designs this is not contemplated and openings are provided in the walls of the oven for the admission of additional air.

Air will be supplied for carburetion by two steam turbine driven fans of 50,000 cu. ft. capacity at a pressure of about two ounces, and will be distributed to the burners from two large headers extending the length of the firing aisle.

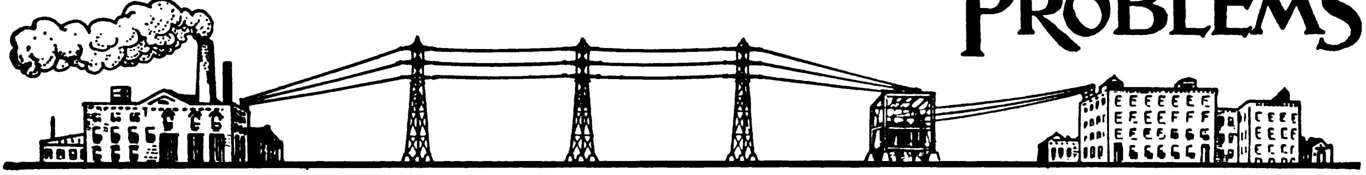
The coal is taken from the botton of the steel storage bins by short screw conveyors driven by variable speed motors and delivered into down pipes communicating with the burners. The passage of the coal through the down pipes is facilitated by air and in the Santmyer burner preliminary mixing is accomplished here.

Electric drive is used throughout the installation with the exception of the fans for the driers and for the air supply to the burners, where Moore steam turbines are used exhausting into the steam heating mains.

All screw conveyors, elevators and containers for powdered coal are carefully enclosed to guard against the escape of dust and possible formation of explosive mixture with air. In this connection experience has demonstrated that if powdered coal is handled with the same care as oil the liability of explosion is practically nil.

The installation of Western Avenue alone represents a saving of 150,000 barrels of fuel oil per year and the substitution therefor of sludge from our mines at Renton where there is an accumulation of over 150,000 tons hitherto unusable for any purpose. At other mines in this district there is over 500,000 tons of sludge which can be reclaimed at small cost and from which, when dry, an evaporation of from seven to eight pounds can be obtained. As a measure for conservation, therefore, powdered coal may have big significance. Its meaning to this state alone would be wirteen in millions; its meaning to the country might even approach the proportions of a Liberty Loan.

POWER PLANT, LINE AND DISTRIBUTION PROBLEMS



A Record of Successful Practice and Actual Experiences of Practical Men

STEALING ELECTRICAL ENERGY

What is the underlying motive that makes current thieves of power users? asks H. A. Heslip, in Light Company News published by the Duquesne Light and Power Co. Is it because so many of them are of criminal instinct? No, it is not. Statistics prove otherwise. That cause holds good in only a few cases. The usual offender considers himself as upright as anyone. It is the opportunity that makes the thief. The old-fashioned cash drawer—open, and the unprotected meter are too much for some citizens. The man who gets his current, or part of his current for nothing, believes himself no more guilty than when overlooked by the street car conductor. Anyone with a slight knowledge of electrical practice is often tempted to try his hand. He just wants to see if he can beat the game.

Detection of Current Thief

The detection of the current thief is made possible in a number of ways. The special meter tester, the periodic meter tester and indicator tester discover the greatest number of cases at the time they are making tests and inspections on the customer's premises by inspecting all wiring and connections about the meter. The meterman and complaint man have discovered a number of cases while changing meters and attending to a no-light complaint, and a few lead-offs have been received from meter readers, as in making their rounds they may note that the customer is using light that is not registering on the meter. The actions of the customer in trying to remove the temporary jumper frequently betrays the culprit. Comparison of the monthly readings with preceding periods will also, in cases, indicate theft. When an intentional theft is discovered, the tester leaves the connections as found, in order not to arouse any suspicion that the irregularity has been detected. A detailed report is made up of the connection by the meter division, or if discovered by the meter installer or complaint man, a report is made out by the district superintendent, which is forwarded to the contracting department. The contracting department immediately issues an order to the district superintendent to place a check meter in a dummy transformer case on a nearby pole, and connected in series with the meter of the suspected customer. In this way, it is possible to find out what the actual correct consumption is, and a direct basis for determining the amount of loss, and collecting the portion not registering by the regular meter, is afforded. The readings of the customer's meter and of the check meter are compared for a few months, and when it is discovered that a large discrepancy exists, an investigation is made at an unusual hour by two company employes in order to collect all the evidence possible. There are other methods used, but the one mentioned is the most common.

Various Forms of Irregularities

The most common method in use by current thieves is to remove the line wire at the main switch ahead of the meter, and place a temporary wire or jumper from the blades of the main entrance switch to the contacts on the panel cut-outs, or in other words, "jumping around the meter." Another common method on two-wire service where three-wire meter loops are employed, is to disconnect the middle or shunt wire at the main fuse block or switch. Where a three-wire system is in use, 110 and 220 volts, and three wire meters are used, the customer can prevent registration of his current on the meter by simply backing out the outside fuse on the three-wire main fuse block. In the three-wire system the potential coils of three-wire meters are connected directly across the 220 volt outside wires, therefore, if the fuse is backed out or a blown fuse substituted for a good one, the potential coil is "killed." The placing of jumpers on the line and load wires is the most common method employed in securing unlimited service where indicators are installed.

In another instance it was found that the seal of the indicator was broken and the top contact screwed down so that it would not break the circuit. The main adjusting stem was stuck to the bottom of the indicator with candle grease, thereby obtaining uncontrolled service.

Another form of irregularity is the connecting of lighting circuits and beer pumps to flat rate fan circuits. Then again customers have been detected using fan service on old flat rate fan circuits that had not been removed and without having renewed or made new contracts for service.

Adjustments and Settlements of Irregularities

After all the evidence has been secured, the customer is notified to call at the main office of the company with a view to making a settlement for the use of unmetered service. A detailed report of the irregularity, with the evidence, as in the case of a jumper properly tagged which caused the irregularity, is turned over to the proper official.

The customer is informed of the seriousness of the offense, and an effort is made to find out when the trouble first affected the registration, and who informed the offender how to make the connection. An estimate is made of the amount of energy illegally used.

The following is a record of the actual cases investigated and from which judgments were secured:

31 cases intentional theft, for which collection have been made in past nine months	$4,316.04
59 cases unintentional theft, for which collections have been made in the past nine months	2,538.31
Total	$6,854.35

Settlements for theft of current now average $761.60 per month, or approximately $10,000 per year.

Opinions in the past have varied as to the value of the current stolen by customers on the system in any yearly period. The results of the first year's effort in clearing up the situation do not fulfill the expectations, nor coincide with the judgment of those who have had experience in the matter of detecting irregularities, especially as to the amount and distribution. It is believed, however, that if periodic inspections and tests are made at intervals of one year, rather than three years, as has been the practice, that the number of irregulrities detected would undoubtedly be doubled, with a corresponding increase in collections for stolen current.

One hundred and fifty-nine irregularities were reported and corrected, and upon investigation it was found that the majority of these irregularities were by customers using service on a flat rate basis. This service is controlled by indicators. It is usually found that the customer overloads the instrument, resulting in its operating improperly, thus allowing unlimited use of current. Where customers are using electric irons, vacuum cleaners, and fans on a flat rate, in adjusting any irregularity, we insist that the customer sign a meter rate contract. The location of meters and indicators is changed, and reports of meter seals having been broken investigated. Frequently tenants of apartments have been caught tampering with the indicators for the lighting of the public halls. An average of 28 irregularities are investigated per month, and approximately 400 irregularities are reported during a year.

Prevention of Theft

To prevent the theft of current, great care should be taken in the installation of the service wiring. The distance from the service entrance to the meter should be as short a run as possible. The service wiring should be enclosed in rigid iron conduit or flexible steel armoured cable, run directly into a sealed metal protective device, where the meter terminal wires and main entrance switch and fuses are under seal and free from tampering. A broken seal when located requires immediate investigation.

When adjusting the settlement of an intentional theft of current case, the customer is required to equip his service as mentioned above, the expense to be borne by the customer.

THE TELEPHONE IN WAR

An interesting sidelight on the industrial development of Hog Island is contained in the statement that the big yard makes demands upon its telephone system equivalent to that of an average city of 50,000 persons. Calls handled through the fourteen positions in use on the island's switchboard number about 125,000 weekly, which compares favorably with the average in cities in the 50,000 population class, says the *Emergency Fleet News.*

There are eighty trunk lines, thirty of which are connected to the Locust Exchange in Philadelphia. On the island alone there are 1,039 local extensions. Thirty-one trained operattors are required to maintain the service, which is conducted upon a twenty-four-hour basis.

THE HARVESTING OF POLES

Poles and cross arms are some of the most common materials used in connection with a lighting or telephone plant, and there is probably no material connected with either of these plants of which so little is known, says George W. Tissue, of the Beaver County Light Co. in a recent issue of Light Company News. These materials are often produced far from the centers of civilization and it is the purpose of this article to mention briefly the different kinds of wood used for poles and cross arms, and the preparation of same.

The different woods used for poles are northern white cedar, western red cedar, chestnut, juniper or southern cedar, cypress, and yellow pine.

Northern white cedar is found most abundantly in the northern part of Michigan, Wisconsin, and Minnesota, and in smaller quantities in the territory in the same latitude extending eastward through Ontario, Quebec, and northern Maine to the Atlantic coast. Western red cedar grows in Idaho, Washington, Oregon, Montana, and British Columbia. Chestnut in the Atlantic Coast States from Massachusetts to Alabama inclusive, and in parts of Tennessee, Kentucky, Pennsylvania, Ohio, and Indiana. Yellow pine, juniper and cypress are all southern woods, and are found in more or less abundance throughout the southern states extending as far west as Texas.

Of the woods mentioned, Northern white cedar is without doubt the most durable, and for a great many years has furnished the principal supply of poles. This wood is usually cut during the fall and winter months. On account of its extreme lightness it has been possible to ship it to nearly all parts of the United States. As years go by it is becoming more and more scarce so that to-day the northern part of Michigan which for years has furnished the principal supply produces only a limited amount and it has been necessary to look to other fields. This has brought about the opening up of northern Minnesota, which to-day furnishes the large majority of northern Cedar poles.

Chestnut is the next in importance and is largely used throughout the section where it grows. The weight of chestnut poles, however, is about twice that of Cedar and this fact has made it impracticable to ship for any considerable distance on account of the high freight charges.

Probably the next in importance is creosoted yellow pine which is used to a considerable extent throughout the southern states, with an occasional northern shipment. Yellow pine makes a good pole but decays very rapidly in its natural state and for that reason nearly all the poles are treated with some good preservative. The treatment most used, and which, without doubt, gives the best results, is a treatment with dead oil of coal tar, by the closed cylinder vacuum process. Juniper and cypress come next and are mostly used throughout the south.

The Western Electric Company manufactures and sells poles very extensively and has become the largest single distributor of poles in the country, and in this article some brief remarks in the operations in connection with the production, yarding, and shipping of Northern cedar, this being the pole most extensively used, will be made.

After the poles have been cut and trimmed they are concentrated at a landing yard. Formerly, most of these yards were on river banks, as it was possible to float the timber in the water or on ice, to some central point, but as logging operations were not as often available, it has been necessary to concentrate the poles in yards by means of temporary narrow gauge logging railroads.

When a sufficient number of poles have been received in a landing yard they are sorted and graded as to length, size, etc., and are then shipped to an interior concentration point, where this sorting, and grading is repeated and the poles piled according to inspection. This repeated inspection insures high grade poles and is a necessary and essential factor.

A very important part of a pole line is the cross-arm equipment, and among the woods used for this purpose will be found douglass fir, yellow pine, cypress, oak, juniper and Norway pine. The comparative weights of these arms are for a 3¼ in. x 4¼ in. 10 ft. douglass fir, 34 lb.; yellow pine, uncresoted 42 lb.; creosoted 54 lb.; cypress, 40 lb.; oak, 60 lb.; and Norway pine, 40 lb. A comparative estimate of the life of cross arms of the different materials on the pole is as follows: Douglass fir, 25 to 30 years; cresoted yellow pine, 25 to 30 years; all heart long leaf yellow pine, 10 to 12 years; juniper, 6 to 8 years; Norway pines, 6 to 8 years; oak, 4 to 8 years; sap long leaf yellow pine, 4 to 6 years; short leaf yellow pine, 4 to 6 years.

From this it will be seen that douglass fir is the only wood that will last any considerable time without being treated with some artificial preservative. As a result, its use is generally becoming universal.

Douglass fir is the common term applied to the most important Pacific coast wood, if not the most important American wood. Other terms are yellow, red, western, Washington, Oregon, Puget Sound, North Eastern and West Coast fir—all these terms cover the same wood. In general it may be said that of the standard timber in Washington and Oregon, half is fir and of the remainder something over half is cedar.

Cross-arms are made from the highest quality of timber, the same grade in fact, that goes into flooring, stepping and porch decking. This grade is called yellow fir and corresponds to long leaf yellow pine. Yellow fir is the close straight-grained, healthy wood found on the outer portion of large trees. Red fir corresponds to shortleaf and is the coarse grained reddish colored wood found at the center of the tree. The comparison between the longleaf and shortleaf pine is not exact because longleaf and shortleaf pine are two distinct species. The very center of large trees is red fir and the entire portion of small trees up to two feet in diameter is also red fir.

Cross-arms are trimmed by hand and do not go through the automatic trimmers as other grades do. If the automatic trimmers were used many small defects, would develop and unfit them for use in pole lines. Cross-arms, without paint or other preservatives, will be carrying working lines many years after the mill that produces them has been dismantled. This assertion can be safely made because fir arms put up 30 or 40 years ago are still carrying lines. At the National Museum in Washington there is a fir arm from one of the first Western Union lines, that was up 42 years before being placed in the museum. If this arm had not been close grained yellow fir it probably would not have lasted one-third of the time it did.

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SAVES MONEY BY ARC-WELDING

Arc-welding has been brought prominently before the public through the fact that it was to restore the broken engine castings of the interned German ships. When breaking these castings the Germans thought they could not be repaired, and that it would require a year or more to replace them. However, even before the ships could be otherwise overhauled and made ready for transport service the broken castings had all been repaired and were good as new. This achievements has impressed the value of arc-welding upon the minds of many shop managers, and in many plants castings and other parts of apparatus which in the past would have been scrapped as hopelessly damaged, are now perfectly restored by the arc-welding process at small cost and great saving of time.

One large manufacturer, working on munitions, has installed a Westinghouse arc-welding equipment for the sole purpose of making tools for turning shells.

Ordinarily these tools are made from high speed steel and cost about $12 each. This manufacturer uses high-speed steel for the tip of the tool only, welding it to a shank of carbon—or machine—steel, and in this manner the tools are produced at a cost of $2 to $4.

For several weeks this plant has been turning out 240 welded tools per day, the men working in shifts of four, which is the capacity of this outfit.

The equipment consists of a 500-ampere arc-welding motor-generator with standard control panel, and three outlet panels for metal-electrode welding, and one special outlet panel for the use of either metal or graphite electrodes. This special panel is intended to take care of special filling or cutting processes which may be necessary from time to time, but it is ordinarily used in the same manner as the other panels, for making tools.

These four panels are distributed about the shops at the most advantageous points for doing the work, it not being necessary to have them near the motor-generator or main control panel.

For toolmaking, which involves the hardest grades of steel, a pre-heatng oven is used, not because it is necessary for making a perfect weld, but because otherwise the hard steel is likly to crack from unequal cooling, and also because pre-heating makes it easier to finish the tool after the welding process has been completed. For ordinary arc-welding operations the pre-heating oven is never used.

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WIRING CHART FOR COUNTRY HOME LIGHTING

A chart for showing how to limit the voltage drop in the wiring for country home lighting plants has been prepared for distribution by the engineering department of the National Lamp Works, of General Electric Co., Cleveland, Ohio. It comes in a neat carrying case, which is narrow enough to be slipped into a vest pocket. This chart is to be used in selecting the size of copper wire for 28-32 volt installations, and this wiring may later be used for regular 110-volt service.

As indicated on this chart, country home lighting plants operate at 28-32 volts, and the current to amperes is therefore about four times as great as with 110-volt systems of the same wattage. No. 14 B. & S. gage copper wire is satisfactory for a large part of ordinary house wiring where the load is in excess of 300 watts special circuits of larger size wire should be provided, and also in cases where even small loads are great distances from the plant. It should be understood that heavy loads, such as are required for threshing, shelling, etc., cannot be accommodated with ordinary country home lighting plants.

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ELECTRIC POWER IN ZURICH

The amount of power produced by the Zurich city works within 24 hours is estimated at a minimum of 9,920 effective horsepower or 6,2000 kilowatts and obtained by means of electric generators. The maximum estimates are 15,330 horsepower or 13,300 kilowatts.

The power is sold by kilowatt hours at rates varying from 1.55 to 4 cent per kilowatt hour, according to the amount of power consumed. This system of regulating the cost of power would indicate that the small user is discriminated against in the price as compared with owners of large industries. The former pays ordinarily at the rate of 4, 3.47, and 3.08 cents per kilowatt hour; for a consumption of 200,000 kilowatt hours or more, the 1.55 cents rate is applied.

The industries to which power sales are particularly made are: mechanical repair shops; blacksmith; forging industry; cement and artificial stone manufacturers; builders for driving concrete and other machinery, etc. Besides these relative small factories there is quite a number of larger ones than are using the city current, employing 300 and more workmen. The working staff of the small industries varies from 4 to 25 men.

In addition to the foregoing uses the city electric power is also utilized for the operation of the city street cars, water works, pumping stations, for charging automobile batteries and specially constructed electric boilers for producing steam.

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ELECTRICITY AT LOUISVILLE

Improved gross and net earnings of the Louisville Gas & Electric Company reflect the industrial activity and general prosperity of that city. Electrical output from the Company's modern steam turbine station is running upwards of 25 percent. greater than last year. The gain is due largely to the increased demand for industrial power and to the requirements of Camp Taylor, where 50,000 men are now in training. At Stithton, about thirty miles from Louisville, a new artillery training school is being constructed, and it is probable that the Government will look to the Louisville Gas & Electric Company for the electric lighting and power supply amounting to about 4,000 hp. A trip around Louisville shows every industrial establishment, large or small, working at maximum speed. A great many of these plants are handling a wide variety of war orders including flour, candy, wagons, ambulances, ammunition boxes, tool handles, airplane parts, camp construction equipment, submarine pumps, field kitchens, portable machine shops, camp stoves, ship girders, metallic packing, iron castings, car wheels, machine tools, railroad supplies, agricultural implements, worsted yarn, rope, cords, girths, blankets, khaki dye, soap, glycerine, harness, sole leather, gun stocks, tobacco.

Since the beginning of the year Louisville Gas & Electric Company has accepted 145 new contracts calling for 6,250 hp. additional motor business. Nearly 3,000 hp. of this new business is already connected. Practically all of it is permanent and not dependent upon continued war orders. A considerable new piece of business has been developed in the large factory of the Standard Manufacturing Company, where the successful trial of an electrically operated brass melting furnace, will result in the in stallation of three oven furnaces, each requiring 80 kw. to operate over long-hour periods.

HYDRO-ELECTRIC DEVELOPMENT AT ROCHESTER, N. Y.

It is probably supposed that hydro-electric development means a huge plant to serve half a state. Less striking, but often far more practical, is the moderate-sized plant which adds the energy of some waterfall, strategically located, to a system which must rely on other sources for most of its power. Such is the new 25,000 kva. station of the Rochester (N. Y.) Railway and Light Company, located in the gorge of the Genesee in that city.

A study of the topography of the river showed that the proper place for a plant was near the bottom of a series of falls. Here was a reach of 1.5 miles in which about 23,000,000 cu. ft. of water could be stored above two drops of 40 and 90 ft. respectively. The plant was designed to empty this pond daily during the dry season, taking the peak load off the steam station and shutting down over night to allow the pond to fill. This would flatten the steam plant's load curve, giving improved efficiency.

The structures were designed for an ultimate capacity of 48,000 h.p. and apparatus being installed to take 32,000 h.p., a new dam was built composed of two 100-ft. sector gates which retreat into pits into the river bed, and four 50-ft Taintor gates were adopted, as they can be raised clear of the water, giving an unobstructed passage for flood water of 83 percent. of the channel. The intake house is located at the center of the dam, and is provided with curtain walls extending 4 ft. below low-water level. This diverts much trash from the racks inside. Sixteen openings, 12 ft high and 10 ft. wide, are provided with vertical gates to admit water to the tunnel. This is cylindrical, 20 ft. in diameter which drops vertically, then turns into a section 1400 ft. long leading to the penstock connection at the power-house. Directly over this latter point is the vertical connection to the surge tank located on a shelf of the high bluff back of the station. Each penstock connects through a Johnson valve to the scroll case of a turbine.

Two vertical Francis turbines made by the I. P. Morris Company are used. They are rated at 16,000 h.p., 180 r.p.m., 130 ft. head and have runners of 96 in. diameter. The governors are of the double floating lever type, oil-operated. They are provided with remote control from the switchboard gallery, and may be controlled by hand also. A Kingsbury thrust bearing of 100 tons capacity is used to sustain the vertical (gravity plus reaction) load.

The two generators were furnished by the Westinghouse Electric & Manufacturing Company. Each is rated at 12,500 kva. at 0.90 power-factor, 3 phase, 60 cycle, 11,000 volts, star-connected. Protection to the generators is given by the Ricketts. In each phase a current-transformer is connected at the inner end and another one in the cable just inside the first disconnecting switch. The secondaries of these transformers are connected across an overload relay. Normal conditions cause a current to circulate through the two secondaries none following through the relay. Should a fault develop in the winding or cable the leakage current would cause an unbalance in the transformer secondaries, which would force current through the relay. This would trip out the main oil circuit breakers and open the field circuit of the machine in trouble.

The upper guide-bearing bracket of each generator carries a 100-ton Kingsbury thrust bearing, which supports the rotating parts and water reaction. Above this is mounted a 100 kw. 250 volt exciter. Excitation can be secured also from a motor-generator set.

The station structure itself is of reinforced concrete in simple lines with large window areas. It covers a space 75 ft. by 20 ft. which allows liberal space for the two present-units only. Before the third unit is installed the old building adjoining it must be removed and the station extended. The geneator floor is 14 ft. above high water level. From this floor to the bottom of roof trusses is 59 ft. A central line of columns support the switch galleries which occupy one-half the station; the space over the machines is left clear for the crane.

From the generators, 11,00-volt cables pass to the high-tension bus structure on the topmost gallery. The framework of this is a combination of brick piers and precast concrete slabs. The bus bars are arranged in a tier of compartments running down the center, with oil-switch compartments on one side and disconnecting switches on the other. Since this station also supplies a distribution network in its vicinity, two 5,000-kva. 3-phase transformers are installed in compartments on the main floor. These supply a 4150-volt bus on the first gallery level. Oil switches for the distribution circuits and for a number of arc transformers are located directly below this bus. The actual arrangement of switches, etc., is shown on the wiring diagram.

The main operating switchboard is located at the front of the first gallery. It was furnished by the Westinghouse company, and includes panels for the generators, spare exciter, tie lines, etc. Black-dial meters are used throughout. Potentiometers for measuring the generator temperatures are located on the face of each generator panel and connected to thermocouples imbedded in the machine windings.

Auxiliary power is furnished by 440-volt, 3-phase motors These include the spare exciter unit, a 4.5-kw. motor-generator set for the control-circuit storage battery; two 3 h.p. motors driving oil pumps for the thrust bearings; two 15 h.p. motors driving governor oil pumps and two compressors which furnish air for the governor accumulator tanks, for cleaning, and for operating brakes on the generator fields for stopping. The crane motors are operated at 230 volts from the spare exciter. A double-throw switch connects this generator either as a shunt machine direct to the field-control panels at the alternators, or as a compound-wound machine through a circuit-breaker to the cane trolley.

Official approval for the project was given in March, 1916, and ground was broken on May 15. The work included the removal of an old building on the powerhouse site, removal of an existing dam and construction of a new inclined railway down the nearly vertical bluff near the powerhouse, to lower a 40 ton load. The entire job cost approximately $1,750,000.

OIL-COOLED TRANSFORMER CASES

Ingot iron sheets are used principally for the cases of oil-cooled Westinghouse transformers. In order to give the case a larger radiating surface, it is first crimped. They are then welded together by an arc to form a rectangular box without top or bottom. In welding, one terminal of the elec-eric circuit is fastened to the material and the other to a holder in which is fastened a strip of scrap ingot iron sheet. An arc is drawn between the material and the movable electrode, and by the process of melting down the latter, a continuous bridge of metal is formed. These prints are oil-tight and as strong as the remainder of the sheets.

To attach the bottom, the sides are held over a sand mould, molten iron is then ran from a furnace to the desired depth. An oil-tight and very strong joint is thus formed with the sheet iron sides. The top-casting is formed, by inverting the case over another mold, and allowing the flowing sheet iron to run over it. The case contains the necessary openings for the transformer to be enclosed and for the transformer to be enclosed and for the entrance of wires.

This transformer is shown in the annexed cut. It is used extensively, as the link between the central stations distributing lines and the low tension wires, which enter the consumers premises. As these are generally installed out-doors, the rust-resisting qualities of ingot iron, built in sizes up to 200 kva. and for voltages up to 33,000 volts.

The use of rust-proof iron is a necessity, because a failure of one of these cases, due to rusting, would allow the oil to leak out rapidly, and as the transformers are not usually inspected, the unit might be subjected to full load and with no oil to keep it cool. This condition would cause it to burn out in a few hours, and create loss to the operating company as well as giving poor service, or none at all to its customers.

Another type is used in sizes from 100 to 1500 kva. up to the highest operating voltages. It serves as a link between transmission lines and large customers or distribution system. This type is also often installed out of doors.

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ADDITIONAL POWER FROM LINE SHAFT BY TURBINE

Electric motor drive, the simplest solution to additional power supply problems, is oftentimes not available to mill owners, whose plants are driven by line shafts. Often, however, there is sufficient boiler capacity in his plant to do the work, if it is effectively applied. Particularly where line shaft drive to a small number as machines is used. The installation of a turbine with speed-reducing gears is an ingenious solution to the problems.

A unique line shaft drive, consisting of a Westinghouse low pressure turbine with daubee reduction gear has been installed in a western Pennsylvania paper mill. There are two main line shafts to which the machines are belted. To one of the line shaft are belted two cutters, ten beaters and one Jordan, an identical equipment, with the exception of the cutters, is belted to the other shaft.

Only seven of the ten beaters, under ordinary running condition are in operation at one time, and these with one Jordan, require about 600 hp. An additional 20 hp. for the ragcutters.

Heretofore, these two line shafts were each driven by a non-condensing reciprocating engine.

A few approximate figures show the fitness of low-pressure turbine for this application. The exhaust steam from the 700 hp. corliss engine was more than sufficient to give 600 hp. in the low pressure turbine. The engine takes steam at 150 lb. pressure, and exhausts into an oil separator at a back pressure, depending on the load, from 0 to 4 or 6 lb., which is approximately the pressure of admission to the low pressure turbine. The steam is then expanded in the turbine down to a vacuum corresponding to 27½ in. of mercury referred to a 30-in. barometer, the vacuum being maintained by a low level jet condenser and air pump. The pumps are centrifugal and are driven by a small turbine through a reduction gear. They take their water from a nearby creek and discharge it from the condenser into a reservoir at an elevation of 45 ft., which water is used in the manufacturing processes. The small turbine runs non-condensing, and its exhaust steam goes to the feed water heater, so that only a part of the heat energy in the steam used by it can be charged to the turbine, and even that cannot be charged against the main turbine, for it is used to do work in elevating the discharge water from the condenser to the reservoir and should becharged against the total cost of manufacturing. In brief, it may be said, that this paper company actually gets 600 hp. without paying a cent for steam, and that it is using just one-half the steam they formerly used with two reciprocating engines to obtain the same power.

The change in speed is made by means of two reduction gears, because the first cost of a single gear and pinion of ratio 36 to 1 would be prohibitive, and the gear would be very large and unwieldy. The first speed reduction, 3600 r.p.m., to 720 r.p.m., is made with a fixed bearing type of reduction gear, the gear shaft of which is direct connected to the pinion shaft of the second gear which reduces the speed from 720 to 103 r.p.m.

In this, the pinion is supported on three bearings in a frame, as shown in Fig. 3. This frame is supported under the middle bearing on an I-beam at right angles to the pinion axle. The flexibility of the web of this I-beam support allows the pinion to tip slightly and to let the teeth of the pinion line up with those of the gear. This lining-up is entirely automatic and instantaneous in operation, so that no mechanical complications are encountered, and no adjustments from the outside of the gear case are necessary at any time.

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NITRATE PRODUCTION NOT AFFECTED

The production of nitrates for the Government will not in any manner be affected by the recent order causing the temporary suspension of work on the water power development at the Muscle Shoals nitrate plants, according to a statement just issued by the Ordnance Department.

This order was issued upon representatives made by the War Industries Board to the effect that the materials used in the erection of the water power plant on the Tennessee River, should be regarded as non-essentials. The effect therefore is to stop only the erection of the plant, power from which was not anticipated for some four or five years.

The development of this water power project was undertaken by the War Department in line with its established policy of utilizing these plants for the production of nitrates for use in agricultural pursuits after the war is over, by which time the water power would be available.

The work on the Muscle Shoals plants is progressing rapidly, one of which is about 60 percent. complete, and over 20,000 men are now employed there. Ample power for the operation of these plants is obtained from a steam-electric station erected on the Tennessee River, and also purchased from the Alabama Power Company.

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TELEPHONE SUBSCRIBERS MUST PAY MOVING COSTS

The Postmaster General has issued the following order relating to charges for installing telephones:

Owing to the necessity for conserving labor and material and to eliminate a cost which is now borne by the permanent user of the telephone, a readiness to serve or installation charge will be made on and after September 1, 1918, for all new installations, also a charge for all changes in location of telephones.

Installation charges to be as follows: Where the rate is $2 a month or less, $5; where the rate is more than $2, but not exceeding $4 a month, $10; where the rate is more than $4 a month, $15.

The moving charge to the subscriber will be the actual cost of labor and material necessary making the change.

In accordance with Bulletin No. 2, issued as of August 1, 1918, stating that "until further notice the telegraph and telephone companies shall continue operation in the ordinary course of business through regular channels," in all cases where rate adjustments are pending or immediately necessary they should be taken up by the company involved through the usual channels and action obtained wherever possible. In all cases, however, where rates are changed such changes should be submitted for approval.

GENERAL ELECTRIC'S BUSINESS

Reflecting super activity due to war time conditions, the General Electric Co. would surprise but few if the volume of sales billed in 1918 should reach the $225,000,000 mark, against $196,926,318 in 1916. The corresponding total for 1906, or 12 years ago, was $43,146,902, and for 1896, or 22 years ago, was $12,730,058.

The percentage cost of sales of 85.2 percent. in 1917 was the lowest in many years. The percentage cost of sales in the last five years, including depreciation charges, which, on the case of General Electric are always large, has been about stationary and the averge for the period is 88.7 percent. This profit of 11.3 cents on the dollar compares with 14.1 cents in 1916 and 7.9 cents in 1896.

Manufacturing and labor costs being higher, it is probable General Electric this year will report a smaller percentage of net. As compared with 85.2 percent. in 1917, ratio of manufacturing costs and interest charges to sales billed will probably be not less than 88 percent. this year. Applying this year. Applying this percentage to the estimated total of $225,000,000 sales billed would give $27,000,000 net, to which must be added "other income" last year amount to $4,512,290, or $31,512,290 in all.

This company has subordinated regular business to the Government's needs. A substantial part of its present production consists of turbines for merchant ships and war vessels. The company has a blanket order from the Government to turn out as many turbine sand as much electrical equipment as its facilities will permit, so that with ordinary business accumulating, capacity operations at all plants are assured indefinitely.

MOTOR DRIVE IN NEWBURGH SHIPYARD

The Newburgh Shipyard, which will specialize on standard 900-ton steel cargo vessels, is one of the shipyards made necessary by the present war demands for all kinds of ships. A year ago the shipyard's site was a marshland, while to-day on made ground that required thousands of cubic yards of fill, there are numerous buildings and four shipways, while the actual construction of four large steel ships is well under way. The launching of the first standard 9000-ton steel cargo vessel took place in August and the other three ships will shortly be completed.

The structural steel shop leads the various departments in active operation. The system of motor drive employed in the shop is of special interest at this time, because of the typical example of the emergency war installation.

Some of the conditions, which were taken into consideration, in laying out the drive follows: (1) The machinery had to be arranged to allow rapid and economical production. (2) The machines were to be managed by more or less unskilled men and they had to be safeguarded as completely as possible. (3) Time was a vital factor and as deliveries of special apparatus was at that time very slow, the best possible use had to be made of such available equipment as could be obtained within a reasonable length of time.

Power was obtained from the Central Hudson Gas & Electric Co. In order to insure maximum output for each machine, it was decided to use individual motor drive throughout, and to provide complete flexibility as to the arrangement of the machines in the shop.

The Central Station only supplies the alternating current, as practically all the machines in the shop; namely the punches and shears are of the constant speed type, and squirrel cage motors are used exclusively. The only exceptions are the furnace blower and the bending rolls, both of which require speed variation. The furnace blower, which supplies air for the crude-oil plate and angle furnaces, is driven by a slip-ring motor with a drum-type speed controller. The bending rolls where originally driven by a motor generator set, but due to the fact that this equipment was decidedly antiquated (war conditions making it impossible to secure modern apparatus, at the time when it was wanted) variable-speed, alternating-current motor is installed to fill its place.

From the accompanying illustrations it can be seen that all the machines are belt driven. This is not the best practice for such machines, as a punch, or a shear. Engineers generally favor mounting the motor on the machine and driving by means of gears. However this type of device requires special machine work and a special high starting torque motor, and had these been decided upon, it would have added months to the date of delivery of the equipment. For the above named reason standard motors with belts are in use.

The high starting torque motors would have been desirable, because of their considerable flywheel effect, but it was thought that the belts would slip enough in starting to relieve the motors of the excessive stresses that occur at this time and so far this has proved to be the case, as none of the motors have given any trouble.

Wire screens carefully protect all gears, pulleys and belts. All of the motors, that are started and stopped by the steel workers are controlled by auto starters or oil switches, which have no exposed live parts and can not be improperly manipulated by the most careless person. Protection against overloads and failure of power is provided for by automatic means.

The central station supplies the current at 5,700 volts. A small substation in the shipyard, which consists of a bank of transformers and a panel carrying the necessary switches and meters, reduces the voltage to 220 volts, for use around the plant.

SAWMILL REFUSE AS A CENTRAL STATION FUEL

"Hog" fuel consists of sawmill refuse after it has been put through a machine which shreds and grinds it into a fairly homogeneous material.

Following wartime economy, all central stations are giving increased attention to the fuel problem. The price of oil has already advanced to such a point that a very careful investigation of the different kinds of fuel for generating purposes, and their costs, is imperative, and it seems possible that in the near future fuel oil will not be obtainable at all except where authorized by the Government. Where an adequate supply of hydroelectric power is not available, the alternative is to use either coal or wood. A present these two fuels are used most efficiently as powdered coal and "hog" fuel. Lower grades of coal may be burned when finely pulverized and the only practical way to burn wood in the larger plants is in the "hogged" state.

For the large generating station running at a high load factor the use of powdered coal would probably be most efficient, but the cost of the apparatus required to pulverize the coal, and the power consumed in operating the crushing plant, combine to materially increase the price per ton. Especially is this the case in plants used principally for "standing" or in generating plants operating at a low factor. Then it would appear that for stations of intermediate size (from 1000 kw. to 3500 kw. capacity), the use of "hog" fuel is a matter deserving very careful investigation.

Hog fuel varies in consistency from fine sawdust to slivers or shreds eight inches in length. The combustion property of this fuel depends upon the class and kind of timber being cut in the sawmill. In this territory (Bellingham, Wash.) the greatest production is from fir which has the highest heat value of any. The firing qualities of this fuel may be appreciated from the fact that at the Larson Plant of the Bloedel Donovan Lumber Mills, one hundred percent. above rated capacity has been attained on the boilers. In one test upon a 750 h.p. Stirling boiler, starting cold, a full head of steam was obtained in one hour and forty minutes. While the fuel used was partly sawdust and shavings, it would indicate that considerable flexibility could be expected in the handling of peak loads with the ordinary hogged material.

This fuel is usually measured in units of 200 cubic feet. The heat content per pound is approximately 4400 B.t.u., and a units weighs about 5000 pounds. The convertibility of this fuel into heat is naturally not so complete as in the case of oil or coal, although in steam plants having an overall efficiency equal to that which we usually find in plants of 1000 kw. or larger, a unit hog will generate approximate 450 kw. hr.

At the Bloedel Donovan Plant there is, roughly speaking, one unit of waste for every one thousand board feet of lumber manufactured. The proportion of waste depends upon the grade of lumber turned out and upon the size of the timber cut, the smaller logs yielding a higher proportion of waste. From this waste 60 cords of wood are saved daily and 60 units of sawdust and hogged material go to the steam plant. It is estimated that double this quantity or the equivalent of 120 units goes to the dump where it is burned. Incidentally, this amount of waste would furnish fuel for a 2500 kw. station and represents potentially 16,200 kw.-hr. per year.

Following is a description of the production and utilization of hog fuel in the plant of the Bloedel Donovan Mills.

This plant has a capacity of 250,000 feet of lumber per eight-hour day. There are two band saws, a 10 foot and a 9 foot, respectively; also a 7 foot resaw, a 14 by 40 gang, and a 12 by 10 inch edger, automatic air lift trimmers and other up-to-date machinery for speeding up the output of lumber.

In their steam plant the prime movers consists of a 1000 hp. Corliss engine and a 1000 kw. steam turbine. Besides these units, several small engines and some auxiliary apparatus are supplied from the boilers, the normal output being 2200 boiler hp. This fuel is easy to fire and that is an important factor; men can be obtained at the predominating rates of pay without any trouble. A 200 foot brick stack by 10 foot 2 inches inside diameter at the base furnishes the draft. The furnaces are of the usual Dutch oven type of construction. A double grate made up of 5 foot bars is used, thus making an overall length of 10 feet, and affording a large combustion chamber, with a grate surface of 120 square feet per boiler of 750 hp. The fuel is carried to the boiler room by a conveyor into which all the chutes from the different machines about the mill empty. A 40 inch hog fed from an edger, also empties into this conveyor. There are two other main conveyors, one of which carries the slabs and that portion of the timber which goes to the wood bins. The other handles the greater amount of by-product, the waste. This conveyor leads to the dump where several carloads of refuse are burned daily. The last section of the conveyor is hydraulic. The apron is movable and the pile of refuse that has accumulated in one day's run is burned the day following; the apron being moved to accomplish this. At all times there is one pile burning and one accumulating. This refuse is the material which will be ground up by a large capacity hog machine and dumped into cars below when there is further demand for this kind of fuel.

For the central station where uninterrupted service is so essential and where the future must be so carefully guarded, the reliability and the continuity of the fuel supply is most important. Hog fuel being the by-product of sawmill operation, its steady output depends upon the lumber mill operation, which in the past has fluctuated widely. Its use by central stations would therefore be justified only where adequate provision to insure the future supply has been made.

One of the principal disadvantages of hog fuel is its bulk. It would be impracticable to transport it over any considerable distance, as for instance, a plant with an average load of 4000 kw. would require from 18 to 20 carloads per day. Then there must be storage facilities necessary to provide an adequate reserve

Some companies simply pile it out of doors the same as handling a stock of coal. At the generating station the hog fuel is handled from the cars to the storage bins and from the storage bins to the furnaces by a system of chain or belt conveyors. The capital account requirements at this end will include a large capacity stack, the storage bins, and the Dutch ovens.

The price per unit at which hog fuel may be obtained makes it an attractive proposition, but local or special conditions often are the controlling factors in any power situation. In fact the price per unit in most cases would be reduced to the vanishing point in order to compete with economically developed water power.

R. U. Muffley in Stone & Webster Journal

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POWER HOUSE LYRIC

Aladdin's Lamp well rubbed they say,
Could turn the darkness into day.
Build palaces and shift them where
It listed through the desert air:
Yea, if so needed lift the hills aside
Or dim the stars and stem the ocean's tide,
Make jewels rare from sand and human clay,
And ride its owners 'cross the sky's highway,
Speed messages from zone to zone
Where'er its keeper wished to have them known.

Such magic this beguiled our boyhood dreams,
Yet simple now the genii's labor seems:
We do all these, the well-rubbed lamp we know
Is but the purring, whirring dynamo,
Whose current flowing as its owner wills
Can set aside the bulk of earthen hills,
Light up the night and send the stars away,
Replace the moonbeams with the glow of day,
Concoct new jowels in the hot retort
And guide the wandering vessel to its port.
No task too great or small of all we show
To daunt the stirring, turning dynamo!

Don C. Seitz, in the Edison Monthly.

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It has been announced that arrangements are under way for the unification of the two telephone systems in operation in the city of Sandusky. When this is brought about the service should be greatly improved and considerable saving will be effected for the subscribers.

DID YOU KNOW THAT-

BITS OF GOSSIP FROM THE TRADE

Bulletin 47433 from the General Electric Co., Schenectady, N. Y., treats of oil circuit breakers for industrial service up to 300 amperes and 2500 volts.

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The Goodwin Plan, which preaches the gospel of reorganizing the contractor-dealer as the logical retail distributor and treating him accordingly, has been under the consideration of the electrical trade for the last several months. The distributor and central station have long recognized the advisability of such a practice and welcomed the plan. Now it is being adopted and developed by manufacturers. The National X-Ray Reflector Company has recognized it to the extent of making allowance for it in its new system of discounts. With this new system, the distributor, the contractor-dealer and the industrial plant which buys in quantities are all taken care of but each with a different discount.

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Condensers, Pumps, Cooling Towers, Etc., is the name of Bulletin 112-A just published by the Wheeler Condenser & Engineering Co., Carteret, New Jersey. Readers contemplating the installation of a condenser will be interested in a discussion in this bulletin entitled "Choice of Kind of Condenser" and in the remainder of the bulletin which illustrates and describes other Wheeler Condensing Machinery in detail. The bulletin embraces large and small Surface Condensers showing typical complete installations; rectangular and cylindrical types; jet condensers; barometric condensers; Wheeler Edwards air pumps; Wheeler rotative dry vacuum pumps; the Wheeler turbo air pump; centrifugal pumps for circulating water; natural and forced draft cooling towers. In addition, a page is devoted to the Wheeler feed water heater and two pages to Wheeler multiple effect evaporators and dryers.

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Bates Expanded Steel Truss Company, Chicago, Ill., is distributing an attractive paper weight embellished with a view of a Bates steel pole in combination service. A limited number of these serviceable souvenirs is available and will be sent upon request.

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Haller Consolidated Electric Sign Company has moved its new location at 113 N. Desplaines street, Chicago, which provides several thousand square feet of floor space. The building consists of three floors and a basement, so when the electric sign business gets back to normal the company will have facilities for a large output.

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Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been awarded contracts for three 15,000-k.w. generators for a generating plant, which will cost approximately $5,000,000 to erect, and will be used in connection with the Government ordnance plant now being built in Neville Island. The contracts were awarded by the United States Steel Corporation, which acted for the United States Government.

PURELY PERSONAL

G. B. Turner, manufacturer of standardized electric signs at Ypsilanti, Mich., has enlisted in the Ordnance Department of the U. S. Army.

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J. G. Fisher, superintendent of the Drumright division of the Oklahoma Gas & Electric Company, has joined the United States Army, and is now in training at Camp Pike, Ark.

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N. P. Bray, of the Sapulpa Electric Company, Sapulpa, Okla., has entered the U. S. Army.

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Henry L. Doherty has been appointed a member of the American committee on the standardization of petroleum products.

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H. E. Abel, W. J. Bachman and W. H. Boyle, of the Arkansas Valley Railway Light & Power Company, Pueblo, Colo., have entered the service.

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Ralph H. Rice, assistant engineer of the Board of Supervising Engineers, Chicago Traction, has been commissioned as captain in the Construction Division of the army.

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H. H. Murray, recently with the General Electric Co. has been appointed electrical engineer of the Eastern Connecticut Power Co.

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George H. Cook, manager of the Wisconsin Gas & Electric Co. at Kinosha, Wis., has resigned to enter the U. S. Army.

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H. C. Deffenbaugh, formerly assistant secretary of the Emprie State Gas & Electric Association, has been appointed first lieutenant of engineers and attached to the 56th Engineers, Washington Barracks.

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A. L. Martin, manager of the Coos Bay division of the Oregon Power Company, Marshfield, Ore., has volunteered in the U. S. Engineering Corps, and expects to enter a training camp soon.

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D. P. Cartwright has been appointed manager of the New York branch of the North East Electric Company to succeed R. J. Hardacker, who is shortly to assume the management of the Chicago Branch.

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J. F. Owens, vice-president and general manager of the Oklahoma Gas & Electric Company, recently addressed the Enid, Okla., Rotary Club on the subject "What Can Be Done To Aid The Returning Soldier After The War."

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C. H. O'Reilly, formerly of the accounting department of H. M. Byllesby H. M. Byllesby & Company, Chicago office, stationed at Fort Sill, Okla., has been commissioned a lieutenant in the Quartermaster's Corps as a result of his work at the Quartermaster's School at Jacksonville, Fla.

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W. H. Morton, formerly secretary of the National Electrical Contractors' Association, and who resigned that position in 1913 to engage in fruit growing in Porto Rico, has returned to the United States and taken up the duties of general-manager of the new organization, the National Association of Contracts and Dealers.

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Guy E. Tripp, formerly chairman of the Board of Directors of the Westinghouse Electric & Mfg. Co. and recently colonel in the U. S. Army in charge of the Production Division of the Ordnance Department, has been promoted to brigadier-general and attached to the staff of General Williams, Chief of Ordnance, at Washington, D. C.

John D. Ryan, president of the Montana Power Co. has succeeded E. R. Stettinius as Second Assistant Secretary of War. He is Director of Air Service, and is responsible for the furnishing of aircraft to the A. E. F. and home troops. All of his time will be devoted to war work.

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T. F. Johnson, formerly superintendent of transmission and distribution of the Georgia Railway & Power Co. has recently been promoted to assistant superintendent of the electrical department.

P. D. Wagoner, recently president of the General Vehicle Co. of Long Island City, N. Y., has been elected president of the Elliott-Fisher Co. of Harrisburg, Pa.

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Harry C. Brown has resigned as secretary of the National Association of Electrical Contractors and Dealers, the resignation taking effect on Sept. 30. Mr. Brown had served the association continuously since February, 1916, with the exception of three months. Besides acting as secretary of the association, Mr. Brown was also editor and business manager of its official jornal, *The Electrical Contractor-Dealer.*

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George V. W. Ingham, who has been a field representative for the Bryant Electric Company in the central western territory for several years past, has been appointed eastern sales manager, with headquarters at the factory, Bridgeport, Conn. Mr. Ingham will direct the sales activities of the company in the territory east of the Alleghany mountains.

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R. U. Steelquist, formerly manager of the Oregon Power Company, at Dallas, Oregon, has been promoted to manager of the Albany (Oregon) Division of the company, succeeding J. L. White, resigned. H. A. Joslin, formerly local manager of the company at Eugene, has been appointed to succeed Mr. Steelquist at Dallas. Fred Brown, of the Tacoma Gas Company, has been appointed local manager at Eugene.

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Hon. Arthur Whitney, representative of the Dover District to the State Legislature, has given over his residence in Mendham, N. J., to the Federal Government for use as a convalescent hospital for U. S. soldiers. Fourteen of them are now being cared for there. Mr. Whitney has given instructions for the erection of a line about three-quarters of a mile in length, unning over his property from his residence to a point where connection will be made with the lines of The New Jersey Power & Light Company. It is his intention to install all of the latest electrical appliances.

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R. L. Lloyd has severed his connection with the Philadelphia Electric Company and has entered the engineering department of the American International Shipbuilding Cosrporation at Hog Island, Pa. Mr. Lloyd, as commercial engineer for the Philadelphia company specialized in refrigeration and later devoted considerable attention to electric vehicles. He was chairman of the Philadelphia section, Electric Vehicle Association, for a number of years.

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OBITUARY

Thomas R. Taltaval, editor of the *Telephone & Telegraph Age,* and formely associate editor of the *Electrical World,* died at his home in Mahwah, N. J., last month. He was one of the old timers in the still youthful electrical field, being an expert telegrapher long before the telephone, electric light, trolley car, or long-distance power lines came into being commercially. At one time he was superintendent of the leased wire system of the Associated Press.

Lieut-Col. Morris N. Liebmann, second in command of the 105th Infantry in France, and in civil life vice-president of Foote, Pierson & Company, New York City, manufacturers of electrical testing apparatus, was killed by a rifle bullet on August 8 while leading his men in action with the British. Colonel Liebmann was a veteran of the New York National Guard, serving nearly eighteen years, and served throughout the Spanish-American war with a guard regiment from Nebrasko.

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ASSOCIATIONS AND SOCIETIES

A. I. E. E. Committees

President Adams, of the American Institute of Electrical Engineers, has announced the appointment of the committees for the administrative year. The chairmen of the committees appointed are as follows: Finance, N. A. Carle, Newark, N. J.; Meetings and Papers, W. I. Slichter, New York; Editing, Henry H. Norris, New York; Safety Codes, Farley Osgood, Newark, N. J.; Board of Examiners, F. L. Rhodes, New York; Sections, W. A. Hall, Lynn, Mass.; Student Branches, C. Francis Harding, Layayette, Ind.; Membership, H. A. Pratt, New York; Public Policy, Calvert Townley, New York; Headquarters, N. A. Carle, Newark, N. J.; Electrical Engineering Service, Wm. A. Del Mar, New York; Code of Principles of Professional Conduct, George F. Sever, Washington, D. C.; Standards, L. T. Robinson, Schenectady, N. Y.; Power Stations Philip Torchio, New York; Traction and Transportation, New York; Industrial and Domestic Power, A. G. Pierce, Pittsburgh, Pa.; Lighting and Illumination, C. E. Clewell, Philadelphia, Pa.; Economics of Electric Service, W. B. Jackson, Chicago, Ill.; Protective Devices, D. W. Roper, Chicago, Ill.; Electrochemistry and Electrometallurgy, Carl Hering, Philadelphia, Pa.; Electrophysics, F. W. Peek, Jr., Pittsfield, Mass.; Telegraphy and Telephony, Donald McNicol, New York; Marine, H. A. Hornor, Philadelphia, Pa.; Use of Electrocity in Mines, K. A. Pauly, Schenectady, N. Y.; Electrical Machinery, Alexander M. Gray, Ithaca, N. Y.; Instruments and Measurements, S. G. Rhodes, New York; Iron and Steel Industry, Eugene Friedlaender, Braddock, a.; Educational, V. Karapetoff, Ithaca, N. Y.

Arrangements made by the Meetings and Papers Committee have been approved by the Board of Directors for Institute meetings to be held in Philadelphia, October 11-12, 1918, and in Toronto on November 22, 1918.

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Jovian Convention Oct. 24-26

There are two important questions that stand our prominently before the Jovian convention to be held October 24-26, at Dallas, Texas. They are: first, that of financing the organization, and, second, that of directing the greater part of the activities of the organization during the coming year to war work.

The drain of war conditions, through enlistments and other war activities of the membership, have been so heavy that a new scheme for financing has become necessary. While particulars of the plan can not be given out at this time, it may be stated that all officers and members who have been instrumental in constructing it, and other members who have been consulted, belive that it offers the solution for financing the organization that has been sought for the past several years.

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CONVENTION BANQUETS

In response to a recent inquiry concerning banquets the Food Administration stated:

"The Food Administration wants the American people to eat wisely and well and without waste. Our people ought to eat in such a way as to maintain their strength and efficiency and with due regard always to the demands of our food resources in winning the war. To most American that means three good meals a day. So far as food alone is concerned, it makes no difference whether one of these meals is called a banquet instead of a dinner, so long as it does not transgress any of the requirements that loyal Americans should keep in mind.

If in order to be a banquet it must be a fourth and unnecessary meal, or must include foods that American ought to be conserving to meet war needs, or must be wasteful of food, then it is bad. But it is not necessarily bad merely because it affords an occasion for members of a convention or others to gather at a pleasant meal. Many banquets have been made the means of attractively and effectively presnting the gospel of food conservation.

The Food Administration has approved many means for large dinners of marked simplicity, which invariably have been well received."

The query arises, why "banquet" when one can dine?

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DIRECTORY *of* AMERICAN ASSOCIATION OF ENGINEERS

A directory of engineers, giving a brief synopsis of the experience and training of all members of the association, issued for the good of the members and a san aid to the employer of engineers. This directory of the American Association of Engineers improves upon the common society year book, and is an actual engineer's directory. It gives a brief synopsis of each member's experience and training, which will be of definite usefulness to the employer of engineers, who will be able to tell whether an applicant fills his needs without the loss of time from unnecessary interviews.

Classified tables have been compiled based on experienced, so that it is possible to find a consulting engineer, an executive or a subordinate having specific experience and living in any definite locality. Thus, if one needs a consulting hydraulic engineer, or a designer of machine parts, he is able to find men having this experience through the aid of the classified tables.

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NO DRY ROT IN THIS SOCIETY

The annual election of officers of the Cleveland Engineering Society was about due. Most of the members felt their society had been too humdrum in matters engineering as well as matter relating to the city in general. They nominated a young engineer for secretary who, developments later showed, also felt decidedly this way about the matter; so much so that he put the proposition up to the society that it was time they had a real engineering society, and that he would accept the nomination only on the basis that he would either make it or break it, and asked them what they thought of it. The unanimous reply was, "Go to it, my boy," or words to that egect, "and we will help you." The secretary advised them they were going to help all right, as that was part of the program.

What he did was to arrange with the editors of the four leading papers of the city to run engineering articles in the Sunday supplements. These were written in non-technical terms by the society members, readable by the general public, on matters engineering.

They were supplied without charge and published without charge to the society. They were such high-grade reading that the editors clamored for more of them. The Cleveland public soon learned fully that an engineer was considerably more than the man who fired the boilers in the flats, winter times; or one of those fellows they remembered who ran the engine in the grist mill in the country town, "back home." That, however, was only the incidental accomplishment; the large item was that in a very short time the society was called upon for counsel in the Chamber of Commerce, and in the City Council, first results that in less than a year after this secretary proposed his plan, no matter was question involving engineering matters came up, the invariable comment was; first let us find out what the Cleveland Engineering Society thinks about it.

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HOW TO KILL AN ASSOCIATION

There are ten ways to kill an association, no matter how active and thrifty it may happen to be, says the *Builders Bulletin*. They are:

1. Don't come to the meetings.
2. But if you do come, come late.
3. If the weather doesn't suit you, don't think of coming.
4. If you do attend a meeting, find fault with the work of the officers and other members.
5. Never accept an office, as it is easier to criticise than tr do things.
6. Nevertheless, get sore if you are not appointed on a committee, but if you are, do not attend the committee meetings.
7. If asked by the chairman to give your opinion regarding some important matter, tell him you have nothing to say. After the meeting tell everyone how things ought to be done.
8. Do nothing more than is absolutely necessary, but when other members roll up their sleeves and willingly, unselfishly use their ability to help matters along, howl that the association is run by a clique.
9. Hold back your dues as long as possible, or don't pay a' all.
10. Don't bother about getting new members. "Let George do it!"

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Emergency Construction for the War Department of the United States," illustrated by lantern slides, was the subject of a lecture before the Chicago Section of the A. I. E. E. on September 23, by Lt. Col. Peter Junkersfield. It was well attended.

On September 4 the five national engineering societies which have sections in San Francisco, organized what is known as the Joint Council of the Engineering Societies of San Franciso. This council includes representatives of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers, and the American Chemical Society. There are four representatives from each society, or 20 in all, on the council. The executive committee is composed of Messrs: C. D. Marx, chairman; E. C. Jones and E. C. Hutchinson, vice-chairman; N. A. Bowers, secretary-treasurer; E. O. Shreve, assistant secretary. The purpose of this organization is to foster closer relations among the engineering societies of San Francisco, and to act as the clearing house for matters that involve more than one society.

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The Electric Distribution Section of the Empire State Gas & Electric Association was held at Utica, N. Y., on September 6. The following subjects were among those discussed: "Methods of Wiring Poles for Transformers," "Calculating the Size of Wire for Primaries, Secondaries, and Street Lighting to Economize in the Use of Copper," and "Design of Secondary Networks with the Object of Reducing the Number of Transformers."

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The Illuminating Engineering Society will hold its annual convention at the Engineering Societies Building, New York, on October 10. War time lighting topics will be the feature of the meeting.

At the convention of the Illinois State Association of Electrical Contractors and Dealers at Peoria, on September 19-20, the following papers were read:

"Bringing Modern Electrical Conveniences to the Farm," by C. M. Caldwell, chairman State Farm Lighting Development Committee.

"Where the Industry Stands Today," by W. L. Goodwin.

"Some Pertinent Facts About Estimating," by John R. Smith and A. McWilliams, Electrical Estimators' Association, of Chicago.

"How the Government Views the Contracting Business," by Sullivan W. Jones, Washington representative of National Association.

NUTS FOR THE KNOWING ONES

QUERIES AND ANSWERS IN TECHNICS

In the issue May, 1918, in the article on "Electric Welding in Shipbuilding" by James H. Collins, he says:

"Spot welding is done with electrodes of the same metal as the plates to be joined—steel electrodes for steel ship work. These electrodes also fuse at the end and add some of their material to the point. Arc welding is done with copper electrodes, which do not fuse and the operators draw them steadily along the edges of the plates to be joined together, forming a continuous fused seam."

The above two processes of welding are in direct contrast to methods used and observed from my own experience. In spot welding copper electrodes have always been used, the purpose of which is to radiate the heat away and thus prevent the electrodes from being fused to the plates being welded. In arc welding, one pure iron electrode is used, which fuses and helps fill the joint. I think that the author got the two process and types of electrodes reversed.

John P. Hobart, Jr.

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One of the worst troubles experienced with a three-phase alternating-current system, says Frank Huskinson, in Coal Age, is called "single-phasing"; that is, one of the lines may be broken at some point, generally at a set of fuses, or a break may occur in the line. Many small three-phase induction motors will start equally well on two phases or three phases, and larger sizes will keep on running if one phase goes out.

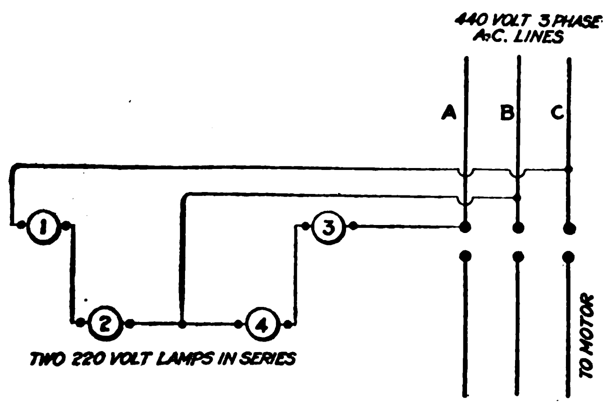

Diagram of connection for a phase testing set

The result of a three-phase induction motor running on two phases is that the windings will become hot and overheat to such an extent that the insulation becomes charred, and the wires will short-circuit together. Sometimes,also, the insulation breaks down between the windings and the motor frame. In a short time it then becomes necessary to rewind the motor.

In order to avoid starting a motor on two phases, and also as a visual sign that all three phases of the circuit or lines are right, I am using a set of lamps arranged as shown in the accompanying illustation at each three-phase motor installation, also at each main or branch line switch or fuse set.

A glance at the lamps will indicate the condition of the current. If phase **A** is open lamps 3 and 4 will not burn. If phase **B** is open lamps 1, 2, 3 and 4 will burn at one-half candle-power. If phase **C** is open lamps 1 and 2 will not burn. If all three phases are O. K. all four lamps will burn at full caindle-power. A leak in a line is indicated by the lamps on that phase not burning up to full candle-power.

A phase test set should be installed at all alternating current motor installations, and also at all switches and fuse sets. Such a set will save its cost many times over if it gives a warning once.

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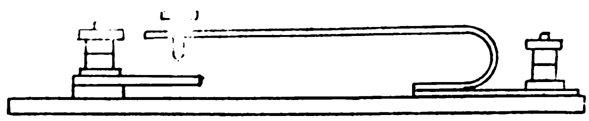
I propose to have electric fire alarms installed in a factory under my control. Can you guide me in the selection of a good system, says a writer in *Electricity*, London.

In response to this inquiry S. J. Berryman, of Camborne says that in one system a small bore copper tubing is installed throughout the portions of the premises to be protected, and is coupled up to a central closed chamber, or series of chambers, each fitted with a flexible diaphragm carrying a contact-making device.

Increasing of air pressure within the system set up by the local heating of the tubing at any given point raises the air pressure in the corresponding chamber. This forces the diaphragm outwards, thus causing the contacts to operate and so complete an alarm bell circuit. Provision is made for gradual expansion, such as would occur with the ordinary temperature changes, during the day or night, or during the course of the seasons. This provision is in the shape of leak values, which allow air to



Homemade fire control thermostat

pass out or or into the system at such a rate that the alarm will remain unaffected, except for a sudden or abnormal rise in temperature. The above described system is known as the "Aero" system.

Another system, and much more simple—that is, if inquirer desires to make his own system—is by means of a thermostat. A thermostat is illustrated in the sketch where a metallic strip is adjusted to almost any degree of heat. The strip carrying the contact is made of a strip of brass. This is riveted to a strip of iron and at temperatures below 150° F. the point is out of contact. As the heat increases, the strip bends inwards owing to the difference in the expansion of the two metals, and makes contact.

The thermostat should be connected up as a switch on an ordinary bell circuit A good method is to fit one thermostat in each room. These may then be connected up in parallel to a bell and indicator fitted in a room which is always in use.

BRIEF TIDINGS FOR THE BUSY MAN

The Government water power project on which work has been suspended, was projected for the purpose of obtaining an adequate supply of cheap power in later years.

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The town of Claremont, N. H., has granted the Claremont Power Company a 25 percent. increase per month on the amount paid for street lighting. Several additional lights are to be installed on the system in the course of another week or two.

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A new high tension electric transmission line will be constructed from El Reno to Hennessey, Oklahoma, to serve Okarche and Dover. This line will also serve the purpose of connecting the Enid and El Reno division of the Oklahoma Gas & Electric Company, a line already being in operation between Enid and Hennessey.

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During the first half of the present year, private generating plants in Manhattan, supplying installations of something more than 7,000 horsepower in motors and 65,000 incandescent lamps, were abandoned in favor of electric service from the Waterside stations of The New York Edison Company. The close-downs averaged more than six a month for the half-year period, and with those of the last half of 1917 bring the total to more than a hundred.

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The Liberty Cotton Oil Company will abandon its steam power plant and hereafter operate with electric power furnished by the Oklahoma Gas & Electric Company. Up to this time the cotton oil company has been employing 440 hp. of electrical energy and with the displacement of steam power will require additional power, 200 hp. of which is now being added.

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The entire power requirements of the Central Coal & Coke Company mines at Hartford, Ark., will be served by the Coal District Power Company (which purchases its entire power supply from the Fort Smith Light & Traction Co.) beginning next month. Contract has been closed and transformers and other equipment to enable the company to take on the load are now being ordered.

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The Concrete Ship Company of the Emergency Fleet Corporation has requested service for motors aggregating 750 hp., from the Mobile Electric Company. The company's power business has increased to such an extent that during the week ended August 9 the peak of the load was recorded at 11.30. The maximum day's output was 40 percent. greater than a year ago, and the load factor for the day was 70 percent.

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The Minneapolis General Electric Company, Minneapolis, Minn., which for three years has been supplying domestic cooking information for its customers based upon its growing number of patrons employing electricity for cooking, has now opened a commercial cooking and baking bureau. The bureau will be in charge of F. W. Cleeland and will specialize in the cooking and baking requirements of apartments, hospitals, hotels, and clubs.

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It will probably be of interest to those who know little of Nova Scotia, to learn that within a radius of fifty miles of the city of Halifax there are no fewer than 11 rivets and streams capable of developing a total of some 17,000 h. p. None of the developments is large, due to the comparatively small watersheds of the respective rivers; but owing to the rugged nature of the country, effective heads of from 50 to 200 ft. and over are obtainable.

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Of peculiar interest in the light of the present fuel scarcity is a recent article on the electrical industry in Siam in which is mentioned the use of rice husks as fuel. The husks are said to make an exceedingly hot fire and to burn with great evenness. The central station at Bangkok, which is up-to-date in every respect, uses incidentally no less than five electric vehicles. Of these, two lighter cars are used for lamp deliveries and the remaining three, which are of the heavy type, are employed by the wiremen of the distribution department. All are operated and with entire success, by unskilled natives.

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A trouble man of an electric company who is furnished by his employer with a motor cycle for use in his work is held in Keck v. Louisville Gas & E. Co. 179 Ky. 314, 200 S. W. 452, not to be acting within the scope of his employment, so as to render the master liable for the negligent operation of the machine, while riding to his home after the expiration of his working hours, although the master permits him to use the machine for that purpose.

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EMPLOYMENT OF WOMEN

The Northwestern Ohio Railway & Power Company has now adopted the policy of employing women as agents and substation attendants at all points on account of the scarcity of this class of labor, very few men being available for this service. It has been found that the servicces rendered by the women agents so far employed is equally as good in most respects and better in some than the services rendered by the men agents formerly employed.

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WESTINGHOUSE MARINE EXPANSION

So imperative have become the demands for marine propelling equipments for the Emergency Fleet Corporation that recently the new Essington plant, South Philadelphia, of the Westinghouse Electric & Manufacturing Company has been placed in operation for the exclusive production of this equipment.

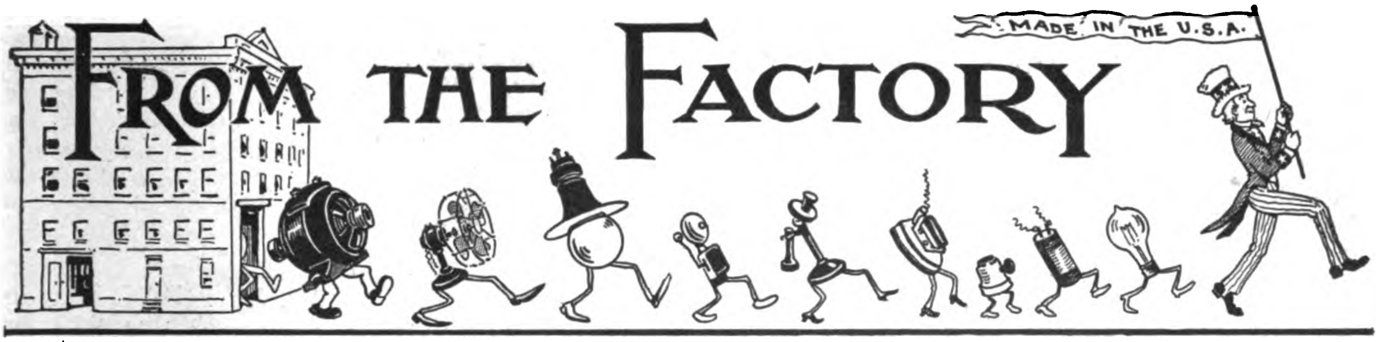
At present the Essington works occupies a comparatively small part of the 500-acre tract, which provides for ultimate expansion, and contemplates an increase of three to four times its present capacity.

A present the particular work at Essington is the production of complete propelling equipment for merchant vessels which are being built for the Emergency Fleet Corporation.

This plant, devoted entirely to the production of Westinghouse geared-turbine ship-propelling machinery, is sufficient for 15 average vessels. In fact, the equipment embraces everything between the steam boiler plant and the propeller of the vessel.

At the Essington plant there are 350 complete marine-propulsion equipments on order or under construction. The significance of these orders can better be appreciated when it is considered that they include steam turbine generator equipment for lighting, stern tubes, propeller shafting, propeller shaft bearings.

The largest equipment is 12,000 shaft horsepower and none of the sets are less than 1500 shaft horsepower.



Short Stories About Electrical Goods Offered By Manufacturers

ELECTRO STYLOGRAPH

This is the name given to an apparatus for marking mechanical tools by means of electric current. It is made by the Electro-Stylograph Co., 1 Madison Avenue, New York. This device writes as early on metal as a pencil or pe ndoes on paper, and the writing is said to be permanent It operates nomainally on 110 or 220-volt, 60-cycle, alternating current, but can be adapted to direct current operation if need be.

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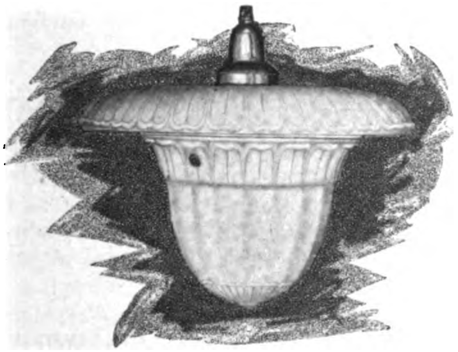
TWO-PIECE LIGHTING UNIT

In this two-piece unit the transmission-reflection system, recently brought out by the Jefferson Glass Co., of Follansbee, W. Va., is said to be seen at its best.



Two-piece lighting unit. Jefferson Glass Co., Follansbee, W. Va.

There are, it is claimed, no dark spots on ceiling walls or floors when this device is in operation.

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NEW X-RAY REFLECTORS

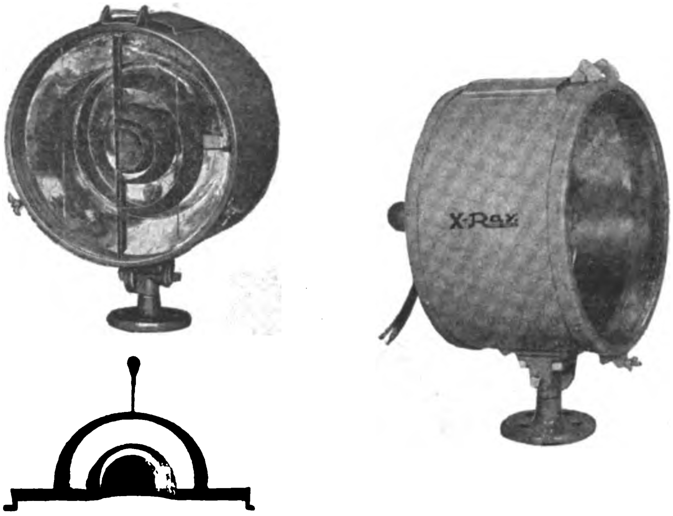
A new corrugated reflector No. 845 has just been produced for the number 60 projector by the National X-Ray Reflector Co., of Chicago, Ill.

This reflector gives a wide diffused beam and completes the line for the No. 60 projector. It is supplemented by the No. 835 reflector which produces a beam of varying spread of from 12 to 30 degrees and the No. 840 reflector which produces an extremely concentrated beam.

This company is said to be the first to meet the demand for a floodlight projector from which the skill-light may be eliminated. (Spill-Light is light direct from the lamp filament, which spreads out in a wide angle immediately adjacent to the unit.)

In fence lighting installations, it is necessary to prevent the spill-light from falling inside the fence, although it is highly desirable outside. Thus the watchman patrolling inside is constantly in shadow and is enabled better to see the fence and area immediately outside.

The spill shield No. 10269 here shown is easily placed in position inside the cove of the No. 60 X-Ray projector,



New X-Ray reflectors. National X-Ray Reflector Co., Chicago, Ill.

and cuts off all skill-light from that side of the unit until where its rings are adjusted.

This spill shield is made of sheradized iron, can be quickly installed, and is designed in such manner that the main beam from the reflector is unimpaired in efficiency.

The new reflector, No. 810, is corrugated and produces a wide distributing beam of light. It is interchangeable with the standard No. 800 reflector for the No. 51 projector and can easily and simply be placed, in any of the No. 51 projectors now in use.

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NOVEL ELECTRIC IRON

An electric iron in which the heat is evenly distributed has just been brought out by the National Electric Heating Co., Ltd., of Toronto, Canada. It is finished in nickle, has suitable cord strain protection, ready contact terminal studs, and a heating element that is held in place formerly by a machined compression plate.

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PORTABLE ELECTRIC HEATER

The memories of last winter, the shortage of labor in the coal-mining districts—most everyone is in the war these days—and the passing of summer remind us that heating devices for the fall and winter months are to be taken seriously. Last year demonstrated the worth of the electrical heater, both for steady use, and in emergencies.

Here is a new type that has recently been brought out by the Willis Mfg. Co. of Cleveland, Ohio. In this "Florida" heater a temperature of close to 260 degrees fahr. is thrown out at the top. The heating element is so placed as to cause the heat envolved by the electrical energy to pass rapidly up a chimney and upward into the room at high velocity. The cost of operation is said to be small for the results produced.

NOVEL RADIANT HEATER

A new form of electric radiant heater has just come into the market. It is made by the Estate Stove Co., of Hamilton, Ohio. Unlike other radiant heaters, this one has a cone-shaped heating element; the heat rays from which are projected outwardly by a polished copper reflector to be entered at will. A wire guard protects the element. This heater is 17 in. high and 9½ in. in diameter.

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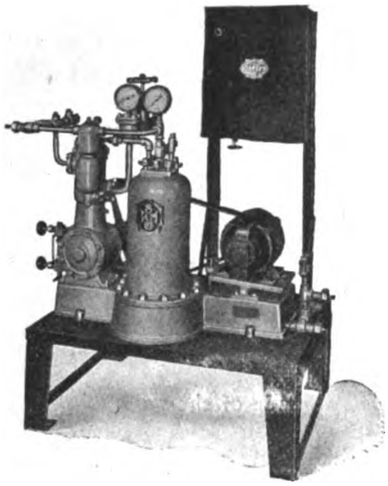
SANITARY REFRIGERATING MACHINE

The "Sanitary" refrigerating machine is an automatic, electrically operated device, which, used in connection with any substantial and well insulated refrigerator or cooling room, is said to produce and maintain a uniform temperature for perfect refrigeration, regardless of natural temperature variations. The machine requies no attention beyond the occasional replenishing of the lubricating oil and the renewal of the ammonia supply. When once installed, it will take care of itself.

The temperature maintenance is controlled by a thermostat in the refrigerator or cooling room which starts or stops the machine, accoding to the temperature desired.



Sanitary refrigerating machine. Sanitary Refrigerating Machine Co., Milwaukee, Wis.

Besides cooling the temperature of the refrigerator, this machine can also be used for making ice in moderate quantities. For this purpose the brine tank is constructed with an inside compartment or cabinet and a set of ice molds or can.

Tests, computed on the basis of daily operations, show that the saving is 60 to 70 percent. of the cost of ice.

The cost of operating this machine depends upon the cost of electricity; at six cents per kilowatt-hour, the cost will not exceed 38 cents per 24 hours. This is operating the machine at full capacity load, which is equivalent to the melting of 750 pounds of ice per day. In residences and commercial establishments where the daily requirements would never exceed 100 to 150 pounds of ice per day, even during the hottest weather, the cost should not exceed $2.50 per month.

It is manufactured by the Sanitary Refrigerating Machinery Co., Milwaukee, Wis.

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MOTOR OPERATED SURFACING MACHINE

The Cavicchi Polishing Machine Company of Quincy, Mass., has developed, in two sizes, a one-man type of motor operated floor surfacing machine for surfacing and maintaining tile, marble, granolitic and composition floors.

Floor surfacing machine. Cavicchi Polishing Machine Co., Quincy, Mass.

A finish flush with the sidewalls is obtainable, and by means of a wheel composed of concentric sections operating brought to a uniform and smooth surface.

The machine is actuated by a 2 hp. motor, made by The General Electric Company. The motor speed is controlled by the switch and rheostat located on the handle of the machine.

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SPIRAL BRUSH VACUUM CLEANER

A newcomer in the vacuum cleaner market is an interval gear driven, spiral brush machine made by the Birtman Electric Co. of Chicago, Ill. The motor is controlled by means of a switch on the grip handle. It has self-feeding oil wells. Low in stature, this cleaner can be readily used under pieces of furniture that approach close to the floor.

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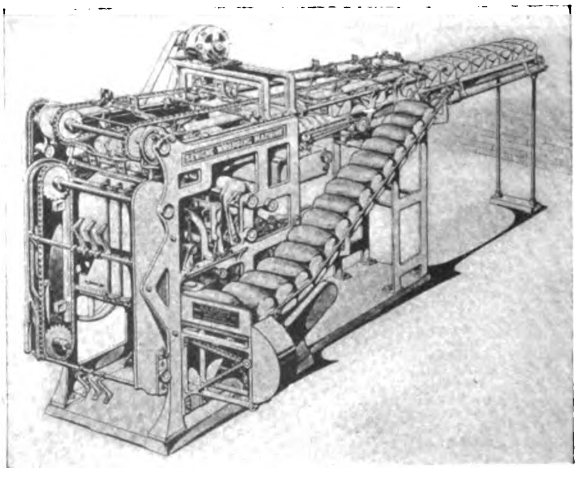
MOTOR OPERATED BREAD WRAPPING MACHINE

Bread wrapping has become a regular part of bread production, as a result of public demands that it be delivered to the customer clean and unhandled. Obviously wrapping must be done by machinery to assure these results and to



Motor operated bread wrapping machine. National Wrapping Paper Co., Nashpa, N. H.

perform the operation at lowest possible cost.

The National Wrapping Paper Company of Nashua, N. H., has developed a motor operated wrapping and sealing machine for this purpose. This machine performs the entire operation, receiving the loaves from the ovens and delivering them ready to hand to the customer.

Power for the entire operation is furnished by a fractional horse power motor made by the General Electric Co.

AUTOMATIC CONTROL OF ELECTRIC HEATERS AND VALVES

In making use of contact arms operated by gauges responsive to varying temperature, voltage, pressure, etc., for the purpose of correcting or automatically controlling the conditions affecting the operation of these gauges, it has been the writer's experience that an undesirable or erratic range or regulation may frequently be charged to the varying value of the contact made by the gauge, and that this variance is due to the inherent characteristics of the contact made by devices, responsive to slightly varying conditions, and particularly so when they are readily affected by external influences such as vibration.

Where close regulation is an essential feature of the control secured by a gauge, any deterioration of the contact-making points will seriously affect its calibration, and when a spark or arc occurs at these contact points, much difficulty is found in compensating for the error introduced by the burning or oxidization of these points, this arc being difficult to control when the trembling motion of the control arm results in an ineffective contact.

The volume of this arc may of course be reduced by various methods, but an entire absence of spark at the contact points may be secured by an arrangement of a secondary contactor consisting of a magnet coil in combination with an external resistance and gauge, as illustrated in the accompanying cut.

The best results in a secondary contactor of this type are usually secured by a solenoid magnet on alternating current, and an electromagnet type of magnet when direct current is used.

This magnet is connected across a difference of potential in series with a resistance, the coil and resistance being of such design that either will carry the full potential of the circuit without destructive heating. The magnet is supplied with an armature; and the relative design characteristics of the magnet, armature, and resistance are such that the magnet will attract and raise the armature to the position shown in cut, closing the circuit D when the resistance is by-passed, and retain the armature in this position when the resistance is again introduced into the circuit. The armature will fall to the position where it closes the circuit C when the magnet is by-passed, but will not be attracted so as to break this circuit when the magnet is again introduced into circuit with the resistance until such time as the resistance may again be by-passed.

SQUIRREL CAGE ELEVATOR MOTOR CONTROL

An elevator control to be used with squirrel cage motors in sizes up to and including 20 h.p. at car-speeds not exceeding 150 ft. per min. has been built by the Westinghouse Electric and Mfg. Company, East Pittsburgh, Pa., for both freight and passenger service.

The equipment of this elevator control consists of a small control panel mounted on the wall somewhere near the motor, a car switch, by means of which the operator controls the movement of the elevator cars, and such elevator safety devices as may be desired.

A line contactor and two mechanically interlocked directional contactors are mounted on a black marnine finished slate base. The motor, being started with full line voltage, requires no secondary or accelerating contactors.

The contacts are graphite to graphite of the butt type (no sliding contacts used), and are interchangeable for the various contactors. The same contacts may be used for alternating-current and direct-current controllers for both car-switch and push-button operation. The car switch closes the line contactor and one of the directional contactors, and thus starts the car in the desired direction.

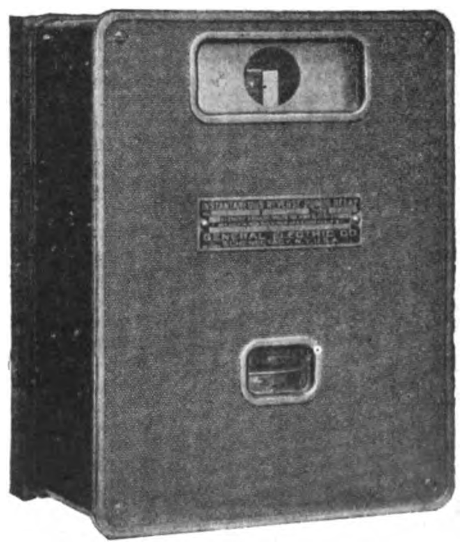
Safety devices may be connected in the control circuit, so that the opening of any switch will bring the car to rest. Those most commonly used are the emergency switches, to be used by the operator in case of accident or failure of the car switch; machine-limit and hatchway-limit switches, which operate automatically to prevent accidents from over-travel, should the operator for any reason fail to release the car switch; and door switches, which prevent the starting of the car until the door is properly closed.

POTENTIAL STARTER FOR SQUIRREL CAGE INDUCTION MOTORS

A starter of this type has recently been put on the market by the Allis Chalmers Mfg. Co. of Milwaukee. It has automatic protective features, and is designed to be operated equally well on heavy and light loads. The operating handle turns only in one direction while the motor is being started. The starter is so designed that it cannot be left in starting position and cannot be held in running position in case of voltage failure or a sustained heavy overload. An under-voltage release automatically disconnects the motor from the line on failure of voltage and returns the starter to its former position. A drum switch makes and breaks contact under oil.

POLYPHASE INDUCTION REVERSE POWER RELAY

The polyphase induction reverse power relay illustrated here will operate correctly on practically all single-phase short circuits, even though the voltage between two lines

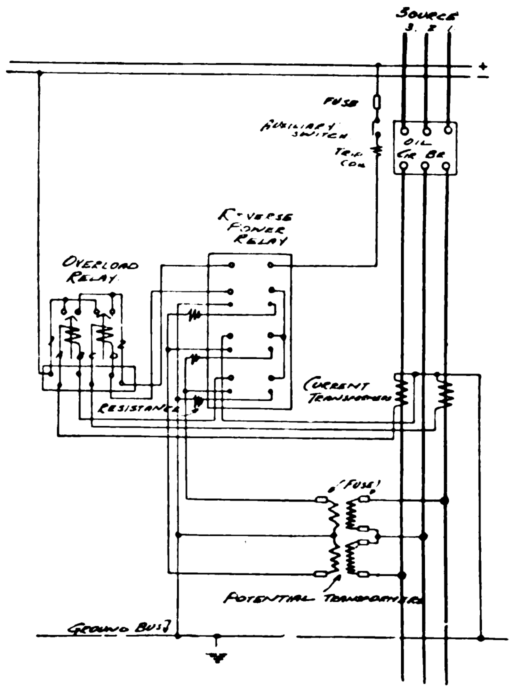


Polpphase induction reverse power relay

which are short-circuited may fall to zero. It will also operate on balanced three-phase short circuits with 10 amperes secondary and one percent. of normal voltage remaining; and in practically every case for balanced short-circuits, with a voltage of one-half percent. normal. (When the voltage falls to such a low value—one percent. normal—however, system conditions are apt to be so distorted that positive operation cannot be assured in every case with any relay.)

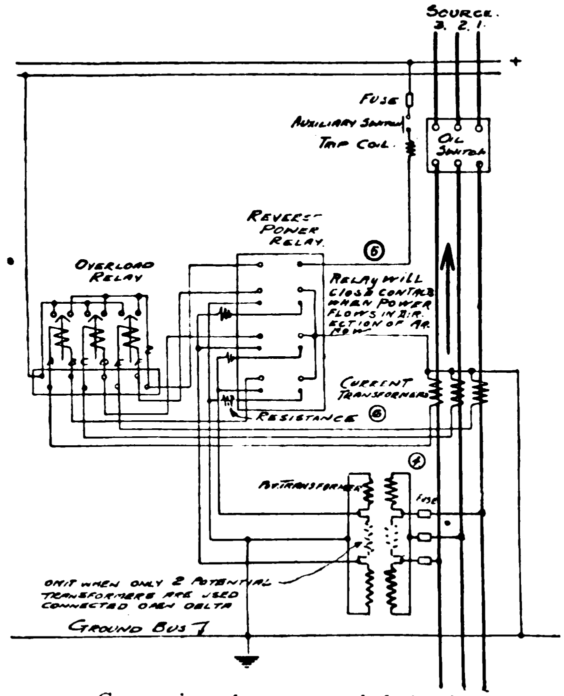
The relay is constructed along the lines of a polyphase watthour meter, but with three instead of two driving elements. Each of the elements has a current and a potential coil.

Two disks connected to a single operating shaft are used, the upper one of which is driven by one element and the lower by two elements, one in front and one in back.



Connections for grounded circuits

The use of three elements is required for grounded star circuits and is a distinct advantage even when the relay is used on ungrounded circuits. If two elements were used many single-phase troubles would involve only one of the



Connections for ungrounded circuits

elements and the benefit of polyphase action would be lost. Although only one element may be involved in case of a ground on a grounded star circuit, the voltage triangle will not become so badly distorted as when a single-phase line to line, short exists. For ungrounded circuits two current and two potential transformers are sufficient. The third current coil carries the resultant current of the two current transformers and the third potential coil is connected across the open delta of the two potential transformers.

The polyphase construction makes the action of the relays more reliable than three single-phase relays because any incorrect tendency on the part of one phase is balanced by a similar but opposite incorrect tendency on some other phase. The incorrect tendencies being balanced out, the true power direction will control the operation.

The relays are made sensitive in order to operate properly on very low potentials. Thus, overload relays must be used in conjunction with the reverse power relays to prevent operation at normal potential until a predetermined current and time are reached. The contacts of the overload and reverse power relays are connected in series so that both must close to trip the breaker. Any type of overload relay can be used, but the plunger type is recommended when instantaneous action is desired. The time and current settings of the overload relay determines the action of the combination.

✦ ✦ ✦

NEW TYPE OF LINE SWITCH

Two new line section switches of different capacities have just been put on the market by the Westinghouse Electric & Mfg. Co., of East Pittsburg. A 750-volt switch is used for low voltages. It is provided with a wooden box so designed that when the switch is opened, the attached handle drops into a slot in the bottom of the box. This allows the door of the box to be closed and locked, thus making closing of the switch by unauthorized persons impossible, and at the same time exposes no live parts.

The other is a heavy-type service switch inclosed in a wooden box which can be locked. This switch is opened and closed by an insulated hook stick which is separate from the switch blade attachments inside of the box. This holds the hook switch when not in use.

The smaller of these line switches are for voltages up to capacities of 200, 400 and 600 amperes. The heavy switches are for voltages up to 1,500, and capacities of 1,200 amperes.

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SERVICE RESTORING RELAY SYSTEM

A new service-restoring relay system has been tried out for a number of months on the lines of several central station companies of considerable size, and the reports received have only justified its design and adoption.

The system minimizes interruptions caused by transient short circuits, which clear themselves as soon as the circuit-breaker has been opened, thus permitting the feeders to be immediately put back into service. If the circuit-breaker is reclosed automatically within a second after the transient trouble has occurred, the service will be restored in time to prevent induction motors from stalling.

The Westinghouse service-restoring relay system has been developed to perform this operation within the shortest possible time and thus reduce all disturbances to a minimum, thereby greatly improving the lighting service. Should a permanent defect occur the system will allow the breaker to remain open until the defect is cleared.

A shematic diagram of operation is shown in Fig. 2. Any type of overload relay may be employed to trip the circuit breaker. A voltage transformer on the feeder outside the circuit breaker is connected so that its potential opposes that of another voltage transformer connected to the bus-bars. The restoring relay which is similar to a magnet switch, is connected in series with these two voltage transformers. Before a short circuit occurs, both voltage transformers are subjected to the same condition so that no current will flow through the restoring relay; but when a short circuit occurs and the circuit breaker has been opened by the overload

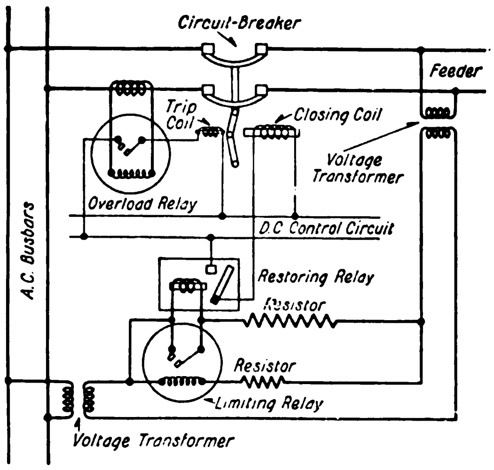

Fig. 1.—Schematic Diagram of Connections of Service-Restoring Relay System

relay, current will be forced by the bus-bar transformer into the feeder transformer through the restoring relay. The restoring relay will then close its contacts, which, in turn, will close the circuit-breaker.

In case of a permanent defect on the feeder, the restoring relay would continue to open and close the circuit-breaker in-

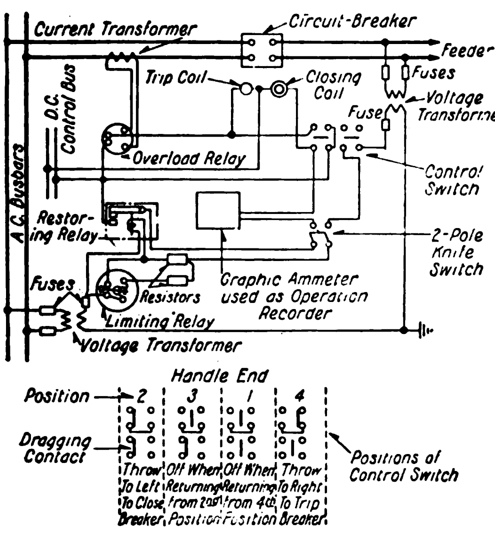

Fig. 2—Complete Diagram of Connections of Service-Restoring Relay System

definitely. To prevent this, a limiting relay is connected in such a manner that while the circuit-breaker is open it is subjected to the same difference of potential that is operating the restoring relay. Every time the circuit-breaker opens, the limiting-relay contacts begin to close and, due to its heavy damping, they do not return to the starting point immediately after the circuit-breaker is closed. After the circuit-breaker has opened and closed a predetermined number of times, this relay closed its contacts, thus short-circuiting the restoring relay and preventing further operation.

When this system is installed at substations having no attendant, it is often found advisable to have an indicating device that will show when the service has been momentarily interrupted. For this purpose, a graphic ammeter is placed

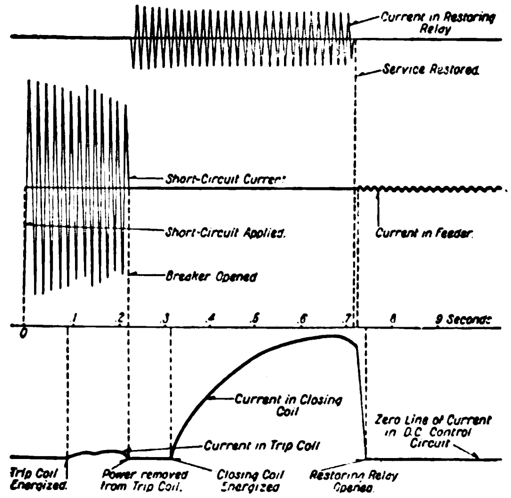

Fig. 3—Oscillograph Records Showing Operation of Service-Restoring Relay System on a Transient Short Circuit

in the direct-current control circuit of the circuit breaker. This will indicate whenever the breaker has been closed by automatic means.

A special control switch is used, which contains one dragging contact so arranged that when the circuit-breaker is tripped manually the switch automatically opens the circuit between the two voltage transformers.

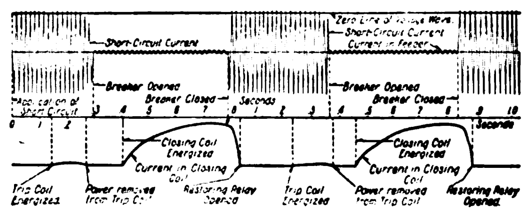

Fig. 4—Oscillograph Records Showing Operation of Service-Restoring Relay System on a Permanent Short-Circuit

The service-restoring relay outfit is a valuable addition to the protective equipment of all central stations and right now it should be especially useful. This relay decreases power interruptions, and thus economizes the times of switchboard and other station attendants, or in some cases releases some of these men for other duties.

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HOMES FOR RETURNED SOLDIERS

Secretary Lane presented to the President and to Congress recently a comprehensive plan for a preliminary study of the unused lands of the country, with particular reference to the irrigation of some 15,000,000 acres of arid land, the drainage of between 70,000,000 and 80,000,000 acres of swamp land, and the clearing of approximately 200,000,000 acres of cut-over or logged-off lands, with the purpose in view of reclaiming these lands through Governmental agency and providing homes for returned soldiers.

✦ ✦ ✦

EDUCATIONAL ENGINEERS WANTED

Four electrical engineers are wanted for work in Ohio. For detailed information and registration blanks apply at once to A. H. Krom, Director of Engineering, 29 South La Salle Street, Chicago. The Division of Engineering is in direct touch with all important military, governmental and industrial activities relating to technical affairs. The Division gives its services free of charge to all engineers, employers and technical men who register.

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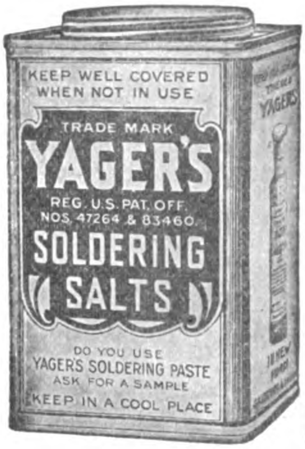

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ELECTRICAL ENGINEERING

VOLUME LII NOVEMBER, 1918 No. 5

Publisher's Announcement

WHEN ELECTRICAL ENGINEERING passed to new ownership and management there were no glowing promises of changes and improvements. It was deemed wiser and more dignified to perfect all plans unannounced, and let the magazine in its new form speak for itself.

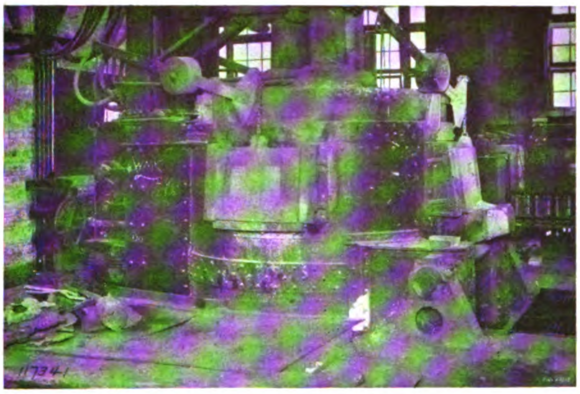
With this issue of the magazine there has been a distinct change in form, not only as to mere externals, but also in plan and purpose. That the improved typographical appearance and arrangement will meet with the hearty approval of its many faithful and devoted readers, we are convinced. Perhaps a glance through the pages will serve better than any words of description to show the scope we intend to give to the magazine, and the method of presentation we shall follow. We shall make this a general electrical monthly, covering, so far as may be possible, the entire field of the application and uses of electricity in the arts, sciences, manufactures, in the public utilities and in the household. There will be theoretical discussion when necessary and advisable, but the main purpose of the periodical will be to give practical help and suggestions to the engineer, the manufacturer, the contractor and dealer, the student, the electrician and the shopman.

We shall welcome any discussion that may be provoked by papers that are printed. In the same way we shall be glad if our readers will bring to us any problems that may confront them in their daily work. When you have met and overcome difficulties yourself, tell others what you have done, and thus lend them a helping hand. It is of incalculable benefit to any trade or profession to have an open forum where all may meet for the frank and free interchange of views. There is nothing that stands more obstinately in the way of progress than narrow trade rivalries and jealousies. The broader the spirit and the more of friendly co-operation that can be found in any industry, the greater surety there is of advancement. The prime purpose of trade journalism is to foster such a spirit, and this is the idea that shall always underlie ELECTRICAL ENGINEERING under its present management.

After a war unmatched in the history of the world for bitterness and destructiveness, victory has finally crowned the right, and peace has come. This means the most tremendous tasks in reconstruction that mankind has ever undertaken. In the conduct of the war electricity took an ever-growing part. With the rebuilding of cities and industries now at hand the province of the electrical engineer and manufacturer assumes an even greater importance. Our pages will give a constant and faithful reflection of the opportunities and development of electrical science

Work of the Electrical Furnace

THE very necessary embargo that was laid on our importations because of the lack of shipping has meant the development of our own natural resources on a greater scale than ever before. The trained scientists of the Government and countless private prospectors have made a thorough examination of the localities likely to yield the rarer metals so much needed in the iron and steel industry. Extensive deposits of low-grade ore have been found in various parts of the country, but much of it is highly refractory, and cannot be smelted by the ordinary processes. In the new industries we have been forced to build up to furnish munitions of war we are using alloys of extremely high fusibility. All of this means not only that a greater opportunity than ever before is offered for the electric furnace, but that this apparatus has become indispensable and will daily find a wider use. It is of interest, therefore, to study in some detail just what can be accomplished by this application of electric power.



VIEW OF 2-TON HEROULT ELECTRIC FURNACE

An electric furnace whose main product is nichrome, the well-known high-temperature resisting alloy, has recently been installed at the plant of the Driver-Harris Company, Harrison, N. J. The furnace is of special interest because of its electrical equipment, which is an excellent example of modern practice. Alloys of various characters are also manufactured by the furnace. It is of the Heroult arc type, featured with automatic regulation, and has a capacity of two tons.

Wattmeter records of the power consumed during a run on 3,000 pounds of nichrome and a similar record of high nickel steel show the effectiveness of this method of reduction. In both cases, the charge consisted of the various metallic constituents fed into the furnace in solid state without preheating. The amount of power taken at the start of the heat is small in both cases, but as the resistance of the furnace circuit decreases, owing to the heating up of the electrodes and the consolidation of the charge, the power consumption rapidly increases until stable conditions are reached. The average amount of power consumed is then held practically constant by the automatic regulator, with the exception of a slight continuous increase due probably to a corresponding decrease in the resistance of the furnace circuit.

There is, however, no uniformity in the actual power consumption. As the charge melts down, pieces of metal fall in between the electrodes and establish short circuits. For the most part these short circuits are only momentary, as the fragments causing them are promptly melted down, but occasionally they persist and then the automatic regulator draws up the electrodes until they are clear. This process sometimes breaks the arc and then there is a sudden decrease in the power consumption until the regulator brings the electrodes down again and re-establishes the arc. As would be expected, the nickel steel alloy shows more of these irregularities than the softer nichrome.

Towards the end of the run there is a marked change in the power consumption when the metal is given a special treatment before pouring. In the case of the nickel steel a higher temperature was necessary, perhaps to lower the carbon content, while with nichrome the temperature was lowered. The temperature of the furnace averages about 2,200 degrees F.

The high momentary overloads are characteristic of electric furnace work and make it very different from ordinary power service. They must be taken into account in designing the electrical equipment for the

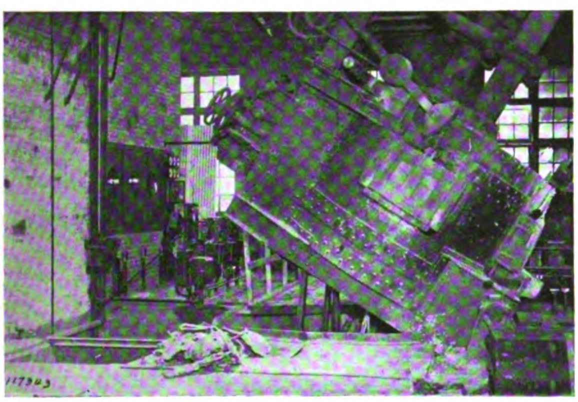
FILLING MOULDS FROM ELECTRIC FURNACE

furnace, and some of the apparatus must be especially designed to withstand them, as shown in the following description of the Driver-Harris installation.

Power for this furnace is furnished in the form of two-phase, 60-cycle, 2,200 volt-current from the lines of the Public Service Electric Company. In the high-tension lines are a disconnecting switch and an oil circuit breaker. This latter is used to control the circuit. It can be operated manually and is also provided with low-voltage and overload protection. In order to prevent its operation on momentary overloads, the overload trip is controlled by relays with definite inverse-time-limit action. The high-tension apparatus and the transformers are contained in a brick compartment behind the furnace. There are two 400-kva, 2,200/110-volt transformers of the oil-insulated self-cooled type. They are Scott-connected so that they change the high-voltage two-phase current into low-voltage three-phase current, one phase for each of the three electrodes of the furnace.

Special construction is necessary to withstand the overloads. These overloads are of such short duration that their heating effect is negligible, but they tend to force the coils apart. Hence the coils are very firmly braced and are in fact capable of withstanding momentary overloads fifteen times greater than the normal load. The reactance of these transformers is about double that of ordinary power transformers of the same size. This reactance, together with that developed in the low-tension leads (which are made as short as possible in order to keep this factor low), prevents the current flowing through the furnace from exceeding five or six times normal values even on dead short circuits. The voltage regulation is from 106 volts on no load to about 100 volts on full load, and the power factor is from 85 to 90 per cent.

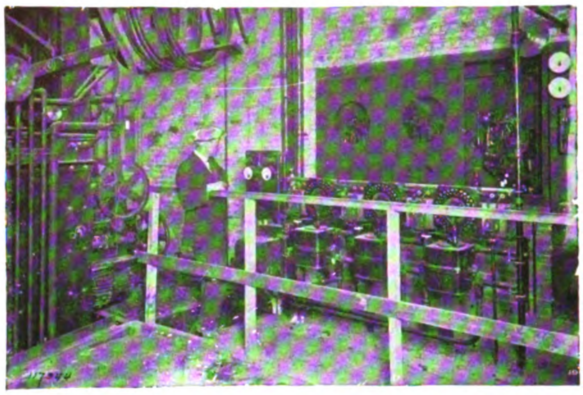
One of the most interesting features of the equipment is the Thury regulator, which automatically maintains an approximately constant current at the furnace electrodes. Without this device the current consumption would vary eratically even if an operator were constantly endeavoring to correct the variations.



View of Electric Furnace Tilted for Pouring

It therefore saves labor and current, reduces to a minimum the time required to prepare a charge, and by providing uniform conditions, keeps the quality of the product uniform.

Each furnace electrode has a separate regulating mechanism and a raising and lowering motor. The regulator can be set for any desired current value, and when this value is exceeded, each regulating mechanism closes a contact momentarily, which causes the motors to raise the electrodes slightly. The contacts continue to close at brief intervals until the electrodes are drawn up high enough to reduce the current to the predetermined value, the intermittent action being employed to prevent the electrodes from being raised too high and thus causing an unstable condition. When the current falls below the predetermined value the electrodes are lowered in a similar manner. The regulator itself is controlled by a solenoid energized by means of current from series transformers in the main high-tension circuit. Damping devices prevent the regulator from acting on overloads that immediately correct themselves.



General View of Thury Regulator

In addition to the automatic device, each electrode motor has a drum controller for manual operation. The electrode motors are direct-current machines, because alternating-current motors cannot be controlled with sufficient delicacy. The operating current is obtained from a 4½-kw. motor-generator set located in the transformer compartment. The motors are of 2 h. p. capacity and are totally enclosed; they are provided with grease-cup lubrication instead of the ordinary ring-oiling system, so that the lubrication is not interfered with when the furnace is tilted for pouring.

An instrument board is located beside the regulators and carries the following apparatus: A kilowatt meter, a volt-meter, a power factor meter, an ammeter for each phase, a graphic watt-meter, a plug switch for reading the voltage of each phase, both across the arc and across the low-tension leads outside the furnace; the operating handle of the high-tension circuit breaker, the inverse-time-element relays for the circuit breaker, and an integrating kilowatt-hour meter. On the other side of the regulator is mounted a small panel carrying the switches and meters for the motor-generator set, below which is the motor auto-starter.

When the charge is finished, the whole furnace is tilted bodily for pouring. This tilting is effected by an 11-h. p. alternating-current slip-ring motor located in a pit beneath the fur[illegible]nd geared to the tilting mechanism. It is contr[illegible]y a drum controller by the side of the furnace. All of the equipment consists of standard Westinghouse furnace apparatus.

Electric Welding in Ship Construction

IN all of the war work nothing has been more marvelous as showing the possibilities of enterprise and organization in meeting unusual conditions than ship construction. Whether steel, wood or concrete, we have built great vessels as if by the touch of magic. What we have done in this country is well known, but other countries as well have also surpassed all previous records and achievements. There was recently launched from a yard on the southeast coast of England the first steel vessel constructed entirely without rivets. This ship has since been in service with a full cargo during exceptionally rough weather, and she showed herself staunch and seaworthy in every way.

The shipbuilding authorities throughout the world attached considerable importance to this work, experimental in its nature, as it was intended to prove the ability of welded construction to withstand the stresses peculiar to a ship at sea. This principle having been established, it is not proposed altogether to dispense with riveting, which in certain sections is cheaper and quicker than welding; it is intended, however, that future vessels should be a combination of riveting and welding, according to *The Engineer*, which gives the first authoritative account of the work. The United States Shipping Board, for instance, having been in close touch with the experimental work, is making arrangements for the construction of a number of 10,000-ton standard ships, in which the use of rivets will be reduced to two and one-half per cent of the number originally required.

The recent progress achieved in electric welding by means of the flux-coated metal electrode process, and its successful use at Admiralty dockyards and elsewhere in the construction of the equipment and superstructures of various vessels, led to permission being obtained for the erection of a standard barge, with riveting eliminated and electric welding substituted throughout. Such a craft, it will be observed, may be exposed to considerable rough usage in dock, besides being subjected to severe towing stresses. Seeing that material already available on the site where she was built was utilized, the barge differs in no way from the standard riveted type with lapped joints, excepting that the hull plates were arranged for clinker build and the plate edges joggled to permit of horizontal downward welding in order to reduce the amount of overhead work, which is more difficult of execution.

The vessel to be welded was 125 feet between perpendiculars, and 16 feet beam, with a displacement of 275 tons. The hull was rectangular in section amidships, with only the bilge plates curved. It was built up of seventy-one transverse frames, and contains three bulkheads, those fitted fore and aft being watertight and that amidships non-watertight. The shell plating was one-quarter inch and five-sixteenths inch. All the joints were lapped in the manner described.

Curiously enough, the first day's work was poor, though all the operators were first-rate men, with extensive experience of electric welding in the shop on minor repairs and on structural work at shipyards. The poorness of the work was probably due to the novelty of the undertaking and to the position—lying flat on the keel—which the men had to adopt to get to the joints. In a few days, however, when they became accustomed to the job, the speed and quality of the work improved so as to become equal to that achieved in workshop standard practice. With the more difficult welding, such as that in the vertical butt joints on each shell plating, and overhead work underneath the keel and on bilge plates it was noted that the quality of the welds was excellent. For this overhead work special electrodes were employed, and proved well worth the slightly increased cost. All watertight joints up to and including the underside of bilge plates were continuously welded both inside and outside, the other watertight joints being welded continuously on one side and tack welded on the other. On the shell plating the continuous welding was on joints and frame construction tack welding was adopted, the length of welding being carefully calculated to give a margin of strength over a similar riveted joint. Taking all positions of work into consideration, the average speed was 4 feet an hour at the commencement, while towards the end of the work an average of 7 feet an hour was easily obtained.

Some interesting details have been given to us of the comparative cost of an electric welded and a riveted barge. In labor, 245 man hours were saved in construction, which can easily be improved on in future work. More than 1,000 pounds of metal was saved, owing to the absence of rivets, but it is estimated that greater economy will result when the design is modified to suit electric welding ship construction. The total cost of welding was $1,500, detailed as follows: Electrodes, $887; electric current, $304; men's time, $309.

It is realized by the Admiralty experts that the proportion of cost for electrodes is high, but this is mainly due to the present limited demand. Demand and competition will have the usual effect, and should reduce the cost of this item by at least 60 per cent. It will then be possible to build a vessel of this size with an estimated saving of from 25 to 40 per cent of time and about 10 per cent of material.

It is interesting to add that, as a result of this demonstration, the yard has prepared a new design of barge, in which it is proposed to incorporate electric welding and riveted construction to the following extent: To be welded—coamings, shell seams to frames, deck butts to beams, bulkheads (including boundary bars), keel plate butts to be welded overlaps, after shell seams welded.

To be riveted: Floor riveted to frames, beam knees to frames and beams, frames clear to shell seams.

All-Electric Shipbuilding Yard

The Egis Shipbuilding Yard, on the northeast coast of England, is an all electrical one, the light and power being exclusively supplied by current. This yard was begun in November last and is now virtually completed well within the year. Throughout its every department electric power on the three-phase system is employed. There are four berths for ships up to 430 feet in length, the huge winches, derricks of enormous sheer, and locomotive derricks actuated by current, do the needful, whilst along the quay breast is a 30-ton electrically-driven crane which can hoist 30 tons within a radius of 36 yards and 10 tons within 33 yards. The platers' shed measures 532 feet in length with a beam of 100 feet, and within it is installed one of the most up-to-date electrical plant in the world for driving the machinery used in working the steel and iron into their finished state.

Vertical Generators for Water-Wheel Drive

PRESENT-DAY fuel and labor shortages, with their consequent increased costs, are going to be instrumental in the promotion of many new hydro-electric developments. Of our fifty-five million horsepower of unused water resources, a great many thousands can be developed economically to meet the existing requirements for electrical power, and these will be a material factor in the conservation of our fuel, and towards the elimination of railroad congestion, and car shortage. Legislation favorable to such development is to be expected of our State and National lawmakers.

We of America expect high efficiency from our people, and from the machines which they manufacture. To utilize our waterpowers to the best advantage, water wheels and generators must both be designed to meet the conditions imposed by Nature. These conditions vary widely, and the range in capacity and speed encountered demands an equally broad experience. Single runner vertical wheels of exceptionally high efficiency are now available for at least all of the low and medium head developments, and it is to be expected that the majority of our future installations will be of this type. The success of the vertical type depends on the satisfactory operation of the thrust-bearing, carrying the weight of the revolving parts.

In 1895 the Westinghouse Company built the generators for the first large station in America and it has manufactured many hundreds of machines since that date. Proposed governmental legislation seems to have determined fifty years as a reasonable period for water-right leases. Whether electrical apparatus will last this long remains to be seen, the art still being considerably less than fifty years old, and obsolescence so far being responsible for far more scrapping of material than wear and tear. Certain it is, however, that to-day no manufacturer is justified in counting on obsolescence for protection, and only those materials which will wear the longest should be employed in the building of water-wheel generators.

INSTALLATION IN AN AUGUSTA, GA., COTTON MILL
Five Westinghouse 2,700-kva., 2,300 volt vertical generator units for waterwheel drive

One of the most frequent causes of generator shut-downs has been, and probably will be, failure of the armature insulation. By a happy choice, Westinghouse engineers early decided on mica, a material which does not age, which is unaffected by temperatures far higher than those found in the modern well-ventilated generator, and which remains unimpaired under the static discharges common to all high-voltage machines. Efforts have been directed for many years to the perfection of their methods in the application of this material as armature coil insulation. Proof that their early choice was a most logical one is found in the increasing use of this material by all electrical manufacturers building large capacity and high-speed machines.

The danger of runaway speeds, 50 to 100 per cent above normal, is ever present in the hydro-electric plant, and a rotor construction which safely withstands the stresses incident to this abnormal condition, is essential. No single type of construction will cover, with safety and economy, all the range of capacity and speed encountered. Cast iron is satisfactory only for low peripheral speed rotors, steel castings, if of very large size, may not be sufficiently uniform in strength to rely on. Laminated steel rims and rolled steel plates are sometimes resorted to for high-speed service. Successful types of construction to fit each and every case have been designed and thoroughly tried out. With a completed product made up of so many small but essential parts, careful inspection and test is desirable. Each operation during the process of manufacture is carefully inspected, all materials employed are well tested and whenever feasible, the finished machine is given a running test under conditions approximating those of normal operation.

War Changes Engineering

"Unusual and radical changes are taking place daily as a result of war demands." This is the comment made recently by A. H. Krom, Director of Engineering, who is registering the technical men of the nation and placing them according to governmental needs. "Up to the present," said Mr. Krom, "engineers as a class have been governed largely by tradition. Once a mechanical draftsman, always a mechanical draftsman. A change to a new line of work was rarely heard of. This, however, is no longer the case. Technical men are changing from one line of work to another; going both to school, studying related branches of their profession and striving to establish new standards.

"Oddly enough, they are changing their attitude toward technical women. We are daily getting calls for women to do drafting for service in new and unaccustomed lines of work. In my opinion, the entire engineering profession is undergoing an important change which will result in great gains for the nation. The activities of the Division of Engineering, 29 South La Salle Street, Chicago, are registering these changes daily and indicate that they are practical and far-reaching."

Conserve Your Condenser Tubes

Mr. George W. Elliott, secretary of the National Committee on Gas and Electric Service, has transmitted to Mr. B. M. Baruch, Chairman of the War Industries Board, a letter he has received from Mr. M. Greenberg, of the Electrical and Power Equipment Section. Mr. Greenberg says:

"As you are aware, the requirements of the Navy and the Emergency Fleet for non-ferrous condenser tubes are so large that the indications are that there will be none, or at best a very small supply of such tubes available for repairs on land condensers.

"May we not therefore suggest that you emphasize the seriousness of the situation to the members of your Association, and urge upon them the necessity of conserving their condenser tubes in every possible way?"

This matter has been brought to the attention of the central station member companies, and will be given full and immediate consideration.

Electric Current in Office Buildings

THE entire progress of the war has emphasized no economic question more forcibly than the necessity for economizing our resources, especially in the matter of fuel. Despite all efforts to stimulate production, the demand for coal to supply our industries, our domestic consumption and the imperative needs of our allies, has far outstripped the capacity of our mines and transportation facilities. If we are to escape disaster and suffering, we must save, and save at every possible point. In seeking methods by which economies may be effected, it is natural that attention should be directed toward efforts to curb waste in electricity. Public service companies everywhere are urging their customers to save gas and electric current wherever it can be done without hardship, and where payment is made directly for service furnished, the warning may not fall on deaf ears. But in large commercial buildings tenants are furnished with electric light free, beyond a certain cost fixed in their rents. Under such an arrangement it is only natural that a great amount of electric current is used needlessly, and it is believed that this can be curtailed without working any hardship.

In an effort to effect economy along this line, the New York Building Managers' Association has just taken action. A special committee, consisting of J. Clydesdale Cushman, Lee T. Smith and Clarence T. Coley, has made a countrywide inquiry as to practice between landlord and tenant in the matter of lighting. The committee therefore recommends that payment be made by the tenant for the amount of current used monthly. To this end it was decided to insert in future leases a clause which would give the operator of a building the option to charge for electric current by the kilowatt hour, install a meter, or arrange with the tenant a charge for current on some minimum basis.

This action was taken following research to test a theory that by charging for electric current, instead of furnishing it in lump fashion along with other service for rentals, a very considerable saving could be effected. This theory was supported fully by data obtained from managers in every one of the principal cities of the United States and Canada.

In such cities where no separate charge for electric lights was made the consensus of opinion among renting agents was that if a direct charge was exacted, tenants would then be more considerate, and there would be conservation of fuel and a reduction of the "overhead." This opinion was amply supported by reports from such cities where charges were made according to the amount of current consumed. In these cities, notably Chicago, Duluth, Minneapolis, Kansas City and Detroit, where electric light is metered and bills are paid by tenants, the average consumption of electricity for lighting office and commercial buildings is 50 per cent less than in cities where light is lumped with other service costs.

The canvass directed for the Building Managers' Association by Mr. Cushman developed the fact that in 129 first-class cities replying to a circular letter asking for information upon the advisability and feasibility of metering electric light, 62 replied that its cost was included via a flat rate in the rents, and 66 charged extra. It also showed that in most of the Central Western States building managers charged for electric current separately, and that in Pacific Coast and Eastern States the general practice was to include the cost in the rent.

An illustration of the saving possible through the metering of electric current as a conservation measure was the planning of the Equitable Building by a Chicago architect. Having in mind the vogue in that city, he arranged a plant accordingly. Upon completion of the building, engineers regarded the electric plant as too small, and increased it 25 per cent, solely because of the fact that, there being no direct charge for current, a larger consumption was inevitable through the carelessness of tenants in their use of light.

Previous to the adoption of the report submitted by Mr. Cushman, as chairman of the committee, his collaborator in the investigation, Clarence T. Coley, manager of the Equitable Building, announced that, regardless of the action the Association might take, installation of meters in that building had already been ordered, and expected that many other buildings would follow suit. Later discussion of the modes of application of the suggestion that tenants pay for electric light, however, developed divergent ideas for an effective curb upon the waste of electric energy, and the coal to produce it; but the agreement for inserting a clause in leases calling upon tenants to pay for electric light and lamps was unanimous.

To meter a building expressly to record electric light consumption would in some cases, it was explained, entail prohibitive cost, and, on the other hand, the cost of maintenance of meters, monthly reading, billing, checking, etc., would offset any saving from reduction of waste current. However, where meters are impracticable, it was deemed advisable to estimate the probable consumption and charge accordingly. This will put a premium on the careful tenant, and fix a penalty on the one who is selfishly or carelessly wasteful.

Extracting Ocean Salt by Electricity

Experiments in Norway with a view to extracting salt from ocean water by means of electricity have been successful and two salt factories will be started for this purpose in the near furure, by the name of De Norske Saltvertker. One is to be in western and the other in northern Norway, as these districts, on account of the fisheries, are the best home markets. Each factory is calculated to produce 50,000 tons of salt per year for a start, but they will be so built that the production can be brought up to double the quantity, if necessary. Besides the salt, different by-products will be made. The capital for the two factories is calculated at 20,000,000 crowns ($5,360,000). Each of them will take about 6,500 horsepower for the normal production. During the war it has been difficult to get salt from abroad and sometimes it has been impossible to salt down the fish. The new salt works should greatly improve the situation.

Plans are being discussed for building a salt industry in Iceland, writes Commercial Attaché Erwin W. Thompson from Copenhagen. Mr. Torfason, of Iceland, in 1914 obtained a concession for 30 years for salt production, but has made small progress. It is now the plan to combine the salt production with the contemplated electric-power stations in Iceland, and with the mining and smelting of iron. Certain by-products of the iron industry formerly wasted may now be utilized in connection with the salt industry.

In this way it is claimed that there is a possibility of covering not only Iceland's own salt consumption of about 100,000 tons, but also of exporting salt to Denmark.

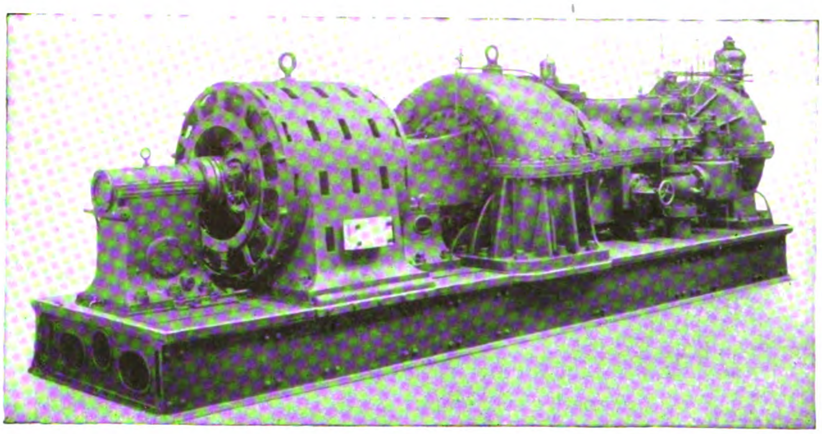
Denver to Furnish Toluol at Cost

As a war move the Denver Gas & Electric Light Company will furnish toluol to the Government at the actual cost of production. In order to obtain this product the Government is erecting a plant for its extraction from the gas. All gas produced by the Denver company will pass through the toluol plant, where a mixture of toluol and benzol will be removed. This crude product will be sent to Pueblo for refinement and separation. At the present time the foundations for the toluol plant have been laid and work is proceeding as rapidly as possible.

Development of the Steam Turbine

ROUGHLY speaking, the whole of the development of the steam turbine has occurred within thirty years. This is a very brief period as compared with the development of the reciprocating engine, which occurred over a period of more than ninety years. Many are inclined to attribute this to the high technical skill and scientifical attainment of the present age, but a more true reason than this is the fact that metallurgical and manufacturing arts were available for the turbine manufacturer which were not available for the early builders of steam engines.

A cursory review of the British patent office records in the early years, say 1800 to 1850, show them to be rich in turbine inventions, and nearly every modern turbine principle and some others will be found exemplified. It is assumed that these ideas were abandoned because of the then apparently greater promise of the reciprocating engine and the undeveloped stage of machine shop practice which rendered production of efficiently shaped blades practically impossible.

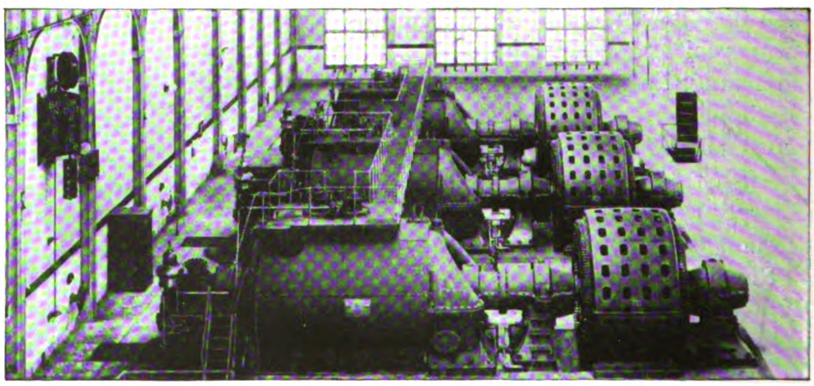


STRAIGHT PARSONS SINGLE-CYLINDER STEAM TURBINE
Installed for the Hartford Electric Light Company in 1900 and designed to operate at 1200 revolutions per minute

The steam turbine is generally regarded as of European origin, the reduction to useful practice having been carried out by Messrs. Parsons and DeLaval, and it is not generally known that steam turbines were commercially built in Syracuse, New York, as early as 1833. Several of these were sold and employed for driving saw mills, and were of the kind which might be described as of the "Hero" type, steam being admitted through the shaft and issuing tangentially from two radial arms. One user of these, Mr. N. Felt, of Cicero, New York, reported in 1835 that the turbine driving his saw mill used two-thirds the fuel of the reciprocator it replaced.

It is reported that in 1836 one of these was placed upon a locomotive near Newark, New Jersey. The turbine had an arm tipspeed of 14.25 miles a minute. Its life was ended in a ditch. It is, however, interesting to record that Parsons built a precisely similar machine about 1890, comprising a single "Hero" element. Its capacity approximated 20 horsepower, and with 100 pounds pressure and 26 inches vacuum, had a steam consumption of 40 pounds per horsepower hour. His attempts to improve performance by compounding were unsuccessful because of friction of the arms in the more dense fluid.

No historical review of the development of steam turbines would be complete without tribute to the work of Sir Charles A. Parsons, who, in spite of the many difficulties to be overcome, had the courage of his convictions and expended a large personal fortune in this work. He commenced work in 1884 by determining whether bodies could be operated at eighteen or twenty thousand revolutions per minute, and then proceeded to the building of a small turbine. Sir Charles at the outset thoroughly realized that the sphere of the steam turbine was in large sizes rather than small, but he had associated himself with a firm of engineers whose principle business was the equipping of ships with donkey boilers, winches, windlasses, etc., so it was natural that his activities were confined to the building of lighting sets for shipboard use. These sets were of small capacity, running at from fourteen thousand to eighteen thousand revolutions per minute, driving direct-current generators. The generators, while highly unsatisfactory from the standpoint of a modern direct-current machine, were remarkably

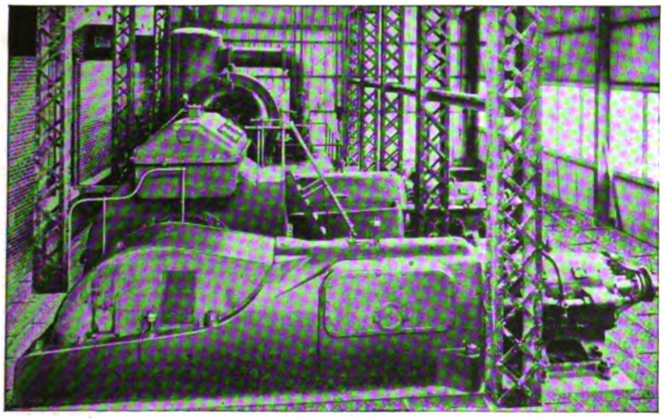


STRAIGHT PARSONS STEAM TURBINES
Regarded when built in 1905 as of unprecedented capacity and still in serviceable operation

ingenious in their design. It was not until he dissolved partnership with the above mentioned firm and established his own engineering works that he was enabled to build steam turbines and apply them to what he believed to be their proper sphere; viz., central station work. He applied them to the earliest central stations; viz., Newcastle, Cambridge, and Scarboro, in England in 1899, a 75-kilowatt machine being furnished to the former city. Of course, early progress was retarded by the small demand for high-speed machinery. Practically their only application was for driving dynamos which were then built only in small sizes.

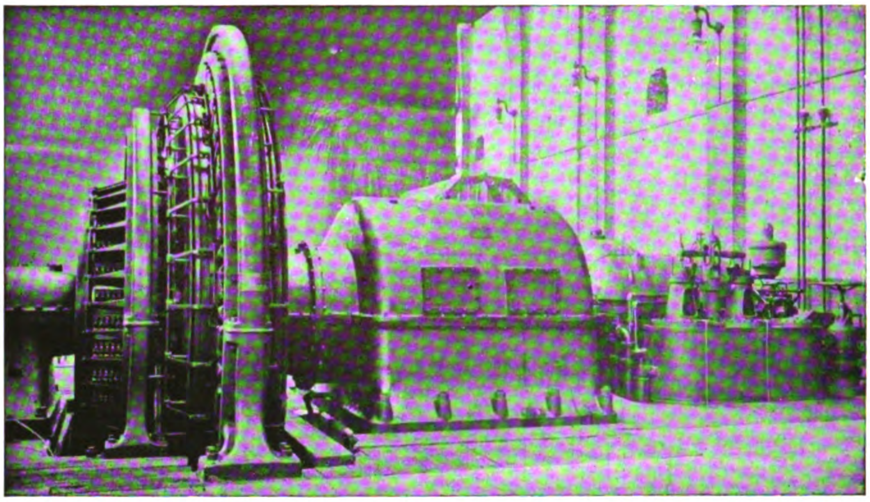
During the period from 1884 to 1889 about 300 turbines were built, ranging up to 75 kilowatts. In 1894 a number of 350 to 500- kilowatt non-condensing turbines were built for driving 50-cycle generators at 3000 r.p.m. These were furnished to the various electric lighting companies in London and displaced both Willans and Westinghouse single-acting engines, as the company operating them had received an injunction on account of the vibration being a nuisance to the community which was withdrawn with the installation of these turbines.

In 1896, the steam turbine as a practical machine was almost unknown in the United States. A foreign built DeLaval turbine of 300-kilowatt capacity had been furnished to the Edison Company of New York. A few Dow turbines of small capacity had been built, and while exceedingly ingenious in their character, they did not have much commercial application except for use in speeding up the flywheels of Howell torpedoes for the United States Navy.



Plant of the Hope Natural Gas Company
3000 H.P. 155 R.P.M. Westinghouse low-pressure steam turbines driving through reduction gears two 125 R.P.M. Ingersoll-Rand gas pumps, which raise the pressure in the mains from 75 or 100 to 340 pounds.

At this time Mr. George Westinghouse realizing the possibilities of the turbine, secured the rights to manufacture them under a license from Sir Charles A. Parsons. In 1896 a 120-kilowatt turbine was built in Pittsburgh of condensing design and drove a direct-current generator at 5000 r.p.m. This turbine had a water rate of 25.6 pounds per kilowatt-hour operating with 160 pounds steam pressure and 27.1 inches vacuum. The turbine was regarded as entirely satisfactory, but it need hardly be said that the generator did not come up to standards of direct-current apparatus, even of that day. In the succeeding years the Westinghouse Company was substantially alone in the turbine field; gas engines and large Corliss engines occupied most of the activities of the company, so that until 1899 turbine development, except for some experimental machines, was practically at a standstill.



Installation at the Plant of the Cleveland Electric Illuminating Co.
3750Kw., 1800 R.P.M. Westinghouse non-condensing steam turbine, driving a 190 R.P.M. direct-current generator through a reduction gear

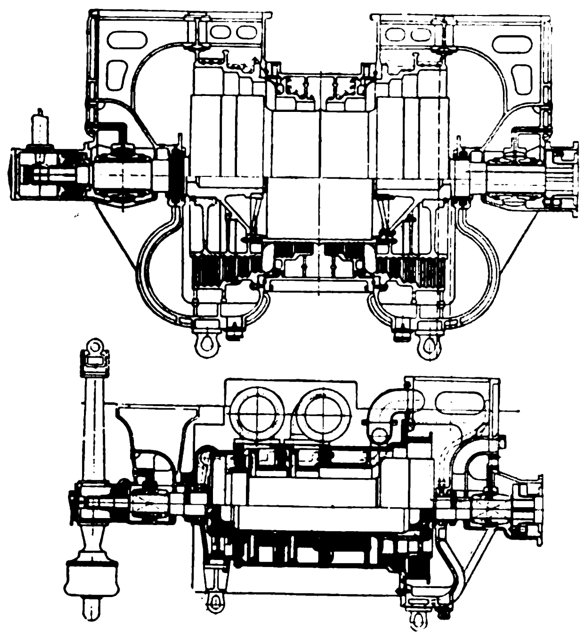
During the year 1899, the powerhouse of the Westinghouse Air Brake Company, Wilmerding, Pa., was equipped with three 400-kilowatt turbines which was the first serious turbine installation carried out in this country. The performance of these machines with 150 pounds steam pressure, 100 degrees F. superheat, and 28 inches of vacuum was as follows:

Load in Brake Horsepower	Pounds Steam Per Brake Horsepower Hour
264	14.48
445	12.87
593	12.05
759	12.06

A quite historic turbine installation was made in 1900 at the plant of the Hartford Electric Light Company, Hartford, Conn., which was of 2000-kilowatt capacity, running at 1200 r.p.m. This turbine was at least twice as large as any turbine that had ever been built and caused much comment at that time. The whole of the expansion was carried out in a single cylinder. European turbine builders, commenting on this, regarded it as a courageous thing to attempt to build such a large turbine structure in one single cylinder, and here came about a crossing of ideas, which is not infrequent in engineering progress; viz., two groups of engineers each abandoning their own line of progress and adopting that of the other.

At this same time; viz., 1900, Sir Charles Parsons constructed the historic Elberfeld machine wherein the expansion of steam was carried out in two separate turbine cylinders coupled to each other tandem fashion. This machine, operating with 144 pounds absolute steam pressure, 26 degrees F. superheat, and 28.2 inches of vacuum, gave a steam consumption of 19.0 pounds per kilowatt-hour at 1250-kilowatt load.

Sir Charles Parsons and also Brown Boveri, of Basle, who had by that time become a licensee of Parsons, encouraged by the success of the American Hartford machine, proceeded to build large size turbines



Cross Compound Westinghouse Turbine

High and low-pressure sections. The steam expansion is divided into two elements, each driving a separate generator, and each operating at different speeds

in single cylinder, while we in America, being impressed by the reliability to be obtained from dividing the steam cycle of the turbine into two separate elements, proceeded to build several machines of from 1000 to 2000 kilowatt-capacity in two cylinders; these being constructed in 1903. Plainly two cylinder machines of such small capacities were expensive, but it is interesting to point out a reversion to this type, by the Westinghouse Company, in the last two years. The Hartford machine above referred to caused sufficient interest that the General Electric Company saw their way to enter the turbine field and shortly thereafter commenced the construction of 5000-kilowatt units for the Commonwealth Edison Company, of Chicago.

Referring again to the two cylinder tandem turbines built in 1903; one advantage of the design was expected to accrue from the use of a reheating receiver between the two cylinders. Tests, however, showed clearly that the gain due to this did not warrant the expense, when high pressure steam was used for reheating. But the prophecy is ventured that there will be a reversion to intermediate reheating by means of separately fired superheaters for large machines in the near future.

The rapid strides made in central station practice in this country have brought about developments of turbines for land purposes in sizes that have gone beyond any European practice, and very remarkable steam engine performances have been obtained by the principal manufacturers. There is an impression that this development has, in this country, within the era say from 1900, grown from a very poor and uneconomical machine. It is seen, however, from the steam consumption of the earliest machines quoted and in what follows, that they do not compare very unfavorably with what can be done today with similar speeds and capacities. Unquestionably, improvements have been made in producing less expensive and more reliable detail design. Improvements in economy, however, have been due to increased speeds for a given capacity rather than to any material change of thought or principle as regard turbine systems. Very material advances have been made in the development of the high-speed alternating-current generators, which have permitted turbines to be designed more appropriately for the volumes of steam involved. Today, 5000-kilowatt, 60-cycle machines have been built for operation at 3600 r.p.m., while in the year 1900 electrical engineers looked askance at such speeds even for 500-kilowatt units, and regarded 1800 r.p.m. as the more desirable speed for this capacity and frequency. Improvements in condensing apparatus have also contributed to the development of the turbine, bringing ordinary available vacua from 26 inches to 29 inches, this improvement having been brought about by the demands of the turbine builder, which were largely responded to by manufacturers of the more modern systems of condensers apparatus.

Today it may be said that the maximum capacities of generators at given speeds are as great as the capacities for which the turbine can be conveniently designed. In other words, the turbine ceases to be a machine of too high speed for general application. It may be designed for its best speed and direct connected to the generator in the case of alternating-current machinery for all but the smaller sizes below 500 kilowatts. It may be still operated at its most economical speed and by the intervention of toothed gearing be connected to direct-current generators or to other apparatus for any other purpose whatsoever, including direct mill drive, large reciprocating pumps and the propulsion of ships.

The principal field for the steam turbines has in the past been driving alternating-current generators; and as there are, broadly speaking, but two frequencies in conventional use in this country, 25 and 60-cycles, the speeds available were limited. Because of the difficulties of electrical transmission there has not been much demand for direct-current generators of large size. Further, because of the difficulty of designing direct-current generators for high speeds, the number of direct-current turbine installations is comparatively small. In the installations of direct-connected turbines and direct-current generators which were made, the speeds selected were too high for successful operation of the generators and too low for the economical operation of the turbines. Within the last eight years, however, reduction gears have been developed which remove this objection; so that today first-class designs of direct-current generators may be driven by turbines as successfully as can alternating-current units. A number of such geared outfits have been installed, giving entire satisfaction, the speeds being as follows:

Capacity Kw.	Turbine Speed R.P.M.	Generator Speed R.P.M.
150	6,000	900
300	6,000	900
500	5,000	720
1,000	3,600	514
1,500	3,600	360
3,750	1,800	180

The past two decades have seen a growth in the size and economy of steam turbines beyond the most optimistic expectation of twenty years ago. It would be impossible within the limits available in ELECTRICAL ENGINEERING to discuss every step in the progress made, but it is interesting to describe and illustrate some notable installations that have played their part in electrical development.

In 1900 a 2000-kilowatt turbine was shipped to the Hartford Electric Light Company. This turbine was of the straight Parsons single-cylinder construction, and was designed to operate at 1200 r.p.m. Its performance was as follows:

Kw. Load	Steam Press. Lbs. Gage	Superheat Degrees F.	Vacuum In. Hg.	Lbs. Per Kw. Hg.	Eff. Ratio
1,998	155	41.6	26.9	19.1	58.2

In 1905 some large machines were constructed, capable of being given a normal rating of either 5500 or 7500 kilowatts. These were regarded at the time as of unprecedented capacity. They were operated at 750 r.p.m. and were of straight Parsons design. Fourteen of these machines were built, and twelve are still in serviceable operation. Their performance—

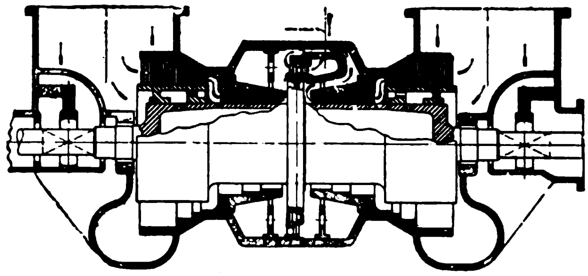
Kw. Load	Steam Press. Lbs. Gage	Superheat Degrees F.	Vacuum In. Hg.	Lbs. Per Kw. Hg.	Eff. Ratio
9,806	177.6	96.0	27.31	15.21	67.4

An epoch-making machine was shipped to the City Electric Company, of San Francisco, in 1909. This machine, which was of 10,000 kilowatt normal rated capacity, 15,000 kilowatt maximum, at 1,800 r.p.m., was of double-flow construction, except that the impulse element only was single flow, all of the reaction blading being double-flow. Its performance—

Kw. Load	Steam Pressure Lbs. Gage	Superheat Degrees F.	Lbs. Per Kw. Hg.	Eff. Ratio
9,173	167	59	14.572	69.0

In 1912 two of the largest geared direct-current units of 3750-kilowatt capacity were installed by the Cleveland Electric Illuminating Company and have been in successful operation ever since. These turbines operate now condensing against 20 pounds back pressure, the gear reduction being from 1800 to 180 r.p.m.

Some important machines of 30,000-kilowatt capacity were installed by the Interborough Rapid Transit Company, of New York, in 1914, in which the principle of so-called cross-compounding was introduced; the steam expansion being divided into two separate elements, each driving a separate generator. The high and low-pressure element respectively operate at different speeds, each at the nearest synchronous speed most suitable to the steam volume involved. The advantage of cross-compounding is commended for the increased reliability thereby gained. Its performance—



SECTION OF DOUBLE-FLOW WESTINGHOUSE TURBINE

An epoch-making machine, the impulse element only being single-flow, but all the reaction blading being double-flow

Kw. Load	Steam Press. Lbs. Gage	Superheat Degrees F.	Vacuum In. Hg.	Lbs. Per Kw. Hg.	Eff. Ratio
26,740	209	108-5	28.862	11.47	75.51

Discussion of the general progress of turbine development in the past is not complete without reference to the possibilities of the future. It is plain that with turbines of large size, which deliver to the switchboard 76 to 80 per cent. of the theoretical energy available from the steam expanding between the limits specified, further improvements in the turbine itself will not materially raise this efficiency, and that further improvement in central station economies must be looked to from causes other than the steam turbine. This is a subject of the greatest importance in view of the rapidly increasing cost of fuel and justifies considerably more capital expenditure for economizers and other plant apparatus which will reduce fuel cost.

Storage Batteries

THE marked development of the storage battery during the past four or five years is largely due to the growth and demand of the automobile industry. With our entrance into the great war there came many calls for new applications of this apparatus, both in heavy trucking and also in connection with the Liberty aviation engine. The wide extent to which the storage battery is being used for war purposes cannot be told at this time. When the industrial and mechanical sides of the great conflict are recorded, this method of storing energy will be found to have played no inconsiderable part. At a recent meeting of the Cleveland Engineering Society, Mr. O. W. A. Oetting, special engineer of the Willard Storage Battery Company, of Cleveland, read a paper on the subject, with particular reference to the use of storage batteries in the automobile industry.

The developments during the last few years in the storage battery line have been principally along three general lines, viz., isolated lighting plants, automobile batteries and batteries for various applications for carrying on the war, said Mr. Oetting. There have been no types of batteries developed lately using plates other than the lead or the nickel and iron elements. A new insulation, however, has been developed and used successfully, first in the automotive types of batteries and lately applied to some batteries used for war purposes. This insulation is made of rubber and has embedded in it minute threads which extend through the insulation from one surface to the other. In the automotive batteries, this insulation has been found to give an increase of starting voltage over that obtained with wood insulation and the life of the battery using this insulation is considerably increased over that of a battery insulated with wood separators. All other changes in storage battery developments were only along the lines of details in construction or slight changes in the methods of mixing the pastes for the plates.

We will consider first, batteries for isolated lighting plants. This development has received quite an impetus in the country districts in farm lighting equipments. It has brought all the conveniences of electricity so long enjoyed by the cities, to the home and the service of the farmer. In the past, electric service has been confined almost entirely to the larger cities and towns beyond which it would not be profitable for public service corporations to extend their lines. The result was that people living in the country districts have been forced to do without the advantages of electric light and power. The advent of the isolated storage battery plant has brought out a new line of low voltage electric appliances, so that no difficulty is experienced in securing such appliances that can be operated on low voltage battery systems.

Thirty-two volt systems have been adopted as standard for isolated battery plants. It was possible to use this low voltage because the line drop in the system is very small. For lighting, the low voltage system also is desirable on account of the shorter filaments that can be used in the lamps. Added to these, there is the safety factor that makes a 32-volt system more desirable than the usual 110-volt system. The battery used for these systems consists of sixteen cells sealed in glass jars with a sealing compound. The plates are made by the paste process and the insulators are made of treated wood, or a rubber sheet and wood combined. These batteries were first placed on the market with Plante plates in glass jars. Then a change was made to a Plante plate in hard rubber jars. The reason for the demand that brought about the change to the glass jar again is not apparent. It may have been made to have a physiological effect on the farmer so he could see the "innered workings of the durned thing," and thus prevent his tampering with the cells that could only result in harm to the system. The glass jar type of battery undoubtedly has the advantage of allowing visual inspection of the heights of the electrolyte in the cells.

The nickel-iron alkaline battery is used to some extent in isolated lighting plants. An estimate made by a person actively engaged in the application of batteries for this purpose gave the extent of this type of battery in this service as not exceeding 10 per cent. The high first cost of this battery probably prevents a more extensive application of this battery for isolated lighting plants.

The successful application of the storage battery to the automobile within the past five or six years has resulted in practically a universal adoption of the electric motor for starting internal combustion engines for this class of service. The convenience and safety features of this starting system are well recognized and are quickly bringing about the adoption of this system for starting other types of internal combustion engines. Electric starters are being placed on trucks and tractors and also are used for starting large marine engines. In the lighting field, the storage battery displaced the old gas systems, in which the gas tank was usually found to be empty when the lights were most needed.

With the advent of the battery on the automobile, battery ignition naturally followed, and today we find the larger majority of cars using battery ignition. There has been considerable controversy from time to time as to which is the better ignition, battery or magneto. It is recognized today by engineers that there is little difference in the two systems in respect to power requirements. A well-designed battery system will give as good results as magneto ignition. There is one feature, however, in which the two systems differ that probably has led to the adoption of battery ignition and that is the characteristics of the systems under starting conditions. The magneto depends on speed to increase the power of the spark, while the battery system has the hottest spark on starting. In the winter, when the engine is very cold or when the engine for some other reason is hard to turn over, the cranking speed is liable to be very low and the spark from the magneto may not be hot enough to fire the charge, due to the low speed at which the engine turns over. With the battery ignition, the conditions are just the opposite, *i. e.*, the hottest spark is obtained on starting.

The application of the storage battery for starter service brought about high rates of discharge from batteries previously considered next to impossible with a proper life of the battery. Discharge rates of one hour's duration were commonly used for rating batteries. With the advent of the electric starter, the batteries were first given ratings of discharge for a period of twenty minutes, and later voltage tests were called for at rates four and five times the current at the twenty-minute rate. An electric starting motor normally draws current from a battery that will discharge the battery in about fifteen minutes. Under cold weather conditions when the engine is very hard to turn over, this rate of current is increased several times this amount. The battery designer had the problem presented to him of developing a high capacity battery for these high discharge rates of current with a minimum of weight and size. In addition to this fact, these batteries must be made to stand the vibration to which stationary batteries never were subjected and also were placed in the hands of persons usually unskilled in the care and attention of electrical apparatus. Each year's development in these batteries has brought about a gradual increase in the average life of the batteries. Reports from service stations all over the country show such an increase in the average life of the battery. Another feature that has led to this increase in life has been the education of the ultimate user by means of national advertising campaigns in magazines and by other literature describing the proper care and use of the electrical systems on automobiles.

The Society of Automotive Engineers have standardized on two rates for testing storage batteries. One of these is to determine the lighting ability of a battery and calls for a discharge at normal temperatures at the five-ampere rate. The second rate is determined by discharging a battery at normal temperature at such a current that the battery is discharged in a period of twenty minutes. This procedure necessarily is a "cut-and-try" method and no doubt could be stated in more definite terms. The purpose of the rule is to determine the starting ability of the battery. As a matter of fact, as previously mentioned, the normal starting current is more nearly the fifteen-minute rate of discharge. Manufacturers frequently call for tests on starting batteries to determine the "five-second voltage" both at normal and low termperature. By the term "five-second voltage" is meant the voltage that a battery will give at the end of five seconds at a certain discharge rate of current. These high discharge rates are often four or five times the so-called twenty rate of the battery. These five-second voltages are used for determining the proper size of battery necessary for starting the engine and also in the design of the electric starter.

Considerable engineering data has been compiled within the last two years with reference to the successful starting of automobile engines. There are several factors that must be considered to make this starting successful. Naturally, the battery is one of the first that must be considered. Usually on the automobile the battery is called upon to supply the starter, the lights and the ignition. From these requirements we can determine the proper size of battery that should be used. It has been found that the factor that determines the size of storage battery is the power required to start the engine under cold weather conditions. At low temperatures, the battery capacity and the terminal voltage are considerably reduced. At these low temperatures, the lubricating oil in the engine thickens and the result is an increase in the demand of current from the battery, the efficiency of which has already been reduced due to the low temperature. If the engine with its starting motor and storage battery is placed in a refrigerator, the proper starting characteristics can be determined and the correct size of starting motor and battery for successful starting can be applied. Such tests were made on various sizes of engines and a summary of the same were published in the February issue of the *Journal of the Society of Automotive Engineers*. This paper gave the minimum battery sizes in terms of engine displacement that should be used for successful starting at 10 degrees Fahrenheit temperature.

The importance of improving the starting battery characteristics for low temperature performance has been realized by the battery manufacturer. Minor changes were made that improved these starting characteristics of the battery by increasing the capacity at the twenty-minute discharge rate at the expense of the five-ampere discharge rate. The replacement of the wooden separator in starting and lighting batteries by the threaded rubber insulation is another step toward better cold weather starting characteristics. Perforated rubber sheets have been used for insulation between the plates of storage batteries, but to prevent short circuits through the perforations in the insulators, and additional separator made of wood is required. The effect of this double insulation is to lower the voltage of the battery and, therefore, decrease the efficiency of the battery, especially for cold weather starting conditions. On the other hand, the threaded rubber insulation is made in such a manner that no additional insulation is necessary between the battery plates. The structure of this insulation is rubber which is perforated with thousands of minute holes and each hole contains a short piece of thread which extends from one side of the insulator to the other. These threads not only prevent the passage of the active material from one plate to the other, but also aid the diffusion of the electrolyte in that they act like wicks in the acid. This increase in rate of acid diffusion probably is the reason for the increase in the five-second voltage of the rubber insulated battery.

One would naturally suppose from the high rates of current demanded from the automobile storage battery that failures in service would be due principally to this reason. As a matter of fact the deterioratior of the battery plate is due largely to overheating in the summer time. This overheating acts in two ways. It tends to loosen the active material in the battery plates and also carbonize the wood insulation between the plates. The charging rate should, therefore, not be excessive, especially during warm weather. If the battery is of insufficient size, the current demand may be so large that an excessive charging rate is required to keep the battery fully charged. Naturally the proper size of battery will rectify this cause of failure. Here again the rubber insulated battery will give longer life as the excessive charging would not deteriorate the insulation by carbonizing it as in the case of wooden separators.

There has been no application of the iron-nickel-alkaline battery for electric starting service. Two factors have prevented the use of this type of battery for this service. One reason is the high internal resistance of this battery. The other is the poor performance of this battery at low temperatures. At 10 degrees Fahrenheit the lead-acid type of battery has about 50 per cent. of its normal capacity, but at this same temperature the capacity of the iron-nickel battery is below 10 per cent. It probably would be possible to use this type of battery for automobile lighting, but to the best of our knowledge we have no recollection that any such application has been made.

In the development of storage batteries for war purposes, there are two types which have already seen considerable service and have been thoroughly successful for the applications for which they were designed. These types are the heavy duty truck battery used on the Liberty truck and the ignition battery used for the ignition on the Liberty aviation engine.

The truck battery is one in which the component parts have all been built for greater mechanical strength so as to withstand the rough usage that it would meet in this class of service. The plate thickness has been considerably increased, the hard rubber jars have been increased 50 per cent. in thickness, and the wooden box has been made more rigid by increasing the thickness of the wood and bolting together the sides. This battery was developed on a vibrating platform which was dropped 5-16 of an inch about 560 times a minute. The battery was required to stand up on this vibrating test for at least one million bumps in a test of about thirty hours duration. The Government had a duplicate vibrating platform for these tests on which the battery finally adopted was tested.

The aviation battery is a small storage battery used for the ignition of the new aviation engine. Necessarily this battery had to be made of a non-spillable type so that during the various maneuvers of the aeroplane the electrolyte was not spilt out of the battery. This was readily accomplished and the battery in an inverted position during a discharge test gave 67 per cent. of its normal capacity.

In some of the other applications of batteries we find a great range of plate sizes. Some batteries are built with plates 1-16 inch thick. These are batteries for services where high capacities are required at a minimum weight. Necessarily no long life is expected of such batteries. They are made in several voltages and are easily adapted for portable use or applied to other purposes where a minimum weight is essential. The other extreme in plate size is reached in batteries for naval purposes where the plates are made 1-4 inch in thickness. These batteries are used for auxiliary lighting purposes and for auxiliary power purposes in turrets and for steering.

Electric Hoists in South Wales Collieries

One of the results of the war has been the application of electricity to many colliery undertakings in South Wales. The centralization of power generation is progressing satisfactorily by private enterprise, and it is now announced that in some of the collieries hoisting machines up to 5,000 horsepower are working in a very efficient manner. In this country wide use is made of electric coal cutting machines, and there is no reason why there should not be a more general adoption of them in Great Britain.

There is no "can't" in America, says an English exchange. In this country we often see a house we like in the garden we hate, or the garden that attracts surrounding a house that repels. But we can't change the location of the houses. In America they can. For example, a three-story house in West Summerville, Mass., was cut in two and re-erected a mile away Each section was 35 feet by 25 feet at the base, and about 40 feet high. The chimneys and foundations were removed, and the first floor of each section loaded with brick to act as ballast. Wonderful people, the Americans!

The Telephone in Great Catastrophies

NOT until there is some great catastrophe is it fully brought home to us how dependent we are in our modern life upon the telephone. The summoning of help, the marshaling of forces to restore order, the giving of news to an anxious public, and the announcing of the safety of dear ones in peril, for all of this we instinctively turn to the telephone. What is more, back of these terrible disasters there is almost always a story of quiet heroism and devotion to duty on the part of operators and repair men. Very seldom does this reach the public. "It is all in the day's work," would be the comment of those who would scorn to boast of their fidelity in danger. When the greater part of Halifax was shaken and wrecked by a terrible explosion some months ago telephone operators stuck to their posts and gave invaluable aid in the work of rescue. Then followed fire and a blizzard, with no means of obtaining water or light, or of heating shattered buildings. But the repair men went steadily at their task of restoring service, in a temperature below zero.

During the past month a series of terrible explosions rocked northern New Jersey and wrecked the great shell-loading plant of the T. A. Gillespie Company at Morgan, near South Amboy. There have been countless tales of the heroism of the employees, of the Coast Guard hastily summoned to police the plant, and of the Red Cross, the physicians, and the volunteers who aided in the work of rescue. It is most fitting that there should be proper recognition of the heroic devotion of the entire telephone force, in constant peril of life and limb. A long, detailed report of the work that was done has been compiled for *The Telephone Review*. Advance sheets of this have kindly been placed at our disposal, and a summary will have general interest.

The first explosion occurred in a building known as Unit 6-1-1 at 7.30 P. M. on Friday, October 4. The original explosion, while terrific in itself, caused a conflagration which resulted in a series of titanic explosions as the creeping flames reached the various loading units and storehouses, until virtually nothing was left but smoking ruins of what had been considered the largest and most up-to-the-minute shell-loading plant in the world.

It happened that Installation Foreman Sheldon and Installers Davis and Van Binsberger were doing some special plan work in the Administrative Building at the Gillespie plant when the first explosion occurred. Realizing the importance of telephonic communication at such a time, Mr. Sheldon tried to get the operator at the private branch switchboard from one of the extension stations on which he had been working, but was unable to do so.

The private branch switchboard (which consisted of five positions No. 600 P. B. X. type) was located in a detached building approximately one-half mile from the Administration Building, and Mr. Sheldon, knowing from what was happening that time was mighty precious just then, bundled his two men in the Company's Ford car which is assigned to him and drove through a veritable rain of projectiles of all kinds to the telephone building. The switchboard was deserted, but the building was apparently intact. At the request of the Gillespie Company these men began to operate the switchboard. Repair men from near-by stations were soon on hand. An aerial cable close to the exploded Unit 6-1-1 had failed, and an effort was made to repair this, but the men were stopped by the United States Coast Guard, then on duty. About midnight, as the fire was spreading, it was thought that the switchboard would have to be abandoned and that it would be well to provide for emergency service at the Administration Building, which was at a safe distance, so that, if the unexpected did happen, the Gillespie Company would not be without telephone service. Fortunately, this plan could be put into effect quite readily, as the switchboard was originally located in the Administration Building, and the central office trunks were still routed through cables which terminated in this building. Arrangements were made accordingly, so that if it was found necessary to abandon the switchboard, the trunk lines could be transferred directly to extension stations in the building, insuring telephone service on a direct-line basis, regardless of the switchboard.

The fire was fast approaching another loading unit, 6-3-3, which was dangerously near the telephone building. The job of transferring the trunk lines to the Administration Building was completed at 2 A. M. Saturday, and at 2.06 the Unit 6-3-3 blew up. At 2.15 A. M. orders were given to abandon the telephone. Van Binsberger stuck to his job at the switchboard until ordered out of the building, which order was none too soon, as a shell struck the rear of the building a few moments later, and a short time afterwards another shell went through the structure, practically demolishing it and setting it on fire. The explosions continued all through the night and the next day, as the flames licked up unit after unit, finally reaching the Administration Building, which was destroyed.

On Sunday temporary service on a direct-line basis was established in one of the officers' quarters on the outskirts of the plant, while the shells were still falling at intervals. On Monday the Gillespie Company found temporary quarters in Perth Amboy, and a rush order for one 40-line position, 4 trunks, 10 tie trunks, and 25 extension stations was passed at 4 P. M. This equipment was installed and working complete at 11 P. M. the same day.

Monday afternoon it was decided by the Gillespie Company to restore the telephone service at the plant, as far as could be done, and work was begun at once on the switchboard installation, consisting of two positions No. 4 P. B. X. type, which were placed in one of the few buildings that had escaped destruction. This equipment, with 10 trunks, 6 tie trunks, and 68 extension stations was connected that night and put into operation the next morning.

In all, a total of thirty-five direct-line stations and three private lines to New York were installed on Sunday and Monday in Perth Amboy, while seventeen direct-line stations were installed at different points in South Amboy and connected to the Perth Amboy central office, as on Sunday the South Amboy office was not giving service. The connecting of this emergency equipment in the danger zone was full of thrills, but fortunately no one was injured. Although two Ford cars were struck by pieces of exploding shells, no damage was done beyond a few dents on the metal bodies.

As the electric power at Keyport, N. J., was shut off, due to the danger of crossed wires after the explosion, and Saturday being the regular day for charging the Keyport central office batteries, the heavy telephone traffic incident to the explosion caused their rapid depletion, and for a time it looked as though the Keyport central office might go out of commission. Dry batteries were resorted to as a temporary expedient, and at 9.30 A. M., Saturday, Division Equipment Engineer Barnes ordered that a type M-3 Western Electric generator at New Brunswick be demounted and sent to Keyport by automobile, where it was set up and operated successfully, using the rear wheel of a Ford car as a prime mover, thus enabling the recharge of the almost depleted battery.

The New York-Washington line, carrying 60 wires, was built along the west side of the Gillespie plant, and 15 sections of this was destroyed. Repair men were started out, but they were held up by the guards. By special permit, an inspection was made Saturday afternoon, although shells were exploding within 150 feet. Three gangs were set at work Sunday morning, and by 7 P. M. the line was clear.

Electric Smelting of Manganese Ores

In 1917, 115,000 tons of manganese ore containing more than 40 per cent of metallic manganese were produced in the United States, as compared with 27,000 tons in 1916 and 4,000 tons in 1913. This great and rapid increase in the domestic production has resulted from the higher prices due to the shortage of the foreign supply. As the imports of foreign manganese, which formerly largely supplied the domestic demand, have been restricted on account of the shortage in shipping, the United States Geological Survey has tried to assist in stimulating the domestic production by sending geologists to examine little known and undeveloped deposits in various parts of the United States in order to determine the quantity and availability of the ore at the several deposits. An examination of the manganiferous area in Mason County, in the Olympic region, Washington, shows some promising outcrops.

Although the visible ores of the Olympic Mountains are more siliceous than ores from which ferromanganese is commonly made and cannot therefore be smelted advantageously in the blast furnace, they could be melted to silicomanganese and to standard grades of ferromanganese in electric furnaces if cheap electric power were available and other conditions were favorable.

H. H. Piper, of Olympia, Wash., has begun work on the Apex claim on the north fork of the Skykomish River. In association with Mr. MacKean, who has the adjoining claim, he proposes to erect a small electric furnace at the foot of the mountains to make ferromanganese from ore from the various claims in the vicinity.

The Arkansas Valley Railway Light & Power Company, of Pueblo, Colo., has been approached by a company organized in Colorado Springs for the purpose of working manganese ores in the Cripple Creek district, with reference to supplying this company's electric energy requirements amounting to approximately 300 horsepower in motors.

A Reconstruction Conference

Preliminary plans for the War Emergency and Reconstruction Conference of War Service Committees to be held at Atlantic City, December 4, 5 and 6, are announced by the Chamber of Commerce of the United States. Reconstruction will be given a prominent place on the program, as it is recognized this subject must be taken up by business men to the end that there may be placed at the command of the Government all available sources of information. The work of reconstruction suggests the creation of a federation of all war service committees that whatever study and planning is carried on may be on behalf of all business. War industries and non-war industries are concerned equally in the determination of reconstruction problems. All European countries already are under way with reconstruction plans.

The Atlantic City conference, a call for which has been sent out by the War Service Executive Committee of the Chamber of Commerce of the United States, will include four general sessions and numerous group and committee meetings. Into the final session will be brought for final action all the proceedings of the meetings. There will be four general sessions participated in by all the delegates. On December 4 there will be both morning and afternoon sessions, and on the 5th and 6th, morning sessions. The Chamber is engaged now in obtaining the best speakers available to discuss among others the following suggestions: Reconstruction, industrial relations, raw materials and their control, price control, economic legislation affecting combinations, export and import operations, finance, etc.

The conference will be divided into groups at three sessions, the first to be held on the evening of December 4, the second on the afternoon of December 5, and the third on the evening of the same day. On the evening of December 4 each war service committee will meet with its chairman to consider the problems of reconstruction as they affect that particular industry as well as to take up other problems which the war has demonstrated are vital to industry. On the afternoon of December 5 the war service committees will meet in groups which are related as to their use of basic materials and as to their distribution problems, etc. With these groups will meet the commodity or section chiefs of the War Industries Board. Related groups will form themselves into ten major groups on the evening of December 5 to take up the question of raw materials, price control and subjects arising from related group meetings. After the general meetings of the committees of the related groups and of the major groups, it is hoped there will be presented definite recommendations covering the reconstruction period, with the possibility of creating an executive committee empowered to gather data and to function with industries to meet the many problems that the nation's industries will be called upon to solve with the end of the war.

Electrical Appliances An Economic Necessity

What is a necessity—what is a luxury?

Purchasers and dealers everywhere are asking this question of themselves and each other. All are anxious for an answer. All want to know that they are buying and selling the things that are really necessary, and that will directly or indirectly help in winning the war, writes Sidney Neu, of the Westinghouse Electric & Manufacturing Company.

What is the dealer's real duty—to make a quick clean-up of his electric irons and percolators and refill his showcase with cast-iron sadirons and graniteware coffee pots, or to keep right on selling electrical appliances?

How about the housewife—ought she to shut her eyes to the attractions of the toaster stove and decline to see anything except the three-pronged iron toasting fork?

For an answer to both these questions consider the case of the electric iron.

Assume that the average user saves fifteen minutes a day with her electric iron because it heats more rapidly, stays hot and doesn't have to be carried back and forth to the stove.

Suppose that this saving is introduced into five million homes. More than a million and a quarter hours is saved every day by this one common appliance. Actual time saving would amount to the time of 150,000 workers busy eight hours every day.

Then there's washing. It's a once-a-week job in most homes, but it takes six or seven hours every time it's done. Assume that your wife serves notice to the laundress (if she hasn't already done so) and installs an electric washing machine. Perhaps your wife will spend only two hours of her own time at the job, but she's freeing six hours of other labor, which might be extremely useful in war work. A net saving, say, of four hours a week.

Suppose that this wash-day saving is accomplished in two million homes. There is a direct saving of more than a million hours a day—the time of 15,000 workers.

Consider the saving in fuel. The average home uses six to eight tons of coal a year in its range. An electric range uses on the average three tons of the central station's supply—other fuels in proportion. Greater economy in burning the fuel and more efficient application of the heat, second for the saving, and every heating appliance adds its share to fuel saving for the same reasons.

Decidedly these electrical appliances are not luxuries. They are necessities that can be classed with modern residence heating systems, up-to-date plumbing, running water and electric light.

Some day, when you're not in a hurry, try going without the electrical conveniences to which you and your family are accustomed. Prove to your own satisfaction that the iron, the sew motor, the washing machine, the vacuum cleaner and the many electric cooking utensils have a real place in the modern household. Convince yourself, and then convince others, that electrical appliances are even more necessary now when every minute must be saved to insure victory than in deliberate, quiet times of peace, when wasted time meant only wasted money or wasted personal opportunity.

Use of Water Power in Spain

The laws in force in Spain for the use of public water power are the outgrowth of legislation of 1866 and 1879, enacted before the advent of the great hydroelectric enterprises, writes Consul General Carl Bailey Hurst, from Barcelona. Rapid development has necessitated numerous additions to the laws, which by their diversity caused certain misinterpretations. Accordingly by royal decree the dispositions relative to securing concessions for the use of water power, the classification of various bodies of water as public utilities, as well as adjacent land necessary for construction work, have been coordinated and published in the Spanish official organ, *Gazeta de Madrid*, of September 12, 1918.

Japan's Imports of Electric Machinery

The imports of machinery into Japan have shown a striking increase this year, according to the *Japan Salesman*. Electric motors and their accessories have increased in spite of the greater development of the electrical engineering in Japan. At the end of May, according to the official trade report, the import of dynamos, electric motors, transformers, converters and armatures was 1,059,556 pounds valued at 908,511 yens, against 401,599 pounds valued at 285,678 yens for the same time last year. Compared with the same time of 1916 the increase comes up to 896,772 pounds valued at 818,996 yens. Dynamos combined with motive machinery, however, have fallen off, their import being valued at 109,519 yens against 207,887 yens for the same time last year. The value of the yen is 49 cents.

Public Utilities and Fuel Conservation

APART from the problem of financing, the great economic question forced upon this country by the war is the conservation of fuel and food. This is a matter that affects not only the movement of troops and supplies, but the health and comfort of our people, our allies and of many neutral countries as well. Our public utilities are among the most considerable consumers of coal and oil, and any means by which their consumption can be reduced to the minimum assumes prime importance. In a general way, fuel can be conserved, first, by increasing the efficiency of production; second, by reducing the losses, and thirdly, by limiting consumption of the services rendered. These three methods are discussed by L. R. Nash, E. B. Powell and H. Vittinghoff, in the Stone & Webster *Journal*. With regard to central stations, the authors say that the most important factors in fuel conservation within existing power plants may in general be grouped as follows:

1—Loading.
2—Operation.
3—Quality of Fuel.

Of the three, it is believed that the first offers the greatest possibilities of prompt, positive improvement, although efforts under the second and third should by no means be neglected. They are merely slower in producing results and require greater perseverance.

Efficient power plant loading, viewed broadly for the district as a whole, involves consideration of the possibilities of co-operative relations between different plants and between the industrial consumer and the central plant. Co-operative relations between plants for the purpose in view will mean the electrical interconnection of plants within the same community, or within commercial range, to the end of raising the economical utilization factor of their combined equipment, permitting the continuous operation of the most efficient at high load factor, and the curtailment of operation, or the discontinuance, of the others, except for peak or reserve purposes. The advantages are not only reduced total fuel consumption but increased dependable output from the given total of capacity, as the result of pooling is to make any reserve capacity available for all.

Broadly speaking, a small plant is inherently less efficient than the larger central station; not only have the smaller units larger proportionate losses, but the smaller output cannot justify the same degree of refinement in operation that should be regular practice in the larger plant—also, where the power plant is merely an adjunct to the factory and power is a comparatively small item in the total cost of production, it is unusual for the management to take the degree of interest in power economies that is practically essential to the success of the central plant. On the other hand, any operating power plant, no matter how inefficient, will have value represented by a certain investment in equipment, and interlinked with the main system, and properly maintained, its capacity may be made almost as useful for reserve purposes as the equivalent in more efficient equipment at the central plant. Also, many small power plants are operated in connection with heating systems or manufactories requiring low pressure steam in their processes and the power is produced from engines or turbines exhausting into the low pressure steam systems. While plants of this type are extremely inefficient when discharging the engine or turbine exhaust to the atmosphere, they are frequently capable of producing power, to the extent of the low pressure steam requirements, with fuel economy quite equal to that of the larger central station and, accordingly, may advantageously be continued in operation if closely scheduled in output. When so operated the generation of power will rarely absorb in excess of 20% of the original heat imparted to the steam, leaving the remaining 80% or more, fully available for manufacturing or other uses. When governed by questions of fuel conservation, interconnection with the central station will in general mean, for a plant of this type, the purchase of power during the summer months, thereby improving the loading and the economy of the central station, and the generation of power during the winter, so leaving the central station capacity available for other users for the season of heavy demand.

The second consideration under power plant loading involves co-operative effort between the industrial consumer and the power plant towards the improvement of station load factor by more uniform distribution of power demand throughout the twenty-four hours and throughout the year. There is at present a commercial incentive to this in practically all power contracts, the rate of charge being in a measure based upon the maximum demand, yet there is opportunity for further material improvement. Many of our industrial plants are still working on only one shift per day and their many manufacturing processes are subject to wide seasonal variation. The advantages of high load factor are not only more efficient utilization of fuel resulting from more uniform loading of equipment, but increased power obtainable from given capacity of equipment in the power plant and also increased volume of product for the power consumer per unit of manufacturing equipment.

The second of the primary factors in fuel conservation, the operation of the individual plant, is of course, limited and in a measure governed by the type and class of equipment installed; yet, in general, the ultimate economy is more directly dependent upon the efficiency of management and the training and spirit of the operating organization.

Our consulting engineers in the past have been too prone to regard power station efficiency as a matter of mechanical design. The factor of personnel has been too often entirely neglected, whereas it is common experience that the older plant in the hands of a competent enthusiastic organization will frequently exceed in economy the plant of more modern equipment in the hands of a poorly managed organization. Training of the operating organization is usually a slow process because it involves the breaking down of old, inefficient habits and the building up in their place new habits of efficiency. It is for that reason that the adjustment of power plant loading would seem to offer greater possibilities of immediate results than correction of operation itself. Correspondence or other long distance methods can only be of comparatively slight assistance in improving power plant operation. The ground must first be thoroughly prepared by continued and intimate drilling.

The third primary factor referred to above is the selection of fuel. Very little can be done in the way of selection of high-grade fuel under existing strained conditions. In general, it may be said that low grade fuels should be consumed near the source, while better grades should be reserved for more distant consumers. Such a policy will result in keeping at a minimum the cost of transportation for a given number of heat units.

Closely allied to the proper selection of fuel is the question of selection of grates and furnaces necessary for burning a given coal. The present shortage of labor and fuel will in many cases make it distinctly economical to install mechanical stokers where it did not seem economical to do so a few years ago. In deciding upon the advisability of installing additional appliances for promoting the economy of fuel consumption, the question must never be lost sight of, however, whether or not the benefits to be obtained will offset the absorption of additional capital at this time when all resources of the nation should be exerted towards the successful termination of the war.

Turning now from the consideration of the economy of production of power to economy of consumption we are confronted with the problem which is at once vast and vital. The whole public will have to be called upon to do its utmost to reduce outright waste of power, such as useless operation of motors and burning of lights. Here too, however, the local lighting industry can help to a great extent; for instance, by using its every effort to abolish the use of carbon filament lamps.

There were sold in 1917 about 16,000,000 carbon filament lamps. From these sales it may safely be assumed that there were not less than 30,000,000 in actual use. The same illumination could have been obtained from an equal number of Mazda lamps of half the rated wattage. This superfluous wattage in the carbon lamps totals not less than 750,000 kilowatts. Only a part of these would be operated at one time, but if this superfluous lamp capacity is accompanied by something like 150,000 kilowatts of capacity of generating, distribution and other central station equipment, there is represented altogether an unnecessary total investment in the United States on account of carbon lamps of something like $30,000,000, based on the present cost of construction. If the carbon lamps were displaced forthwith this $30,000,000 of investment would be released for necessary war time expansion and extensions of service, the financing of which is being found exceedingly difficult.

Turning now to the more immediate question of fuel economy, and assuming that each carbon lamp in use is operated 175 hours per year (2% load factor), the energy wasted, assuming the carbon lamps to average 25 watts more than the Mazda lamps, amounts to 130,000,000 kilowatts per year, with a corresponding fuel waste of 250,000 net tons. This is 2% of the estimated total lighting energy consumption in the United States and is about 30% of the saving sought by the Fuel Administration through curtailment of electric sign service. It is obvious that if the central stations can release $30,000,000 of superfluous investment and save 250,000 tons of coal per year without undue loss they should unquestionably do so.

Supplementing the abolishing of carbon lamps a similar procedure is suggested in connection with such carbon arc lamps as are in use. Most commercial lamps of this type have already disappeared but a considerable number remain in street lighting service. Equal illumination can be obtained from type "C" Mazda lamps of one-half the energy and, therefore, fuel consumption. This change where necessary can be made at small construction cost by using the old arc lamp fixtures and casings after removing the arc mechanism. In one case which developed in connection with a rate case it was found that an increase in fuel cost of over two hundred per cent. could be offset by this change in lamps.

With regard to direct saving in power in electric railway operation, the authors declare that the most direct results are obtainable by curtailing heat, light and car mileage within permissible limits. They recommend a wider adoption of the skip-stop operation, which, particularly if staggered—that is, with inbound and outbound stops at alternate streets or stopping places—really involves no material hardship. Another possible means of material power saving is in the increased efficiency of manipulation of the car by the motorman. This is accomplished through more rapid acceleration and braking, and is approximately measured by increase in coasting. These are emphasized because they entail no additional capital investment, and will bring immediate results.

Among other incidental possibilities of reducing fuel consumption are improvements in the return circuits, particularly track bonding. Tests frequently show, particularly on small systems, that a few broken bonds may seriously increase return resistance and, therefore, the power consumption. Power, of course, may be decreased by more ample feeder capacity and by lighter weight cars, but such improvements are not to be recommended at the present time except under most unusual conditions on account of the absorption of additional capital.

The suggestions for a possible conservation of fuel by the gas companies are important and practical, but they are beyond the province of ELECTRICAL ENGINEERING.

The Engineer's Creed

MANY different professions have adopted a code of ethics. In some professions this has taken the form of a rule of conduct, for any violation of which penalties are imposed. In others the code is merely a statement of the ethical standards to which all members are urged to adhere in their professional life and practice. No one can dispute the wisdom, not only in fixing the standards of conduct on a high plane, but also in crystallizing these standards in worthy form and embodying them in clear, concise and vigorous language. It helps to clarify a man's mind if he has always before him in permanent form a code of ethics accepted by his fellow practitioners and recognized as embodying the settled principles of the leading members of his profession.

At the third annual convention of the American Association of Engineers, held in Chicago, in accordance with a resolution, a committee of one was named to submit a code of ethics. The man to whom the task was given was one of the most prominent and most loved of engineers. He has finished his task, but he has asked the association not to send his enunciation of "The Engineers' Creed" out over his own name. He prefers that it should fare forth on its own merit. If it lives up to its name, engineers will preserve it. If it does not find a place in their hearts, it will be forgotten. The Creed is printed in full in the November number of *Monad,* the official publication of the association. From advance sheets which have been kindly placed at our disposal, we quote the following:

In accepting an engagement in any field of service in which he has not already proven his attainments to be equal to the task, the engineer should be frank with his client and state just what his previous experience has been and give the reasons which, in his judgment, justify his undertaking the contemplated work. Many a man has had responsibilities thrust upon him by clients who, though fully aware of his lack of previous experience in the field which they wished him to enter, recognized in him resourcefulness, good judgment, industry, and frank honesty, which they believed fitted him to carry the new responsibility to a successful issue; and not often has he failed.

The engineer, in responsible charge of construction work which is being done by a contractor, individual or firm, at once exercises two functions, one requiring engineering knowledge, skill and experience; the other judicial fitness. He becomes the arbiter between the principal, man, firm, or corporation for whom the work is being done and whose money is paying for it, and the contractor who is doing the work. He must be a judge, executing righteous judgment between the parties to the contract, without fear or favor. The fact that his client, the principal or first party to the contract, pays him must not have the value of a pennyweight in tipping the scale in favor of the source of his income. The engineer owes his client an allegiance demanding intelligent, conscientious, and diligent service. That he owes, but his debt demands for its liquidation no act, no word which would compromise his integrity or offend his sense of justice and right.

The engineer's obligation to serve is not limited to the duties for which he is paid; he owes it to his equals in service, to his subordinates, and to the public at large. His equals are his brothers with whom he should share his knowledge and experience, should they seek it. His subordinates should find in him the help of good example; the friend with whom they may take counsel, and the mentor who will impart of his knowledge of life, of men, and things, to aid them in shaping their conduct and their purpose.

To the public at large, he owes good citizenship. With every other citizen he shares responsibilities for government, civic, state, and national, and his efforts should be to make government good. He cannot hold himself aloof from those activities which our form of government imposes upon those who live under it, and escape responsibility for its shortcomings and its failures. If an unworthy man represents him in any governing body, he shares that unworthiness unless he exercised the right and duty of good citizenship and tried to put a good man into the office that the weak or bad man holds. "They also serve who only stand and wait" may be true of those who through misfortune are cut off from life's activities, but the saying does not apply to any live engineer. "He must be up and doing." He must keep his mental equipment as fit for service as the soldier keeps his arms, and the guiding motives of his life true, lest they fail him when the hour of trial comes.

Moreover, an engineer owes a professional obligation to the public by reason of his special training along technical lines. Therefore, he should use his knowledge and experience to promote the general welfare by every means in his power. He stands upon the watch tower of progress to warn against danger and to show the way to better methods in dealing with problems of engineering. He should stand against the individual or group of individuals who try to exploit, for their own profit or advantage, forces of nature which belong to the nation, the state, or the municipality, without making a just return therefor to the rightful owners of the potentiality.

Wherefore should an organization of honorable men present a code of ethics when each carries in his own mind and heart rules of right living and honorable action?

It is "Lest we forget."

The law-abiding are not conscious of the restraints of the law, but the lawless are made to feel its power. A code of ethics accepted by the great body of professional men is the declaration of their faith, the chart by which they direct their course in the voyage of life. To this chart one who is in doubt may turn for suggestion as to the right course in any time of perplexity and by the principles laid down in this chart transgressors will be judged and disciplined by their fellows.

The Code

Any code of ethics must be predicated upon the basic principles of truth and honesty. "Whatsoever things are true, whatsoever things are honest," are the things for which engineers must contend.

An engineer may not "go beyond and defraud his brother" by any underhanded act or method. He may not do or say anything which will injure his brother's reputation or his business for the purpose of securing his own advancement or profit. This admonition carries with it no obligation to refrain from telling known and absolute truth about an unworthy brother, as a protection to others, but the truth so told must be such as can be substantiated, and he who tells it must have the courage which will not shrink from the consequence of his telling.

The engineer owes his client allegiance demanding his most conscientious service. But conscientious service to the client must never entail a surrender of personal convictions of truth and right.

An engineer who receives compensation from an employer may not receive gift, commission, or remuneration of any kind from a third party with whom he does business for that employer.

An engineer seeking to build up his business may not resort to self-laudation in advertising. He may state briefly the lines of work in which he has had experience and enumerate responsible positions which he has held and give his references.

An engineer who employs others, either in his own service or in that of the client who employs him, should recognize in his relationship to them an obligation of exemplary conduct, of helpfulness, and personal interest in those with whom he is thus brought in contact, and he should discharge such obligation tactfully and kindly.

The honor of the profession should be dear to every engineer and he should remember that his own character and conduct reflect honor, or the reverse, upon the profession.

If, then, he so lives that his own honor shall never be smirched by his own act or omission, he will thus maintain the honor of the organization to which he belongs.

Ordnance Department Changes

Brigadier General W. S. Peirce, Head of the Administration Division of the Ordnance Department, has been appointed the Assistant Chief of Ordnance and as such will have general administrative charge of the Ordnance Office and will act for the Chief of Ordnance, Major General C. C. Williams, during his absence. General Peirce will be succeeded as head of the

Administration Division by Colonel W. W. Gibson, who will also continue his duties as Director of Ordnance Training. Colonel Gibson acted in this capacity during the recent absence of General Peirce overseas.

Brigadier General C. C. Jamèison, head of the Production Division, has been appointed a Special Assistant to the Chief of Ordnance in Charge of Artillery Ammunition Metal Components, but not Loading Plant Operations, to succeed Mr. T. H. Symington, resigned.

Colonel Earle McFarland has been appointed a Special Assistant to the Chief of Ordnance in charge of drop bombs and trench warfare material, except explosives, propellants and loading operations.

Brigadier General John H. Rice, formerly Chief of the Engineering Division of the Ordnance Department, has been appointed Chief Ordnance Officer of the American Expeditionary Forces. General Rice is succeeded by Brigadier General G. W. Burr as head of the Engineering Division.

Colonel J. C. Heckman has been appointed Chief of the Supply Division to succeed Colonel Thales H. Ames, who has been detailed for duty overseas.

The Ordnance Department also announces the abolishment of the Production Division as a separate organization and the distribution of its functions among the other Divisions of the Ordnance Department. All of the functions formerly performed by the Production Division in Washington have been transferred to the Office of the Chief of Ordnance under the direct supervision of the appropriate special assistants to the Chief of Ordnance. For example, the Cannon Section, charged with the production of guns and their carriages, reports to the Assistant to Chief of Ordnance in Charge of Cannon, Carriages, their Appurtenances and Accessories; similarly the Small Arms Section, which is responsible for the production of small automatic and side arms, reports to the Assistant in Charge of Automatic Arms, Rifles and their Ammunition.

The functions previously performed by the Production Division in the field are transferred to the District Ordnance Chiefs of whom there are twelve located in the following centers: Boston; Bridgeport, Conn.; New York; Rochester, N. Y.; Philadelphia, Pa.; Pittsburgh; Cleveland; Detroit; Cincinnati; Chicago; St. Louis and Toronto, Canada.

The service function sections of the Production Division such as Administration, Industrial Service, Plant and Miscellaneous, as well as the general activities of the District Offices, are under the jurisdiction of Brigadier General Guy E. Tripp, Special Assistant to Chief of Ordnance.

Telephone and Telegraph Men Needed

The War Department authorizes the following statement. The Signal Corps of the Army needs men who have had experience in connection with the operation and maintenance of telephone and telegraph systems. The Commanding General of the American Expeditionary Forces in France has made a cablegraphic request for the following technical personnel; the services of whom are sought for immediate duty in France to assist in the operation of the important lines of communication in the rear of the battle front:

Multiplex Attendants with previous experience as such.

Multiplex Supervisors with experience as supervisors of punchers.

Multiplex Punchers with previous experience of not less than 3 months' training.

Telegraph wire and repeater chiefs.

Experienced toll and maintenance linemen, including 5 line foremen.

Experienced common battery and magneto switchboard repairmen.

Experienced toll test board men.

Experienced telephone traffic equipment and circuit engineers.

Telephone operating traffic chiefs.

Men selected for this duty will enter the military service in an enlisted capacity. However, they will not be required to pursue a long course of training except for a sufficient time for clothing, equipment, etc. The physical standards may also be lowered in cases of men having the requisite technical qualifications. Men between the ages of eighteen and fifty-five (both inclusive), are eligible for this service and should apply to the Chief Signal Officer of the Army, Washington, D. C., for full particulars.

Public Utilities in Bristol

Bristol's electrical plant is owned and controlled by the city, writes Consul J. S. Armstrong, Jr. During 1917 the electrical industry was busy preparing for the changes which must take place after the war, and Government committees have been considering the steps which must be taken to reorganize the supply throughout the United Kingdom, with the result that a comprehensive new system for the generation of electricity is expected. As the consumption of electrical energy for power purposes, since the outbreak of the war, has enormously increased, the local plant has found it necessary to increase the capacity of the generating system during the past year. More than 80 per cent. of the output is for power purposes, due to the greatly increased use of electric driving in factories. The total British horsepower connected to mains during 1917 was 25,285.

Bristol has about 33 miles of tramway. The system of penny fares (2 cents) is still adopted for the street cars, and the longer distance fares are multiples of these. While tramway fares have not been increased since the war, the bus fares have been raised from a minimum of 2 cents to 4 cents.

Under the Corporation Tramways Act of May, 1914, the city acquired the right to operate the tramways if it agreed to purchase them, but this point has not yet been definitely settled, and will no doubt be put off until after the war. The Tramway Company is engaged upon the construction of carriages and motor cars, and is doing important munition work.

The post office, telegraph, and telephone services are operated by the Government. Owing to the more general use of currency notes for sums of 10 and 20 shillings, the number of postal orders has decreased, and long-distance telephone calls have further declined as a result of increased charges. There has, however, been an increase in the number of telegrams dealt with, and the amount of mails handled.

Public Utilities and the War

FOR a number of years past, as every one knows, there has been a steady and very considerable increase in the cost of labor, of matrials of construction of all sorts, and of supplies. The manufacturer and the business man met this condition of affairs by raising the price of his finished product or the commodity he handled, and was no worse off than before. But it was entirely different with the transportation companies and the public utilities. With these great industries, upon which the prosperity of the country so largely depends, the National Government or the State exercised direct supervisory control in the matter of prices. Railway and public service commissions and legislative bodies did not look with favor on rate increases. Arguments that some relief was necessary if bankruptcy was to be avoided generally fell on deaf ears.

With the coming of war, and especially after this country's participation in it, there was of necessity a change. The National Government took over the railroads. There had been emphatic denials of the need of relief in the way of increased rates. It was held that the advancing costs of labor and material could be fully met by economies in administration. With the Government in control, some of these economies were put into effect, but at the same time there was a sharp advance in freight and passenger rates, a greater increase than corporate management probably would ever have ventured to ask.

The public utilities are in a somewhat different category. At the same time they cannot but be benefitted by the experience of the railroads. They must increase their earnings if they are to steer clear of bankruptcy, and public service commissions, legislatures, municipal law makers, and the general public as well, begin to see the imperative need of higher rates for service. In many cases increased charges have already been put in force, and it promises well for the future development of our most necessary industries that these have not met with any great opposition, although some cases have been taken to the courts. *Public Service* has compiled reports of rate movements in two hundred of the leading cities. To indicate exact changes would require more space than we have at our disposal, but they may be summarized briefly. Proposed increases in street railway fares are pending in 37 cities. In 68 cities fares have advanced to 6 cents; in 33 to 7 cents; in 2 to 8 cents; in 12 to 10 cents, while in 2 there is an increase of 20 per cent. In 25 cities there has been an increase in fares by adoption of the zoning system or the discontinuance of reduced rate tickets. In one city an increase was asked but withdrawn, and in 4 cities increased rates were denied to the railroads. In 13 cities no increase in fares was asked. In one city the roads were in the hands of a receiver, and in another negotiations were in progress for municipal ownership.

Out of 200 cities where information was sought as to charges by electric light and power companies, no reports were received from 72 cities. There has been an increase in rates in 100 cities. There have been very few changes in established rates for lighting, the great majority of increases being for power. In 22 cities there has been no advance in rates, while there are pending increases in 4 cities. These figures are interesting and suggestive and point to a general and equitable adjustment.

M. H. Aylesworth, former Chairman of the Public Utilities Commission, of Colorado, has discussed the relations of the public and the law-making bodies to the public utilities in a very forcible way. Among other things Mr. Aylesworth says:

"Within the memory of all of us, the public utility has grown from an industry of local interest to one of national importance. Within a period of twenty years the public utility has so expanded its usefulness, due to improvement of equipment and centralization of operation, that the service rendered is admittedly adequate and efficient. The service of the small local public utility, which existed twenty years ago—or even ten years ago—could not and would not be tolerated today by the consuming public. Vast investments in improved facilities have brought to the electric, telephone and gas utility the responsibility of a continuous service to the consumer, and the street railway rider the benefits of street railway service, covering the entire territory of the municipality in which he lives. These investments have naturally been made by those who have had unlimited faith in the people—for only through the sympathetic understanding and co-operation of the general public can the utility furnish an excellent service or commodity at a reasonable rate, and return to the investor any interest upon the investment.

"The public utilities laws of the various states enable the state commissions to prescribe rates for service rendered and to compel the public utility corporation to furnish service which will be adequate and efficient in all respects, and which shall cost no more than its value. Since the purpose of the public utilities commission is to stand between the public and the utility corporation as an impartial referee in all matters, it was realized that to properly regulate the rates and service of the utility and thus obtain the greatest possible benefit for the people from efficient management, each utility should have a regulated monopoly in the field in which it operates, thus preventing unnecessary duplicate construction, which in the end compels the customers of each utility to pay an excessive rate or charge, and in many cases results in the confiscation of public utility property. Most of the state regulatory laws have eliminated the economic waste of competition and it became the duty of the state commissions to see to it that there was no further competition between the public utilities, and that the cost of operation should be kept as low as possible, to the end that the public would pay a rate not to exceed the value of the service rendered, and that there should be no undue hazards in the business which would compel the commission to give a higher rate of return due to ruinous competition and the uncertainty of the life of the utility. If the public is required to sustain more than one instrumentality, such as two electric light plants, two telephone plants, or two gas plants, operating in the same field, when one is amply sufficient, the actual cost to the public served is not only necessarily greater than it would be under one system, but the service also is less efficient.

"So today the municipality is relieved of entering the field of private business in order that its inhabitants may receive public utility service at reasonable rates. The commissions carefully scrutinize the operating expenses of the public service companies and encourage the most economical operation by prohibiting competition. They permit the utility to earn only a fair return on its investment, and having the authority to compel it to give efficient service, the unnatural burden of municipal ownership is largely disappearing.

"Immediately following the establishment of state regulatory commissions, demands were made for a reduction in rates, although this demand was not accompanied, in most instances, by a request for a higher grade of service. We may assume that the public, being without knowledge as to the earnings of the public utility, assumed that the rates were excessive, and did not attach any significance to the relationship between good service (which in most instances prevailed) and the rate of charge.

"From time to time the local utility has been combined with other utility properties, so that the community has been able to enjoy the full advantage of the lessened cost of centralized operation, either through steam generation or water power. As a result part of the public cried that the utility had in reality become a trust, and was a foreign-owned corporation, and seemed to lose sight of the fact that although by centralization a better service could be given at a lower cost, the stockholders would not obtain this advantage, but through state regulation the public would be saved the duplicate costs which had heretofore existed.

"The public utility met this accusation with the offer of the sale of its stock in the community served, thus endeavoring to bring a closer relationship between the utility and the public, and at the same time give to the consumer the right to participate in the profits which could lawfully be earned under regulation.

"Prior to the time when the United States declared Germany to be its enemy, the cost of materials and the price of labor had been steadily increasing, and after the declaration of war the cost of materials, labor and money so quickly increased that the utilities faced certain ruin unless relief could be immediately granted. The public utilities throughout the country marshalled their facts and appeared before the state commissions and local authorities for relief. In most instances, through misunderstanding, public protest was immediately filed with these authorities, and quite naturally the local authorities and state commissions hesitated before proceeding. It was apparent to the commissions that the rule of regulation works both ways, and that while the regulatory laws may have been originally drawn to prevent the public utility from charging excessive rates, that the laws in every instance provided for an increase in rates and charges in the event changes in operating costs justified it; and it was then that many of the protestors demanded valuations of the properties of public utilities before any relief was granted. It can readily be seen that if this attitude were taken by the public utilities commissions at a time like the present, the utilities would be ruined and the public utility service of the nation would completely collapse.

"The financial condition of the street railways was even more serious than that of other public utilities, as the street railway had grown in each community in most instances far in advance of actual demands of the public, reaching out for more business, with an anticipated increased revenue without increased fare. Practically every line of business, when confronted with increased costs, had raised the price of the commodity, and without question we paid $8 for our shoes where we had heretofore paid but $4, and 60 cents a pound for butter as against 40 cents before the war. The price of coal doubled, and the cost of clothing increased about 80 per cent. The people, struck dumb for the moment with these increasing costs, look to the only industry that could be regulated at that time, and demanded that the public utility rates remain unchanged, although it was apparent that the costs of the utility had increased with the cost of every other industry. This demand could not have been made, however, because of the large amount of money which would be saved by the consumer of the public utility service or commodity, for, as has been brought out in the chart prepared by S. S. Wyer, consulting engineer, of Columbus, Ohio, from exhaustive studies made by Dr. Ellen H. Richards, of the Massachusetts Institute of Technology, and himself, it is demonstrated that for all utility service, including telephone, electricity, gas, water, street car and railroad, the family with an income of $1,000 to $2,000 per annum spends about 10 per cent. of the income. The percentage is reduced in the greater income of $2,000 to $4,000 to approximately 7 per cent. Food, the first demand of the nation in war, has claimed the largest part of the income of the average family, taking 25 per cent. of the incomes cited. Rent has come second on the list with 20 per cent., while clothing claims 15 per cent. The other classifications in Mr. Wyer's chart are betterment, expenditures made in the interest of better living, and miscellaneous operating, covering emergencies which arise in every household.

"In practically every instance the family income has been increased through increased wages, and yet the utility, in most instances, is the only essential which has not shared in the additional money which has gone to the family income as a result of war conditions.

"The capital requirements of electrical street railways are great, due to the new industrial centers which have sprung up within or near every large municipality in the United States. More than $4,500,000,000 is invested in electrical properties, $5,000,000,000 in electrical railways, $3,500,000,000 in gas plants, $1,500,000,000 in telephone and telegraph, with approximately $1,500,000,000 in concerns furhishing equipment and supplies—a total of over $16,000,000,000. The funded obligations of public utilities maturing in 1918 amount to $225,000,000, and the money required by these utilities for unavoidable extensions during the year 1918 is variously estimated at between $100,000,000 and $200,000,000. These estimates are based on the assumption that no extensions will be made or allowed to be financed unless directly or indirectly essential to the vigorous prosecution of the war, and are in accord with the recommendation of the Capital Issues Committee, made on August 23, 1918, calling on public utilities commissions and municipal officials to refuse to permit service corporations to make extensions and betterments which have heretofore been made in normal times, whether the same be made on the initiative of the public utility or by direction of the regulating commission. And further: 'May we ask of you consideration of the propriety of deferring even the performance of contractual obligations arising from franchise or other local requirements, when no military or other local economic necessity is served by such expenditures.'

"The situation confronting public utilities today does not pertain to rates and charges alone, as the costs of operation have risen so quickly and the money market has been so absorbed by Government demands that the utility finds itself unable to obtain the necessary funds for capital requirements. The War Finance Corporation has held that it can deal only with utilities which can provide a banker's guarantee, and as has been pointed out by Mr. O. B. Willcox, vice-president of Bonbright & Co., in a recent article:

" 'Meaning, as it is generally understood, that they (the War Finance Corporation) will lend money to banks on their own responsibility where the banks in turn have bought or loaned upon public utility securities, requiring the endorsement of the bank, as well as the obligation of the borrowing company. This would require the assumption by the banks of the country of obligations to the War Finance Corporation for the payment of such loans at their maturity, an obligation which, as the bankers of the country declare, they ought not and cannot under the law or with safety to their depositors, properly undertake. The banks of the country are merely merchants in dealing with long-time securities. They cannot safely nor should they be permitted to lock up their funds in obligations of long maturity or which are even temporarily unmarketable. Nor should they be expected to make accommodation indorsement for public utility companies or any other borrowers, as a condition to the granting of national aid to meet a national necessity.'

"Quite recently, however, the War Industries Board has recommended that Congress appropriate $200,000,000 for public utility improvements, so that the electrical plants of the country may continue to meet the ever-increasing demands made upon them by the country's war program. It is apparent that some additional aid must be granted by the Government if the utilities are to function in an efficient manner during the war."

An Electrical Research Laboratory

High grade experimental work cannot be carried on in the midst of the noise and confusion of production. Quiet is the first essential for great achievement in research where uninterrupted concentration is required. Delicate instruments and the costly mechanism of an experimental laboratory must be protected from the dust and vibration of the shops. The Westinghouse Electric & Manufacturing Company's new research building at East Pittsburgh, Pa., is located about a mile from the works on the Lincoln Highway. Architectually, the building is plain but substantial, of reinforced concrete and brick, trimmed with white terra cotta. The distinctive features of the building are its plumbing and wire services, being arranged in such a way as to enable these services to be brought into any particular laboratory when needed without disturbing any other part of the building.

The manufacture of electrical machinery and apparatus is one of the most intricate and complicated in industry, and is characterized especially as being in a state of constant improvement and progress. Every hour the various departments in the works are confronted with new problems that require special research work. Provision is made in the new building to deal with a large variety of experiments in many lines of work, including magnetic insulation, metallographic metallurgy, chemistry-organic and inorganic, furnace combustion, wood-working, illumination, glass, blowing, etc.

The powerhouse contains motor-generator sets for supplying single-phase, two-phase and three-phase current at 220 volts, and direct current at 250 volts (three-wire circuit). A motor-driven air compressor supplies compressed air at 125 pounds pressure (8.75 kg. per sq. cm.) and a large motor-driven vacuum pump supplies the necessary house vacuum. A liquid air machine, capable of supplying 1½ to 2 litre liquid air per hour is also installed in the main powerhouse. The storage battery is in a separate room in the basement of the powerhouse and consists of a total of 218 cells, so divided that various grouping and combinations may be obtained.

In one end of the basement is the furnace room with a battery of electric furnaces of various types, together with the necessary control for melting, annealing and various metallurgical processes. Stacks are provided at each end of the building, with openings in the basement, for experimental furnaces using fuel, usually natural gas. The wood-working and metal-working shop and storeroom are also in the basement. On the first and main floor are the main and private offices, the library and the conference room. The remainder of this floor is assigned to physical, electrical and magnetic research. The second floor will be given over to the same general class of work as the first floor. The third floor is devoted to chemical and electro-chemical research, illuminating laboratories and a glass-blowing room.

Electric Light and Power in Venezuela

Consul Frank Anderson Henry, writing from Puerto Cabello, Venezuela, on the electric situation in Valencia, says:

"There are two electric light and power companies, the Compañía Anonima de Electricidad de Valencia, capital $270,200, and the Compañía de Electricidad La Cumaca, capital $154,400. Both these companies are Venezuelan and controlled by local interests. They employ a total of about 60 men and furnish continuous current, which is generated from adjacent waterfalls. The supply of current is not equal to the demand and further hydroelectric developments may be expected when conditions become more favorable. The machinery for these plants came from the United States and the necessary supplies are regularly imported from there.

The Compañía Anonima de Tranvias Electricos de Valencia was organized in 1915, with a capital of $96,500, by local interests. It operates an electric tramway, receiving its power from the Compañía de Electricidad de Valencia. The equipment is American. All the above companies have proved very successful and are paying substantial dividends.

"The Puerto Cabello & Valencia Railroad Co. has its offices and shops in Valencia. The latter employ about 40 men."

Fuel Saving by Industrial Plants

Through the co-operation of the industrial power plants, which have thus far put into force the standard recommendations of the United States Fuel Administration to promote efficiency in the use of fuel in power plants, a saving of seven million tons annually has been effected. That is to say, in the first six months from the announcement of the National program, three and one-half million tons have been conserved, at the same time maintaining maximum production in the factories. The largest savings have been in the following states: Massachusetts, Pennsylvania, Connecticut, Illinois, New York, Missouri, Michigan, Minnesota and Wisconsin.

Some industrial plants which have adopted the standard recommendations and kept systematic records report a fuel saving as high as 25 per cent., and the average is estimated between 10 and 15 per cent. This large economy is effected at practically no expense to the plant owner since the recommendations treat primarily of proper methods of firing and management in power plants. One manufacturing plant in Abbeville, S. C., writes the Fuel Administration that as a result of the installation of the improvements and records recommended, "We show for the first eight months of this year a fuel saving of over 25 per cent. as compared with the same eight months last year."

A Fuel Administration campaign comprehends voluntary service by engineer inspectors, lectures to fuel conservation classes in educational institutions, addresses before public meetings, explanations of the program to power plant owners, and various forms of printed matter and posters.

For the efficient execution of the program of industrial conservation, under the plan developed, the engineers of the country have been mobilized through the professional societies and the operating engineers and firemen, and as a result there are today fifteen hundred volunteer engineer specialists and power plant men, organized by states, inspecting power plants, classifying them according to their operating efficiency, and aiding the work of rapid development. As a direct result of the operation of this plan, it is estimated that the total annual saving throughout the country will be about twenty-five million tons of coal without reducing the output of the factories. Special printed material, instructing on the proper use of fuel, has been prepared by the United States Fuel Administration and may be obtained free of cost upon application.

The campaign has been organized in consultation with the State Administrators, the Bureau of Mines, and the Committee of Consulting Engineers of the Engineering Council, which represents the four National engineering societies. These four societies have contributed largely in supplying expert advice of engineering talent; special relations have been formed between the Fuel Administration and the National Association of Stationary Engineers, the International Brotherhood of Stationary Firemen and Oilers, the Laundry Owners National Association, the Portland Cement Association, and other National bodies who have given full co-operation to this National plan.

Limits Building in New York

Following a conference in Washington with B. M. Baruch, Chairman of the War Industries Board, and Dr. R. McLennan, chief of the Non-War Construction Section, the announcement is made that by order of the board no theatre, school, hotel, hospital or church will be allowed to be built in New York during the war, or until further notice from the War Industries Board. This ruling of the board is the latest addition to the non-war building order recently published by the War Department. Operations on buildings partly completed must cease at once, but those structures so near completion that only finishing material is needed may continue, providing a permit is obtained at the office of the Mayor's Committee on National Defense at the Hall of Records, New York City.

Another new feature of the non-war building ruling deals with buildings substantially completed and with builders who have materials on the ground of operations. Manufacturers and distributors of and dealers in building materials may continue to furnish such materials for the completion of such building, pending further action by the War Industries Board.

According to the Director General the labor, material, fuel and transportation power of the city must be thrown into the war programme. The great loss to builders, contractors and supply men must be faced, he pointed out, as a war measure to end the great struggle within the shortest possible time.

Economy in Electrical Furnaces

Recently the Louisville Gas & Electric Company installed an electric furnace in the plant of a manufacturer of sanitary bathroom articles. An eight day test of the installation shows that not only was there an actual saving in money per 100 pounds of metal poured, but there was a decrease in metal loss and a fuel economy of nearly one-third. Tests of 100 pounds of metal poured showed the cost, with oil, 24 cents; with electricity, 19 cents, a saving of 20 per cent. Metal loss, with oil, 7 pounds; with electricity, 1.13 pounds, a saving of 51 per cent. Heating units required, with oil, 708.000 BTU; with electricity, 475.000 BTU, a saving of 32 per cent.

Overhead Expense

Overhead expense. That's what causes half the trouble for the contractor. If he figures it in when he makes his estimate he doesn't get the job.

If he doesn't figure it in he gets the job, but wishes later that he hadn't.

If he doesn't get the job, the chances are that the man who was willing to throw in bookkeeper's hire, postage, telephone, office rent, and the score or more other things that go to make up overhead expense, will be the lucky (?) bidder.

Sometimes a man fails to figure in overhead expense in his estimate, and figures on "getting through" by "skinning" the job. That's plain dishonesty. Dishonesty doesn't pay. Contractors who are wise learned that fact long ago.

The standard of honesty has risen steadily among contractors in the last generation. Point to the successful contractor, a man who has made money in the business, whose services have been in demand over a period of years, and you will point to a man who has believed in getting a fair profit for himself and giving the owner a first-class job.

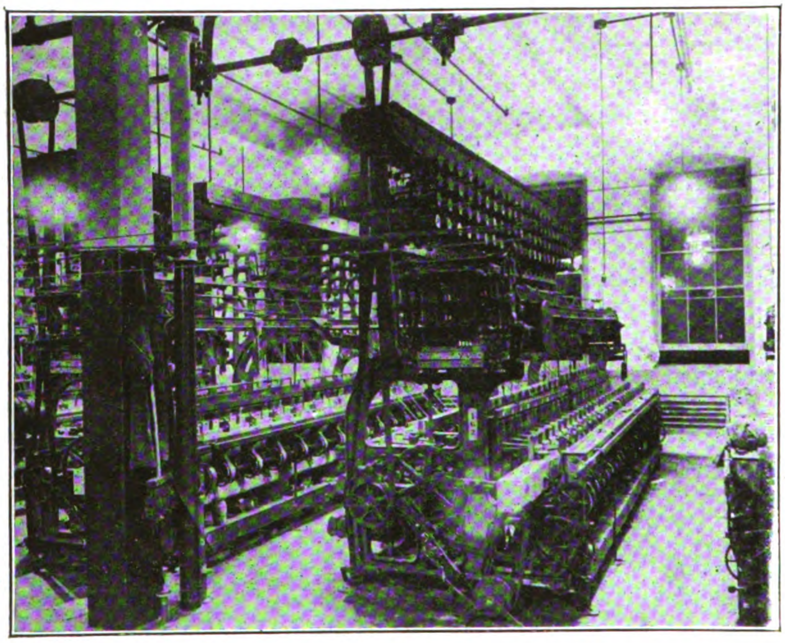
A man can't be a fair, square, successful builder and neglect to take overhead expense into account when making up his estimate.

Building Activities in Cities of New York

The estimated cost of building work authorized in the month of July in first and second-class cities in New York State amounted to $7,469,993, as listed by the New York Department of Labor. This is the smallest volume of building reported for July since 1915, which is the date when these figures were first collected. In comparison with June there was an increase of 6 per cent. but in contrast with July, 1917, there was a decline of 16 per cent. Building costs as reported in July, 1917, 1916 and 1915 were, respectively, 9, 59, and 18 millions of dollars. The boroughs of Brooklyn and Richmond and the cities of Binghamton and Utica reported larger expenditures in July, 1918, than in July, 1917. The boroughs of Brooklyn, Bronx, Queens and Richmond and the cities of Binghamton, Buffalo and Schenectady filed plans for July, 1918, showing a larger volume of building than in June, 1918.

Textile Mill Illumination

EVERY indication points to the growing use of general lighting in textile mills, with a marked tendency toward the indirect methods of lighting for work requiring close visual application wherever the character of the ceiling is such as to give efficient reflection. With the indirect types of lighting, the reflecting power of ceilings is of prime importance, writes A. L. Powell, of the Edison Lamp Works, General Electric Company. Not only should the ceilings be free from obstructions, but they should be finished with a white paint which does not depreciate to any extent with age. Moreover, all glassware, ceilings and other reflecting surfaces must be kept clean, so as to utilize their reflecting and diffusing powers. By using the most economical lamps, such provisions economize and improve the illumination to an extent which justifies their predominance under the old law of the survival of the fittest.



NIGHT PHOTOGRAPHS OF A ROW OF WARPERS

It is always of interest to the engineers of an industry to watch the changes in practice which take place as new developments in electrical appliances come into general use. Lighting devices, or lamps, have undergone startling improvements more rapidly than any other class of equipment. As a result lighting practice has been constantly varying, sometimes going from one extreme to the other.

It is the duty of the skilled illuminating engineer to watch the progress and attempt to foretell the general nature of future developments. He must act as a balance wheel and bend his energies to directing the light users along lines which will produce the best results. The variations which have occurred in the field of lighting under consideration serve as an excellent illustration of the principles outlined above.

It was not many years ago that the only suitable light sources for textile mills were low candle-power, inefficient carbon lamps, and relatively high-wattage enclosed arc lamps. This resulted in two methods of lighting which were quite different. The plant using incandescent lamps had to rely entirely on so-called local lighting, where lamps are placed close to the work. With this system operators lose no time in moving the lamps about. There are spots very brightly lighted and intervening spaces are in comparative shadow. Reflectors become dirty through handling and are often omitted or misplaced, so that bright light sources are directly in the field of view. Nevertheless, on account of the inefficiency of the lamps, local lighting was the only thing feasible if a sufficiently high intensity was to be secured at the work.

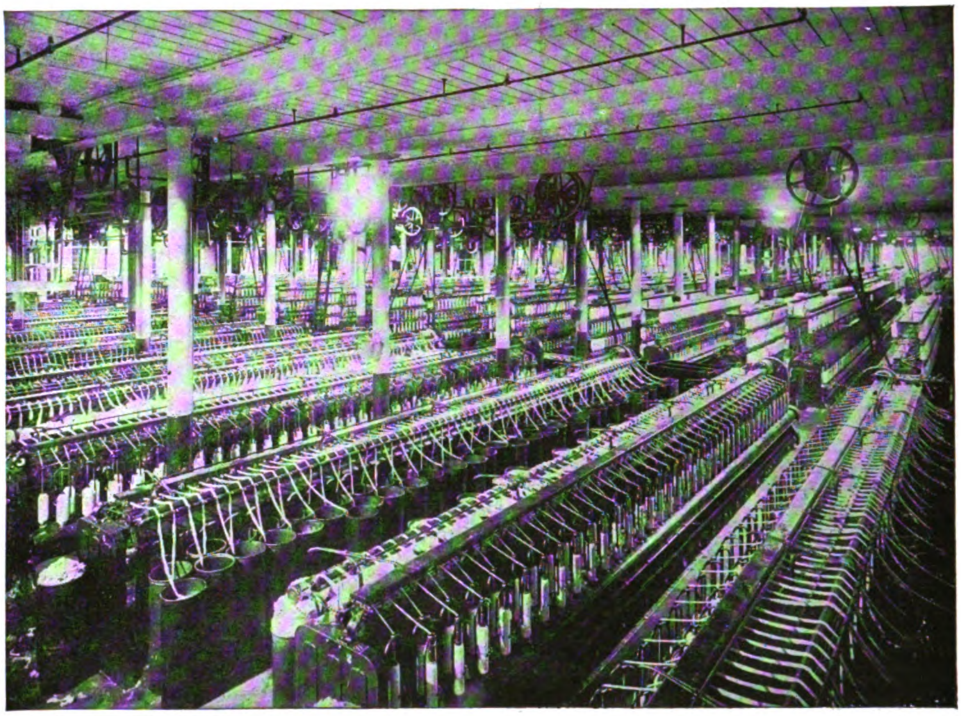
Where enclosed arc lamps were employed, they were hung as high as possible and spaced rather widely. This lamp was none too efficient, and economic considerations prevented lamps being placed as close together as desirable for producing the most effective results. The travel of the arc precluded the use of reflectors which could accurately control the distribution of light. In some instances a combination of general illumination from arc lamps and local lighting with incandescent lamps was used.

About eight or nine years ago the Mazda lamp came into general use in industrial plants, and in textile mills a new method or practice in lighting developed. This was known as group or localized general illumination. The effect of the old practice with carbon lamps was still quite noticeable, for only the small sizes of Mazda lamps were extensively employed. Forty- and sixty-watt lamps in deep bowl steel reflectors were hung from 8 to 10 feet above the floor and localized with reference to important working points. Of course, this hanging height kept lamps out of reach of the operatives and allowed sufficient spread of light so that the aisles and surrounding spaces were illuminated. Localized general lighting was certainly a big step forward and still is particularly advantageous for some exacting processes.

A short time ago the Mazda C lamp was placed on the market and high candle-power sources of very high efficiency became available. A point of special interest in this connection is that in general the larger the lamp the greater its efficiency as measured by specific output. Improvements in mill construction paralleled these advances in lamp development and we now find the modern mill with high ceilings and less overhead obstructions. Individual or group machine drive has replaced line shafting so that conditions are much more favorable to a wider spacing of lamps. Practice seems to be tending toward general illumination.

General illumination implies a symmetrical spacing of outlets with regard to the building structure or bays. It is of such a character that the position of machines can be varied at will and yet they will remain well illuminated. It approaches daylight in character and uniformity. The advantages of general lighting are, of course, the opposites of the disadvantages of local lighting. Fewer outlets are required, reflector equipment does not depreciate through constant handling, the room is cheerful and safe, the workmen lose no time adjusting the lamps, and the general appearance of the plant is far more businesslike than when drop lamps hang over each machine.

The accompanying photographs show two interesting installations in textile mills. The view of the row of warpers is a night photograph. The light is from 75-watt Mazda C lamps in deep bowl steel reflectors hung over the beam and creel. Work can be carried on effectively, independent of daylight conditions. The perfect illumination permits the keeping of the mill clean and safe. The second photograph shows a general lighting system for slubbers and roving frames. The 500-watt Mazda C lamps in dome-shaped enameled steel reflectors are placed close to the 18-foot ceiling on centers 24 by 33 feet. The operators can work efficiently in any part of the room.



Slubbers and Roving Frames Well Lighted

Consolidation of Branch Offices

The Westinghouse Electric & Manufacturing Company, automobile equipment department, announce that on December 1, 1918, they will close their Indianapolis office, now located at 512 Merchants Bank Building, until after the war. The business for both the Indianapolis and Chicago districts will be handled out of Chicago. The automobile equipment department's office will be combined with the general offices of the company in the Conway Building, Clark and Washington Streets, Chicago. Mr. Prescott C. Ritchie, at present in charge of the Indianapolis office, will assume charge of the office in the new location. In addition to soliciting equipment business for passenger cars and trucks, arrangements are being made to give special attention to the tractor field.

Developing Irish Water Powers

The question of utilizing water-power sites on the Liffey River in the vicinity of Dublin for the production of electrical power has lately been receiving serious consideration. It is understood that the Dublin & Lucan Electric Railway Company is primarily interested in the scheme, which is now under the consideration of engineers. The project is attracting the attention of the Dublin Chamber of Commerce, the Dublin Corporation, and the English and Irish Coal Controllers, and it is hoped it will receive the approval of the Government, whose assistance is being sought.

The idea of utilizing the water power of the Liffey is not a new one. Some few years ago the matter was suggested, but the financing of the undertaking and the then abundant supplies of coal appear to have been obstacles in the way of its realization at that time.

More recently the shortage of coal and Government control of the electric line have given the matter a different aspect. The directors of the line believe they could abolish the use of coal for its operation and at the same time effect a great saving in coal consumption in other directions. The scheme has thus far met with the approval of riparian landowners and others who would be interested.

ELECTRICAL ENGINEERING

With Which is Incorporated the

SOUTHERN ELECTRICIAN and the ELECTRICAL AGE

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VOL. LII NOVEMBER, 1918 NO. 5

THE War Industries Board has made a strong appeal to electric service companies to conserve condenser tubes. The Electrical and Power Equipment Section of the National Committee on Gas and Electric Service has reported that the demand for non-ferrous condenser tubes for use in the Navy and Emergency Fleet is so large that the supply available for repairs on land condensers may be very greatly curtailed, or even cut off entirely. We understand that the situation in this respect is serious, and that it has given a great deal of anxiety to managers of large public service systems, who realize the necessity for increased and strenuous watchfulness. The appeal of the National board will not fall on deaf ears, and every effort will be made to conserve the supply.

THE important part played by public utilities in our modern life is illustrated in a very forcible way by the financial requirements of public utility corporations, as contrasted with those of the railroads and various industrial corporations. During the first nine months of 1918, according to figures compiled by the *Wall Street Journal,* the securities offered to the investors through various channels ranked in this order: Railroads—bonds, $45,078,100; notes, $49,586,000; industrials—bonds, $92,795,000; notes, $157,966,000; stock, $125,045,225; public utilities—bonds, $137,175,000; notes, $243,482,900; stock, $14,387,200. This gives a total for railroads of $94,664,100, industrials, $385,806,225, and public utilities, $400,045,000. With the coming of peace the financial requirements of the various industrial corporations, with the exception of those that have taken up the production of munitions and war supplies, will, of course, show a large increase. But no one can doubt that the period of reconstruction and readjustment will also furnish the very largest opportunities for the development of public utilities.

THERE is scarcely an economic problem that has arisen from the war that has assumed greater importance than the shortage of coal and the necessity for the most stringent conservation of available supplies. Almost every country has felt the effect of the fuel shortage, and in some countries, notably Italy and France, the suffering entailed has been very great. It is scarcely conceivable that with the coming of peace there will be the same prodigal use of coal as formerly. It may be expected that the development of water power for industrial purposes will reach unprecedented proportions. Great Britain has already made a movement for the utilization of water powers throughout the Empire. There has just been issued the preliminary report of the Water Power Committee of the Conjoint Board of Scientific Societies. The chairman is Sir Dugald Clerk, an eminent engineer and inventor, and the membership includes men of world-wide reputation as water power and engineering experts. The committee estimates that the power now being used all over the world is in the neighborhood of 120 million horsepower, of which shipping uses 24 million, railways 21 million, the remainder being used in factories and public utilities. This power is developed roughly as follows: Thirteen million horsepower in the United Kingdom, 24 in continental Europe, 29 in the United States, 6 in the British Dominions, while Asia and South America use only 3 million. Of this total amount between 15 and 16 million horsepower is developed hydraulically. After discussing the reasons for the neglect of this field in the past, the report expresses the belief that the potential water power of the British Empire amounts in the aggregate to at least 50 to 70 million horsepower, and that much of this is capable of immediate economic development. The report concludes with a number of recommendations which urge the British Government to bring to the attention of the overseas governments the necessity for a close systematic investigation of all reasonably promising water powers and of their economic possibilities. In event that any government is unable to undertake such work it proposes that a British or Imperial Water Power Board be appointed to control such investigation, such Board, which shall include a representative each from the Dominions, shall also act in an advisory capacity to the Imperial or overseas governments. It also suggests a policy of state-aided water power development. This country has already made an excellent beginning in the utilization of our water powers, although millions of horsepower in our rivers and streams is still running to waste. As soon as we can turn from the immediate and pressing demands of the war, it is certain that we shall give more attention than ever to the development of this potential energy. We have the advantage of Great Britain in the mass of invaluable data now available from our systematic and long-continued stream measurements undertaken by our National Hydrographic Department.

Over the Top

Despite pessimistic articles that appeared during the progress of the campaign, no one really doubted in his heart that the Fourth Liberty Loan would go "over the top." It was absolutely unthinkable that Americans, north, east, south and west, would fail to back up to the utmost limit of their ability the boys in the trenches. Though success was assured from the inception of the project, it is none the less a marvelous achievement. The fourth demand of its kind made upon us, in addition to unprecedented increases in the price of all commodities, onerous taxes, and hundreds of millions contributed to various charities, it yet represented the largest loan ever floated in the history of the world. A particularly satisfactory feature is that the number of bonds sold was no less than 22,000,000, showing how general was the response. We have every excuse for a fair measure of self-complacency. With millions of men at the front and billions of dollars at home to enable them to "carry on," America has made an unequivocal answer as to where she stands. The utter hopelessness of Germany's position should penetrate even the dense minds of her egotistical and self-centered ruling classes. If they have not learned the lesson yet, we have other billions ready to make our will manifest.

The electrical industry has done its full share in raising this loan, as it has in all else connected with the conduct of the war. It has bought the bonds most generously. It has contributed tireless and enterprising workers to the very arduous campaign that was necessary. In addition to all this, the electrical industry furnished many of the most novel features that awakened and stimulated public interest. Every city had its illuminated devices, and these have never been surpassed in variety and effectiveness. The myriads of twinkling lamps and the flashing of the searchlights played their part just as surely as the pageantry, the oratory, the music, and the pictorial art.

Illuminating Engineering in War and Peace

At the British Scientific Products Exhibition in London, Mr. Leon Gaster recently delivered a lecture on the above subject. He declared that in modern warfare light plays an essential part, in the form of searchlights, range-finders, optical signaling devices, parachute lights and flares, and many problems of visibility. The acquirement of knowledge of the proper application of artificial light in time of peace has proved of great value in time of war. Even in the problems met with behind the lines, the "scientific darkening" of cities liable to visits from hostile aircraft, for example, these same principles have to be applied; curiously enough, uniformity of brightness, which was coming to be regarded as the main object in street-lighting before the war, is recognized as equally desirable now, though in part for different reasons. Sharp alternations in brightness and darkness are undesirable, not only in the interests of traffic but because they are apt to mark out areas and give information to hostile aircraft.

Mr. Gaster proceeded to argue that artificial lighting was essentially a "key-industry"—one of the greatest key-industries in the world. He quoted figures to show the difficulties encountered after the outbreak of war in the supply of many essential articles required for artificial lighting, arc light carbons, incandescent lamps, illuminating glassware, and even materials and machinery required for their manufacture. War requirements had been sufficiently met, and there was hope that, with proper encouragement, these industries would be placed on a sounder and more substantial footing after the war. Artificial lighting, besides being a key-industry, was essentially a scientific industry, and illuminating engineering was one of the best instances that could be quoted of applied science.

In closing, Mr. Gaster made an imaginative forecast of the development of a new branch of illuminating engineering—"the illumination of the air,"—when the use of aircraft for peaceful purposes would necessitate aerial luminous devices to facilitate the passage of air-traffic. The problem would then be the reverse of that at present encountered; instead of endeavoring to conceal objects from hostile aircraft overhead, it would be necessary to provide special illumination for landing places, and luminous devices to indicate the locality so that aviators flying by night, might be kept fully informed of their whereabouts. In many of the problems of reconstruction, illumination would play a great part.

Trade Training for Electricians in London

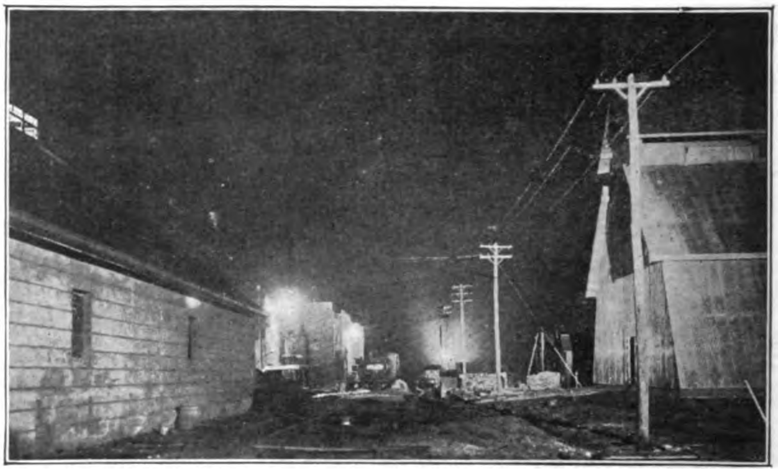
The City Companies of London connected with the various building trades are carrying out a comprehensive educational programme. These City Companies are the survival of the old mediaeval guilds, and in many cases have considerable invested funds. There are various practical courses at the Trades Training Schools, and the fees are almost nominal, being on an average $3.75 for the year of three terms, and half fees for apprentices. Tools for the students are with a few exceptions provided by the Companies. Great attention has been given to the course for electricians, the elementary course of which includes practical wiring, plugging walls, making joints in cables, and installing simple circuits for lighting, bells and telephones. Technical instruction is also given. The advanced course also includes practical wiring, steel conduits, armored cables, precautions and forms of protection, telephone, bell and power circuits, the fixing and aligning of motors, the location and removal of faults, while the accompanying technical instruction is carried much further.

Protective Lighting for War Plants

THE tremendous efforts made in this country to speed up production of munitions and everything else needed in the conduct of the war are unequalled in the entire history of our industrial development. Indeed, no other country can show the like, wonderful as their achievements have been. The work has not been confined to our own borders. Behind the lines in France and in the French harbors there has been construction work of various kinds that has simply astounded all foreign engineers. Except to those directly involved few people realize the very many problems that have been confronted and successfully solved. In the greater part of the work day and night shifts are employed, and this has meant new and vexing questions for the illuminating engineer. G. H. Stickney, of the Edison Lamp Works, at Harrison, N. J., and T. W. Moore, of the General Electric Company, Atlanta, Ga., discuss some of these problems. They say that it has been the observation of lighting experts that better illumination is demanded for all-night work than where the artificial lighting is used for an hour or two a day. This is no doubt due to the strain of the long working hours, as well as to the impracticability of rearranging the work so as to perform only simpler operations under artificial lighting. It has recently become necessary to train new operatives in large numbers. Such employees really need better light than experienced workmen with whom the operations have become more or less mechanical. Figures taken from a considerable number of typical manufacturing plants have indicated that the entire cost of good artificial lighting is on the order of one per cent. of the wages of the workers affected, while the increased cost of providing good illumination to replace poor lighting, now in use, is very much less. On the other hand, good lighting can make a very considerable increase in production.

A particularly important and interesting feature of the discussion by Messrs. Stickney and Moore has to do with the protective lighting necessary for many immense plants engaged in war work. The enemies of this country are well aware of the importance of manufacture and transportation in winning the war Hence, we are encountering a persistent and a more or less organized effort to destroy plants, bridges, tunnels, harvests and other materials. The destruction is accomplished by underhanded methods, mostly under the cover of darkness, they say.

Mr. Edmund Leigh, Chief of the United States Bureau, in charge of Plant Protection, considers good watchmen, good lighting, and good fencing the three essentials of protection. Light is necessary to render either watchmen or fence effective. Good lighting enables a small number of wachmen to detect intruders over a large area, and furthermore it discourages attempts at unlawful entrance.



FLOODLIGHT PROTECTION IN A WAR PLANT

The purpose of protective lighting is to make visible the movements of persons entering a plant, approaching important works, or otherwise acting in a questionable manner. To prevent entrance, approaches are illuminated and a zone of light provided around the boundary covering all possible points of entrance and all vulnerable places.

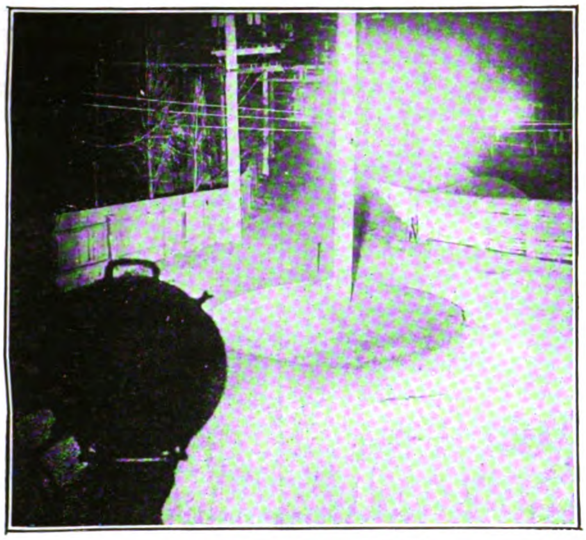
Since it is always possible that enemies may enter as workmen, dark spaces and shadows within a plant, which may serve for concealment, should be eliminated. While it is desirable to illuminate in such a way that the watchmen may be inconspicuous, this feature is ordinarily subordinate to the question of rendering intruders clearly visible.

Protective lighting is relatively new, and the variety of conditions to be met is so great that the details of practice have not yet been very fully standardized. The lighting should be planned with reference to the physical arrangement of the plant, the fencing, location of guards and system of patrol. The best lighting so far installed has employed street lighting units, dome and angle steel reflectors, floodlights and searchlights.

It is common practice to use two or more types of units to meet the various conditions about the same plant. The early installations employed floodlighting almost exclusively on account of its adaptability and the quickness with which it could be installed. More recently, the tendency has been toward the use of other types of incandescent lighting equipment, which is often more efficient, available in a wider range of sizes and can be arranged to minimize glare. For some conditions floodlighting has special advantages, particularly where it is desirable to provide a directional light at quite a distance from the lighting units. Glare itself can often be utilized to advantage.

Besides the ordinary methods of lighting, silhouette lighting has proved particularly economical where large areas must be covered. For example, where the intruder is likely to cross a large level space, instead of lighting the entire area, a whitewashed wall, which will serve as a background, may be lighted. When the conditions are such that anyone moving would be seen in outline against the lighted surface. As a matter of fact, silhouette vision is employed to a much larger extent in ordinary street lighting than is generally appreciated.

For indoor spaces, the practices followed for ordinary industrial lighting generally apply. The intensity need not be so high as is required for manufacturing



FLOODLIGHTED ALLEY OR PASSAGEWAY

places, but all deep extensive shadows should be eliminated by the removal of high objects which may obstruct the light, and by the design of the lighting system.

The government Bureau of Plant Protection has made a thorough study of lighting problems and other features, and is well qualified to give and to secure advice as to methods.

The accompanying illustrations, which are printed through the courtesy of the General Electric *Review,* show two interesting installations. In the first, the yard of an industrial plant is well illuminated for protection by floodlighting projectors, which renders every portion of the area clearly visible, so that no one can cross without being seen by the watchman. In the second illustration a floodlight projector points directly down a path. The guard stands at the rear of the lighted unit in shadow. The brilliant light renders those approaching visible and yet prevents the intruders from seeing the guard.

Ownership of Public Utilities

The *Electrical News,* of Toronto, discussing the subject, "Public Control with Private Operation," concludes with the following two paragraphs:

"Excellent as the theory of municipalities owning their own utilities may be, there is no doubt whatever that it has been a fatal policy for many of our cities and towns throughout Canada, which in their endeavor to avoid the evil of uncontrolled private ownership, fell into the trap of uncontrollable municipal ownership.

"There is evidence, however, that all over Canada, having now had experience with both evils, we are sitting back and taking a survey of the whole situation with a view to effecting a compromise that will include as many as possible of the good points and as few as possible of the bad points of the two tried systems."

Here and There in the Electrical Field

The Oklahoma Gas & Electric Company, Oklahoma City Division, furnished a large electric sign to the Publicity Committee for the Fourth Liberty Loan, which was installed on top of the Culbertson Building, one of the tallest buildings in the city. Current was furnished by the company, and permission was secured from the Fuel Administrator to illuminate the sign on lightless nights as well as others.

The Minneapolis General Electric Company has closed a contract with the University of Minnesota, amounting to 227 horsepower in motors, covering service at the old Exposition Building, now being used as barracks for students inducted into the service.

The Kruse Banks shipyards at North Bend, Ore., have installed additional machinery requiring 50 horsepower additional from the Oregon Power Company, Marshfield Division.

As the result of the appeals to the Quebec Public Utilities Commission, the latter have issued a new schedule of fares to be charged by the Montreal Tramways Company, which is a compromise between the fares favored by the Tramways Commission and those asked by the company. The Tramways Commission reported in favor of a 5c fare with a cent transfer, and the Tramways Company desired a 7c fare with free transfers. The Public Utilities Commission in their judgment deal at length with the arguments of the company and those who objected to an increase in fares, and state that the increases allowed is a matter of maintaining the undertaking as an efficient and going concern. Urban transportation was essential, and it could not be long maintained at less than cost.

For the year ended June 30 last, the gross income of the Quebec Railway, Light & Power Company was $2,027,940, a decrease of $34,943. Operating and maintenance charges totalled $1,235,724, an increase of $79,755, but fixed charges and taxes were less by $9,418.

Since the beginning of the year nearly all quotations of the Italian financial market have been constantly increasing, reaching a distinctively high level in July, 1918, according to Consul North Winship, Milan. There are five electrical companies, with an aggregate capital stock of 125,000,000 lire. These showed an increase in stock prices over December, 1917, of 21 per cent. in April, 1918, and of 40 per cent. in July, 1918.

The receipts of the government-owned telegraph system of

Brazil showed receipts of $335,249 in July, 1918, as compared with $286,575 in July, 1917.

It is reported that the Allgemeine Electricitätsgesellschaft in Berlin will erect a factory in Malmo, Sweden, for production of electric machinery and transformers. In 1913 the German company bought ground in Malmo. The Swedish duties on machinery are so high as to make German export to Sweden almost impossible, and this the German company wants to overcome by building works of its own in Sweden. At one time the company gave the assurance that it did not intend to compete with Swedish enterprises, but only wanted to obtain the cheapest possible supply of half-finished goods and raw materials from Kockums works and others.

Stockholm Superphosphate Factory A/B (capital stock $5,360,000) is purchasing the Alby Water Falls and the Alby Carbide Factory A/B, whose capital stock was $670,000. Nearly all the shares in this latter company have been in English hands. The Alby factory has been using 11,000 horsepower from the falls.

Sres. Echevarrieta y Larrinaga, Cadiz, are building at that port one of the largest dry docks in Spain. They are installing electric cranes and are considering a branch railway, connecting with the main line from Cadiz to Madrid.

A special examination was held recently in Baltimore, Md., for positions as telephone and signal operators at the various station houses of the city. Thirteen of the 17 applicants were women. This was the first time in the history of the Baltimore police department that women participated in the examinations for operators.

The Oregon Power Company, operating in a score of cities in Western Oregon, with headquarters at Albany, Dallas, Springfield and Marshfield, will hereafter be known as the Mountain States Power Company. The Oregon Power Company has always been a part or a subsidiary of the Mountain States Power Company, formerly the Northern Idaho & Montana Power Company, and the change in name, effective October 1, is merely to facilitate work in the various offices of the company.

Western States Gas & Electric Company, of Eureka, Cal., will supply 80 kilowatts of electrical energy to the contractor who will raise the steamer Corona. This power will be required for about six months.

The Corporation of Bradford, Eng., claims to be the first public body in Great Britain to adopt electricity as an illuminant. This was in 1888, in consequence of notices of various companies of their intention to apply for powers to commence operations. The Corporation resolved to take the initiative and keep out rivals by applying for powers, though none were sanguine about success. There had been no previous municipal undertaking as a precedent. The capital outlay was $100,000, and in September, 1889, the works in Bolton Road were opened.

The city of Oceanside, Cal., is installing electric pumps to operate its water system on account of the increasing cost of fuel. The electric energy will be supplied by the San Diego Consolidated Gas & Electric Company.

The Interstate Light & Power Company, of Galena, Ill., (subsidiary of Northern States Power Company is making arrangements for two extensions to the Government acid plants at Cuba City and New Diggings, and for running the Mineral Point extension into the Platteville sub-station.

The Chicago Telephone Company, whose capital stock and bond issues approximate $48,000,000, had a hearing before the board of review recently. The company filed a personal property schedule with the board of assessors April 1, amounting to $23,734,308 for the city of Chicago and $735,598 for the country towns of Cook County. This schedule probably will be raised by the board of review, which contends that the wire, poles, conduits and other equipment covered by this sum should be given a higher valuation. As the company is under Government supervision the matter will have to be taken under advisement with Government officials.

Personal Notes

Mr. C. E. Haygood, manager of the railway department of the Manila Electric Railroad & Light Company, of Manila, Philippine Islands, is visiting the United States on a vacation and for the purpose of consulting with the officers of the J. G. White Management Corporation, New York, N. Y., the operating managers of the Manila company. He expects to return to the Philippines sometime before the first of the year.

Prince Axel-Christian-George, of Denmark, with the other members of the Danish Naval Mission touring the United States on the invitation of our Government, recently visited the immense works of the Westinghouse Electric & Manufacturing Company, at East Pittsburgh, Pa. The prince expressed great admiration for the efficient manner in which this company had transformed its great organization from a peace-time industry into a part of the national scheme of war-production, and evinced great interest in the atmosphere of loyalty and enthusiasm pervading these works. The thoroughness with which the United States has gone into the war seemed to surprise every member of the party.

Major A. H. Griswold, now in France, wishes to establish a section of the A. I. E. E. among the American overseas forces. Many members of the institute are serving in France. Major Griswold was formerly plant engineer with the Pacific Telephone & Telegraph Company, at San Francisco.

Frank Binkley, manager of the United Telephone Company, of Bellefontaine, Ohio, has enlisted in the Signal Corps of the United States Army.

R. B. Lewis, of Minneapolis, has been appointed accountant at the Stillwater, Minn., division of Northern States Power Company, succeeding V. B. Sanders.

Captain Paul F. Sise, Vice-President of the Northern Electric Company, Montreal, has been given a command in the Canadian Siberian Expedition.

Mr. W. G. Gordon has been appointed Transportation Engineer of the Canadian General Electric Company.

C. Nesbit Duffy has resigned as vice-president of the Manila Electric Railroad & Light Company, Manila, P. I., to accept the position of vice-president of the Visayan Refining Company, Manila, P. I., one of the largest cocoanut oil companies in the Philippine Islands. Mr. Duffy is to take over his new duties on November first. J. C. Rockwell, the present general manager of the Manila Electric Railroad & Light Company, is being placed in full charge of the affairs of that company in Manila by the J. G. White Management Corporation, New York, N. Y., the operating managers of the property.

Questions for the Practical Electrician

A correspondent writes: "I desire to find out how to wind a ¼ h.p. 110 volt, 60 cycle, single phase, A. C. motor, full load speed 1,750 R.P.M. The stator has 24 slots."

Another correspondent asks directions for wiring up a board for charging automobile storage batteries from a 275-volt D.C. supply. The same correspondent asks whether it is better to use 60 w. Mazda or 60 w. carbon lamps. The Government has discouraged the use of all carbon lamps as wasteful, and every one is advised to use lamps that are more economical of current.

Will any reader of Electrical Engineering give the information desired by these two inquirers?

Electric Elevator Control

By T. Schutter

THE operation and control of electric elevators is divided into two branches—mechanical and electromagnetic. The mechanical controlling device is designed for the operation of a slow-speed elevator, which has but one speed, as the mechanical controlling device is either full on or all off. This article will treat of mechanical control only, and endeavor to give the reader a clear conception of the various parts, how they operate, and the circuits which they control. The reason for calling this a mechanical control is that a number of cams which are opened and closed by a hand rope or cable are mechanical devices for opening and closing the various electrical circuits, of which there are four.

The controller consists of the following: A potential switch or circuit breaker, which, when the machine is at rest, is open,

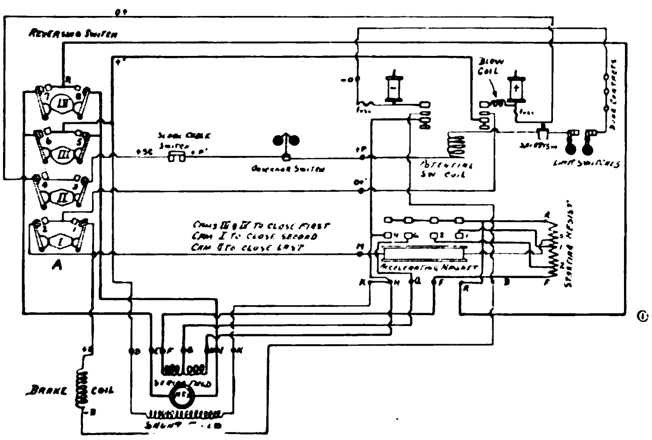


Figure No. 1

and an accelerating magnet, which automatically brings the motor to full speed. These are mounted on a slate board and are located near the motor. The mechanical device known as the reversing switch, consisting of four cams and eight contact points, is mounted at the end of the drum shaft, and is used to complete the various circuits shown at A in Fig. 1, which is the complete wiring diagram.

The motor is of the compound type when starting, but at full speed it operates as a shunt machine. The manner in

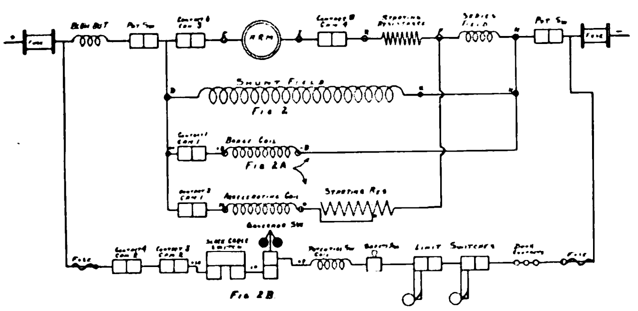


Figure No. 2.

which this change is brought about will be explained later. If the operator desires to run the car up he pulls the hand rope or cable downward. The cams are then arranged to complete the circuit; that is, cams Nos. 3 and 4 first close and they complete the armature circuit. It will be noticed from A, Fig. 1, that cams Nos. 3 and 4 work in opposite directions; that is, contact 6 on cam 3 and contact 8 on cam 4 would close at the same time. On the reverse motion contact 5 on cam 3 and contact 7 on cam 4 would close together. For the up motion of the car assume that contact 6 on cam 3 and contact 8 on cam 4 are now closed. The circuit which is completed is as shown in Fig. 2. The direction of the flow of current is as follows From the positive main line fuse through the blowout coil to the potential switch; from here to contact 6 on cam 3 to terminal E on the motor; through the armature

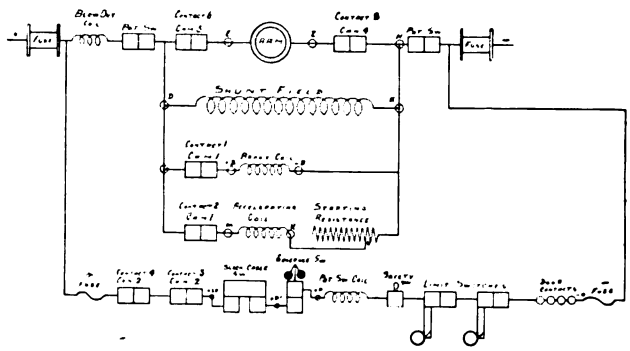


Figure No. 3

to terminal I and back to contact 8 on cam 4; then to terminal R through the starting resistance to terminal F; from here through the series field windings to terminal H, and back to the negative side of the potential switch and the main line fuse.

Cam No. 1 closes next. This cam completes two circuits—the brake circuit and the accelerating magnet circuit. These are controlled by contacts 1 and 2, as shown at Fig. 2 A. The direction of the flow of current is as follows: From the potential switch to contact I on cam 1; to terminal + B, through the brake coil to terminal — B and back to the

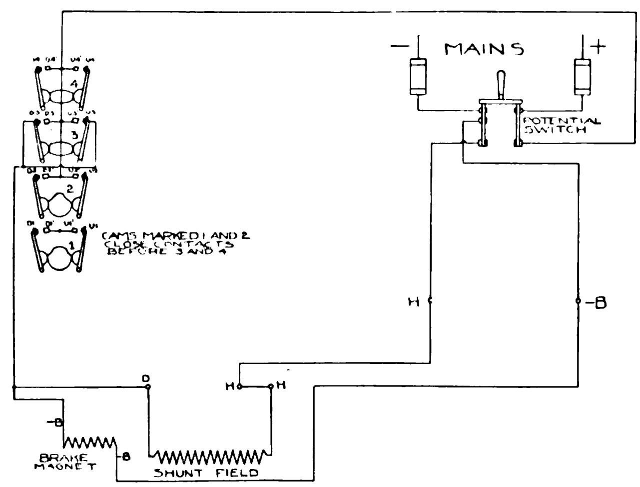


Figure No. 4

negative side of the potential switch. At the same time the circuit completed by contact 2 cam 1 is from the potential switch to contact 2, through the accelerating magnet to point O on the starting resistance, through a part of the starting resistance to terminal F, through the series field windings to terminal H, and back to the negative side of the potential switch.

Cam No. 2 closes last. This cam completes the safety circuit of which the potential switch-lifting magnet is a part. If all the safety devices are closed as soon as cam No. 2 closes the motor will begin to turn over. The flow of current through this circuit is as follows (Fig. 2 B):

From the positive main line fuse to the positive safety circuit fuse, and on to contacts 4 and 3 on cam 2; from here to terminal + SC through the slack cable switch to terminal + P' and then to the governor switch; from here to terminal + P and through the potential switch-lifting magnet to safety switch in the car; from here to the limit switches and door

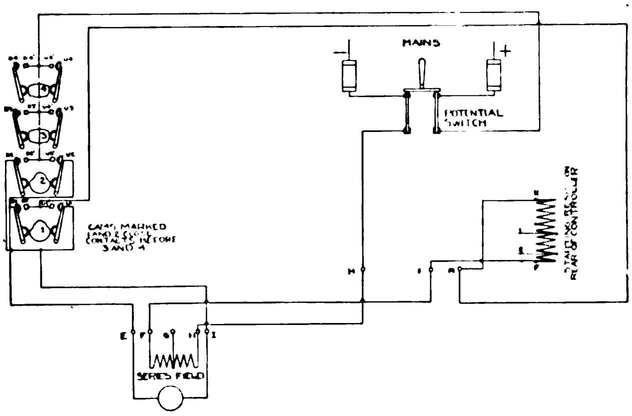


Figure No. 5

contacts to terminal — O and back to the negative safety circuit fuse and out through the negative main line fuse.

The shunt field windings is taped off from the feeder to contacts 5 and 6, cam 3, to terminal D, through the shunt field winding to terminals K and H and back to the negative side of the potential switch.

With these circuits closed as explained above, the motor will start as a compound machine, and gradually increase in speed. As the voltage across the armature terminals increases the magnetic pull of the accelerating magnet will also increase. The accelerating magnet is an oval-shaped coil wound over a core, to which four contact arms are adjusted so that each arm sets a little further from the core than the

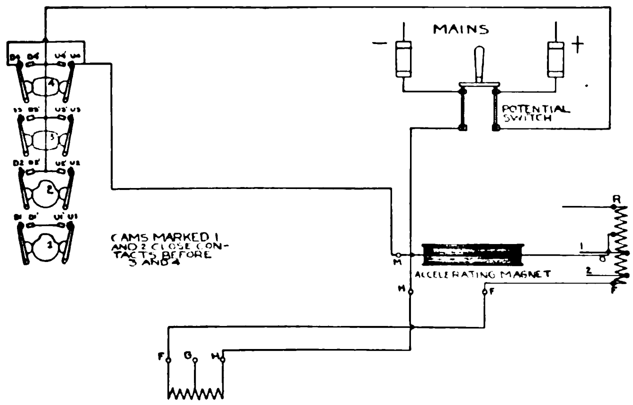


Figure No. 6

preceding one, so that as the magnetic pull increases the contact arms will be pulled in one after another.

From Fig. 1 it will be seen that contact arms 1 and 2 cut out the starting resistance in two steps; and contact arms G and H cut out the series field windings in two steps also. When the magnetic pull has become strong enough to attract all four contact arms, the motor is then running full speed as a shunt machine, and the circuits between the motor and controller are as shown in Fig. 3.

The safety devices as used in connection with this type of controller are practically the same as in other types. A brief explanation of their functions is as follows: The slack cable switch is placed under the drum on which the car and counterweight cables are wound. Should either of these cables become slacked they will open this switch which will cause the potential switch or circuit breaker to open and stop the motor by means of the brakes. The governor switch is usually placed at the top of the shaft and is operated by a separate cable which travels at the same speed as the car. If the car should run away or race for any reason the governor flyballs will spread and open the switch which will also act as the slack cable switch. The safety switch is located in the car close to the operator. The purpose of this switch is to stop the car in case something goes wrong with the hand rope and it is impossible to stop the car. This is a small 2-pole knife switch with its blades short circuited and the connections made to the jaws. By opening this switch the potential switch opens. The gate and door contacts are placed in the door jams, and unless the doors or gates are closed tightly they will not make contact and the car will not start, as the potential switch will not close. The upper and lower limit switches are slightly above the upper and below the bottom landing. Should the car overrun these landings, these switches will open and the potential switch will also open.

At the end of the drum shaft, where the mechanical reversing switch is mounted, there is also what is known as the automatic stop motion device. This consists of a traveling nut along a screw, and when it reaches either end of the thread it jams and opens the cams in the reverse order in

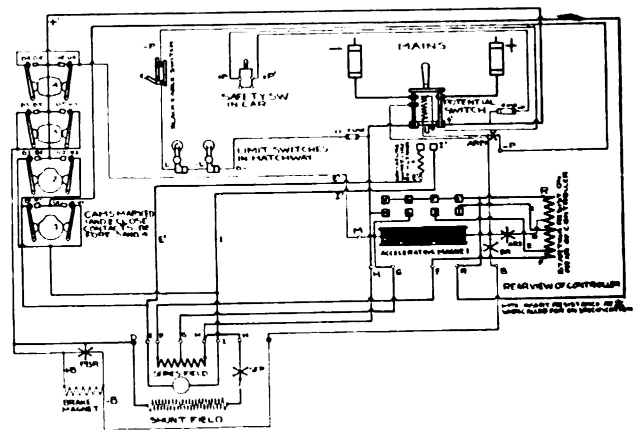


Figure No. 7

which they were closed; that is, cam 2 opens first, cam 1 next, and cams 3 and 4 last. This device will only operate at the upper and lower landings and stop the car independent of the operator.

The brakes on these machines are held off by a magnet coil known as the brake coil. As soon as this coil is demagnetized the brake shoes are applied by means of heavy spiral springs, which are strong enough to hold the car in any part of the shaft under any load up to a little more than full load.

Figs. 4, 5, 6 and 7 show the wiring and the various circuits of another type of mechanical controlling device whose principle of operation is similar to the one already explained. The reader will no doubt be able to trace out the circuits and thus develop for himself the scheme of operation.

Injunction Against Increased Rates Refused

The petition of the City of Atlanta to the Superior Court, asking an injunction against the enforcement of increased electric and gas rates, as authorized by the Georgia Railroad Commission, was refused by Judge Z. A. Littlejohn, of Americus, who had been agreed upon by both sides as thoroughly qualified and disinterested, and who had been invited to hear the arguments. He ruled that the railroad commission had the right to fix rates, even where contracts existed. He also ordered the electric and gas companies to keep accurate record of all increases to customers, so that if his decision should ever be set aside by higher courts, rebates might be paid. The higher rates, he said, should go into effect immediately.

Marine Equipment for Destroyers

Eight complete vessel equipments of ship propelling machinery, consisting of steam turbines and floating frame reduction gears with auxiliary apparatus were delivered in September to the Submarine Boat Corporation at Newark, N. J. This record is especially gratifying to the marine world as more turbines mean more ships; and ships equipped with the most modern propelling machinery. The Essington Works of the Westinghouse Electric & Manufacturing Company made this delivery and is especially proud of the record as the work was accomplished with new men who were neither familiar with the work when they were hired, nor were they familiar with Westinghouse methods at that time. Fewer men are now turning out more work than was formerly accomplished by a larger force. To the same shipyard have been shipped 21 condensers, 8 air separating tanks, 5 circulating pumps and 14 complete sets of propeller shaftings. Shipments of similar apparatus were also made from the Essington Works to the Merchant Shipbuilding Company at Bristol, and to one of the United States Navy Yards, where the Westinghouse marine system is being installed on U. S. destroyers.

Five Telephone Companies to Consolidate

The consolidation of five telephone companies in eastern Indiana, including the Eastern Indiana Telephone Company, the Red Key Telephone Company, the Ridgeville Telephone Company, the Farmland Telephone Company, and the Lynn Local Telephone Company, was authorized by the Indiana Public Service Commission in an order issued on October 4.

The consolidation is to be effected on the basis of the following property value: Eastern Indiana Telephone Company, $129,234; Lynn Local Telephone Company, $55.041; Ridgeville Telephone Company, $21,177; Red Key Telephone Company, $22,690, and the Farmland Telephone Company, $29,-820. The commission authorized the Eastern Indiana Telephone Company to issue $262,000 common stock to be used solely for the acquisition of the foregoing properties, which have a total valuation of $257,962.

The difference between the total authorized issue and the total sale price may be used or sold by the company to secure working capital.

Limitations for Electric Heating Apparatus

B. M. Baruch, Chairman of the War Industries Board, authorizes the following:

The conservation division of the War Industries Board, applying its program of eliminations to conserve essential materials and labor to free capital tied up unnecessarily in manufacturers' and merchants' stocks and to simplify factory production, has issued a schedule for manufacturers of electrical heating appliances which calls for discontinuance of the manufacture of the following electrical utensils and appliances:

List to Be Discontinued

Carbureters, heaters, hand-wheel heaters, in-take heaters, manifold heaters, primer heaters, blankets, robes, cigar lighters, frying pans, plate warmers, curling irons, saute pans, waffle irons, fluting irons, egg boilers, soup kettles, stew pans, corn poppers, hand dryers, hosiery forms, peanut roasters, transfer irons, vaporizers, varnish sprayers, entree dishes, cigar lighters for automobile, bookbinding appliances, instantaneous water heaters, automobile foot warmers, fudge warmers, vegetable dishes and all Sheffield plated ware.

The schedule for domestic appliances (660 watts or less, except ranges) provides:

All appliances that are to be eliminated, but which are now in the process of manufacture or are completed and in stock may be sold, but no more material for any of these appliances to be purchased except to balance up stock on hand, and their manufacture is to be discontinued entirely December 31, 1918.

None to Add to Styles

In no case is any manufacturer to add to the number of styles and sizes that he is now making.

Each manufacturer of the following appliances to restrict his output to the number of styles and sizes specified:

	No. of styles.	Total No. of sizes.
Chafing dishes	3	1
Percolators with faucets	3	2
Percolators without faucets	3	2
Samovars	1	1
Nursery water heaters	1	2
Teapots	1	1
Hot-water kettles	1	1
Ovens	1	1
Reflector heaters	2	2
Toasters	2	1
Toaster stoves	1	1
Convector heaters	1	1
Disk stoves	2	2
Fireless cookers	1	2
Flatirons, 7½ lbs. or less	2	2
Grills	2	1
Heating pads	2	2
Hair dryers	2	*1

*1 in each style.

Ranges: Not more than six different ranges covering both styles and sizes to be made at any one factory, and none to be made at any factory that is not producing ranges at this date. Nickel plating and fancy ornamentation to be eliminated.

Output to Be Restricted

Industrial appliances (over 660 watts): Each manufacturer of the following appliances to restrict his output to the number of styles and sizes specified:

	No. of styles.	Total No. of sizes.
Convention air heaters	3	7
Confectioners' appliances	2	2
Corset irons	1	1
Matrix dryers	1	1
Tailors' irons, 12 lbs. or over	2	4
Laundry irons, 7½ to 10 lbs	1	2
Gluepots (no aluminum pots to be made)	1	3
Circulation water heaters	2	11
Immersion water heaters	1	8
Round disk hot plates, open-coil type	1	4
Round disk hot plates, solid top	1	3

Steam Boilers: To be sold only where the electrical energy is generated from water power and there is a surplus of such energy available.

Restaurant Equipment: Each manufacturer of the following appliances to restrict his output to the number of styles and sizes specified:

	No. of styles.	Total No. of sizes.
Bake ovens	1	5
Broilers	2	3
Grids	2	3
Toasters	2	2
Hotel ranges	1	2

In the appliances not discontinued, the Conservation Division has cut out 691 different styles and sizes. For instance, in chafing dishes, there were 36 styles and but 3 will be allowed; of electric teapots, 20 styles and 1 allowed; of toasters, 10 styles and but 2 allowed. Manufacturers are to discontinue silver plated and copper finished appliances from the styles and sizes they will continue to make.

This bulletin follows closely upon the heels of the pledge given the War Industries Board by the manufacturers of electrical heating devices, who have promised to "police" the electrical industry, to curtail all waste in the manufacture and distribution of this material, and who have been delegated by Judge Parker, of the War Industries Board, to this task.

The Society for Electrical Development, in hearty accord with the Government, recommends that the suggestions of the War Industries Board and the Fuel Administration be carefully followed, especially as regards the distribution of new appliances, the repair and maintenance of old devices, etc. Furthermore, that distributors concentrate their efforts upon the more essential and more necessary labor-saving electrical devices; that they shape their merchandising methods so as to conform in every way with the desires of the Government and the Committee in charge of electrical appliance manufacturing and distribution.

Electrical Industries and Liberty Bonds

More than doubling its sales of Liberty Bonds for the Third Loan (when it broke all records by exceeding its former quota by 1,100 per cent., for which it was awarded a 21-star honor flag), the Electrical Industries Committee, of New York City, in conjunction with the Brooklyn Electrical Committee, in the Fourth Liberty Loan campaign just closed has rolled up a total of $19,368,000.

The work of the committee was organized by groups in the industry, the subscriptions obtained being as follows:

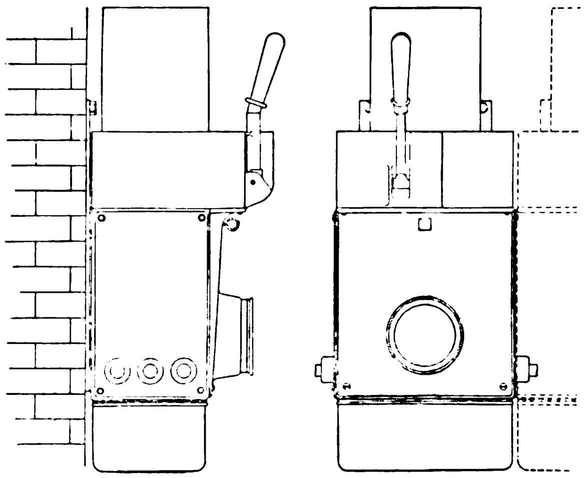
Electrical Manufacturers' Agents, Charles Crofoot, Chairman	$ 457,800
Contractor-Dealers, Louis Kalischer, Chairman	1,409,550
Electrical Machinery Manufacturers' Branch Offices, E. D. Kilburn, Chairman	10,133,550
Electrical Societies, T. C. Martin, Chairman	212,300
Electrical Supply Jobbers, George L. Patterson, Chairman	1,938,700
Electrical Manufacturers in New York, J. Nelson Shreve, Chairman	2,757,600
Total	$16,909,500
Brooklyn Electrical Committee, T. I. Jones, Chairman	2,458,500
Total New York and Brooklyn	$19,368,000

Theodore Beran was General Chairman of the Electrical Industries Liberty Loan Committee for Greater New York; James R. Strong, Vice-Chairman; E. Donald Tolles, Secretary, and H. C. Calahan, Assistant Secretary. Franz Neilson was Director of Speakers, and O. H. Caldwell, Director of Publicity. The Executive Committee included Charles Crofoot, Robert Edwards, J. C. Forsyth, George Gibbs, Louis Kalischer, E. Kilburn, Alanson P. Lathrop, F. H. Leggett, T. C. Martin, Walter Neumuller, George L. Patterson, J. Nelson Shreve, William Walsh and George M. Wheeler. T. I. Jones is Chairman of the Brooklyn Committee, and M. S. Seelman is Secretary.

Wall Type Switching Unit

The wall type switching unit here shown is intended for the control of alternating current circuits up to 300 amperes and 2,500 volts. The unit consists of an industrial type oil circuit breaker with a space above which serves as a housing for disconnecting switch, current and potential transformers, and also provides a location for either voltmeter or ammeter or both when desirable.

Following along the lines of safety-first principles, the disconnecting switch is interlocked, mechanically, with the oil circuit breaker so that the switch cannot be opened when the breaker is closed, nor can the breaker be closed while the disconnecting switch is open. A key, projecting through the front of the panel, is used to operate the disconnecting switch. This key can be removed when the switch is open, and carried by the operator, who then is assured that no one will close the switch while he is working on lines of apparatus on the circuit controlled by this unit. The interior of the switch compartment is inaccessible while the switch is closed and the oil tank cannot be removed while the disconnecting switch or oil circuit breaker is alive.



WALL TYPE SWITCHING UNIT

These switching units are particularly adapted to the control of circuits feeding banks of transformers; motors in steel mills and pumping plants, where it is desirable to mount the motor control appliances on walls or pillars. The units are self-contained and may be considered as "safety first" in every particular.

Wall type units are designed for single or group mounting and have a large bus compartment just above the disconnecting switch and inside the cast iron housing. Conduit connection with the unit can be made from above, below or from either side.

New York Jovian League

At a luncheon of the New York Jovian League, held in the Hotel McAlpin Winter Garden the past month, 150 members, in addition to previous subscriptions, raised nearly $30,000 for the Fourth Liberty Loan in less than thirty minutes. Inspiring talks were given by Congressman Charles P. Caldwell, of New York; Lieut. John Quinney, of the Canadian

Mounted Rifles; Theodore Beran, J. M. Wakeman, President of the Society for Electrical Development, who presided, and T. C. Martin.

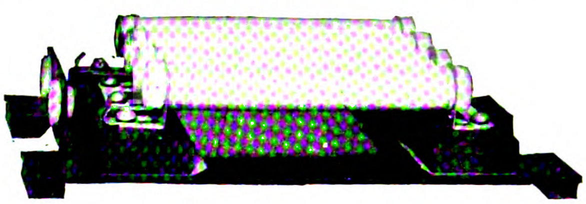
Congressman Caldwell said that it would cost at least 100 billions before our proposed army of 5,000,000 was placed in France and maintained there until the Prussian menace was ended. "We want six billion now and we're going to get it," he declared. "The cost of liberty is high but whatever the cost, it's little enough to pay. If you don't subscribe the money needed we'll take it from you in taxes and you won't get it back. When you subscribe it in bonds you get it back with interest. The faith and credit of America are pledged to this fight for liberty and as long as there is a dollar in the United States we shall back our boys over there to the full."

Lieut. Quinney, with a record of twenty-eight years in military service, was with the Canadian Mounted Rifles at Vimy Ridge and Messines and was twice wounded. "God's whitest manhood is to be found in the trenches," he said and after describing some Hun outrages, of which he had seen the proofs, he told of his brigade's fight at Ypres, when lacking any guns save a few three-inch pieces, they had withstood a terrific Hun bombardment followed by an attack that came in twelve waves. While standing on their fourth line of defense determined to fight to the last man, a German shell unearthed two Lewis guns, which were intact and with these his men made the Huns believe the Canadians were in force. Out of 600 men only 3 sergeants, four corporals and 86 privates survived the battle, and all but 61 were wounded.

"If you lend in 100th the way your boys fight over there," said Lieut. Quinney, "the Allies will be in Berlin before you know it."

Enameled Resistance Units for Regulating Current

Enameled resistance units for regulating current have been developed in various forms and sizes by the General Electric Company. Some of the applications to which these units have been put are railway and fire alarm signals, fractional horsepower motors and locomotive headlights. They are also used extensively in series with relay, contactor and circuit breaker coils on panels and switchboards. They will be found particularly applicable in mines and similar places where a great amount of dampness and

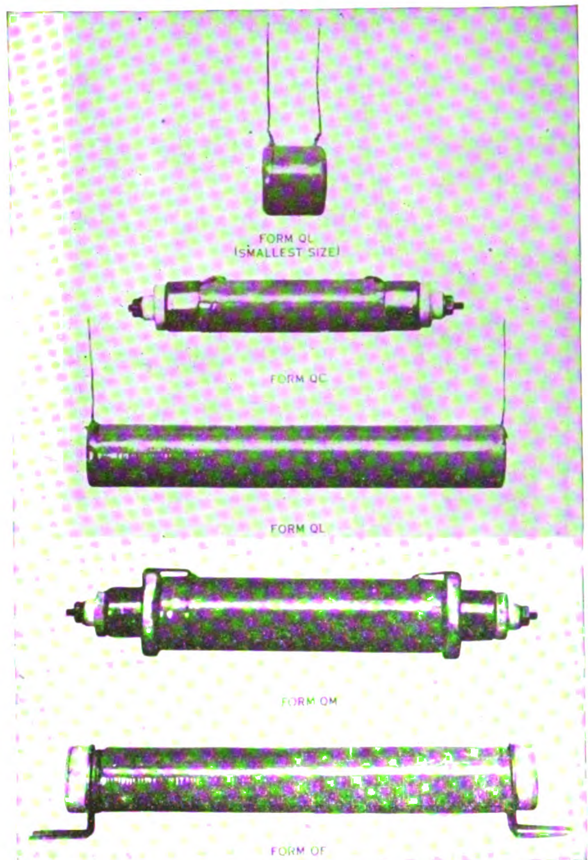


Headlight Dimming Resistor with Cover Removed

moisture are present. These units are unique in their ability to withstand unusually high temperatures as well as sudden changes in temperature from one extreme to the other.

The resistance wire or conductor is wound either upon a steel body coated with a special refractory enamel or paint and high heat-resisting silicate compound developed to withstand sudden extreme temperature changes without cracking or weakening or in any way being injured. The steel body is preferred for extreme lengths where strength for a long span is required and is especially serviceable where the unit might be subjected to severe vibration or shock.

The refractory silicate body is used for most of the ordinary types of resistance. The compound employed is far superior to porcelain or any equivalent ceramic products, which are easily cracked or weakened mechanically by repeated and extreme temperature fluctuations. After being wound upon the proper body the conductor is embedded in a blue vitreous enamel and is fused, until it has a uniform glossy structure, at a temperature of about 1,000 deg. C. This enamel is moisture and heat resisting and



Enameled Resistor Units

forms a mechanically strong casing for the conductor. Enamels of the type used are extremely durable and maintain their dielectric strength and mechanical properties indefinitely.

Several different methods of attachment to the circuit have been developed as shown in the accompanying illustration. A variety of units of various sizes and ohmic capacities have been standardized and units of a special nature are obtainable.

Legal Decisions in the Electrical Field

Damages—*failure to deliver telegram—loss of bargain.* Compensation for loss of the bargain it is held in the Arkansas case of Western U. Teleg. Co. v. Caldwell, 202 S. W. 232, L.R.A. 1918D, 121, cannot be allowed as damages for failure to deliver a telegram announcing an opportunity to purchase a stock of goods at a bargain.

Evidence—*telephone conversation—admissibility.* Evidence of a telephone conversation acknowledging responsibility of a corporation for an automobile accident is held not inadmissible in the Michigan case of Theisen v. Detroit Taxicab & Transfer Co. 166 N. W. 901, because the identity and authority of the person answering the telephone is not established, if the parties are subscribers to the same system, the office of the corporation is called in the usual manner, and the person called to the telephone assumes to be the manager of the corporation. The necessity and sufficiency of identification as a foundation for the admission of a conversation or communication by telephone is treated in the note accompanying the preceding decision in L.R.A.1918D, 715.

MASTER AND SERVANT—*telegraph messenger—servant.* One employed by a telegraph company to collect and deliver messages is held to be its servant in Postal-Teleg. Cable Co. v. Murrell, 180 Ky. 52, 201 S. W. 462, annotated in L.R.A.1918D, 357, so as to render it liable for injuries inflicted upon a pedestrian by him while riding a bicycle to deliver a message although he furnished his own uniform and bicycle and was paid a commission for each message delivered.

MASTER AND SERVANT—*injury by district messenger responding to call.* A messenger boy in the employ of a telegraph company is held to be acting within the scope of his employment in Kuehlmichel v. Western U. Teleg. Co. 125 Minn. 74, 145 N. W. 788, L.R.A.1918D, 355, in obeying a summons of his superior to report at the office to deliver a message after having been given the evening off, so as to render the company liable for injuries to one who collided with the wheel ridden by the boy, the wheel being his own and ridden with the knowledge and assent of the company, but not by its requirement, although the actual purpose of the summons was that he might relieve the night operator, who called him, which was not one of his duties.

Obituary Notes

Willard E. Case, widely known as a student of electrical science, died at his home in Auburn, N. Y., on October 27, of Spanish influenza. He was a millionaire and his research into electro-chemistry gave him international prominence. Mr. Case was born in Auburn on February 19, 1857, the son of Theodore P. Case and Frances Fitch Case, and on his mother's side was descended from John Fitch, one of the first inventors of steam navigation. On the paternal side he also came from a line of men who were pioneers in the early scientific achievement in America. His laboratories at Auburn, among the finest in the country, are now being used by a force of electro-chemists in Government work. In October of last year Mr. Case made what was said to have been the largest endowment in years to the New York Electrical Society, to be known as the Case Fund and used for war research work in electricity.

Wallace B. Lindsay, head of the electrical engineering department of the Ingersoll-Rand Company, died at his home in New York the past month.

Edward Corrigan, general superintendent of traffic of the Chesapeake & Potomac Telephone Company, died recently, after an illness of several months. He was born in New York 49 years ago, and entered the telephone service as an operator as soon as he left school.

Charles G. Roebling, president of the John A. Roebling's Sons Company, Trenton, died at his home in that city on October 5. Mr. Roebling was one of the most eminent of American engineers, and will always be remembered for his work on the Brooklyn Bridge.

Lieut. Leonard G. Byng, of the Grenadier Guards, a director since 1910 of the General Electric Company, Ltd., of London, died of wounds in France. He was awarded the Military Cross for heroism in action.

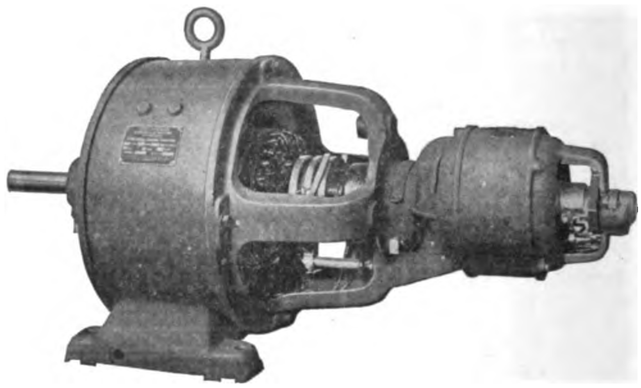
Walter H. Baker, manager of the El Reno, Okla., exchange of the Southwestern Bell Telephone Company for several years, died recently at his home in El Reno after a brief illness.

Leonard S. Cairns, general manager of the Eastern Pennsylvania Railways Company, died of pneumonia on October 10th at Pottsville, Pa. He was thirty-six years of age. Interment was made at Minneapolis, Minn., his former home. For a number of years Mr. Cairns was general superintendent of the Twin City Rapid Transit Company, of Minneapolis and St. Paul, Minn. In 1912 he resigned form the operating organization of that company to join the staff of the J. G. White Management Corporation, New York, and was assigned to the position of assistant general manager of the Manila Electric Railroad & Light Company, Manila, P. I. He was promoted by the management corporation in 1917 to the office of general manager of the Eastern Pennsylvania Railways Company, Pottsville, Pa.

Allan C. Choate, purchasing agent of the Eastern Pennsylvania Railways Company, died of pneumonia on October 13th, in Pottsville, Pa. He was a son of Joseph K. Choate, vice-president of the J. G. White Management Corporation, New York, N. Y.

A Small Belted Alternator

Many small industrial and lighting plants require a small belted alternating-current generator. This generator, as the name implies, is belt driven and has a direct-connected exciter, mounted on a special bracket, making a very compact unit.



A SMALL BELTED ALTERNATOR

Rating.—This Westinghouse small belted alternating-current generator is rated at 25-kva., 3-phase or 17-kva. single-phase, 60 cycles, 1,800 r.p.m., 120, 240, 480, or 600 volts, single or three-phase.

New Catalogues

The National X-Ray Reflector Company, of Chicago, has recently published a new catalogue describing the direct lighting reflectors put out by that company. It is very complete, covering all the X-ray reflectors for industrial, flood, show window and showcase lighting. The flood-lighting section features three new projectors and several new X-ray reflectors for the projectors. This gives the X-ray projectors an even wider range of adaptability than they had before and makes the X-ray line of flood-lighting units comprehensive. It will be of interest to the trade to know that with the publication of catalogue No. 21 the National X-Ray Reflector Company adopted the Goodwin plan and has made allowance for recognition of the electrical contractor-dealer in its scale of discounts. To co-operate with the Government's regulations on paper conservation, there has been no general mailing of this catalogue. It is being sent only upon request.

The McGill Manufacturing Company, of Valparaiso, Ind., has issued a mat illustrated folder devoted to the Loxon Lamp Guard, as well as to the other guards manufactured by this concern. In these days when strict economy is necessary, the Loxon guard should be on every exposed lamp that can be stolen.

DIRECTORY OF CONSULTING ENGINEERS ARCHITECTS AND CONTRACTORS

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912

Of "Electrical Engineering," published monthly at New York, N. Y., for October 1, 1918.

State of New York, } ss.
County of New York, }

Before me, a Commissioner of Deeds in and for the State and county aforesaid, personally appeared Frank A. Lent, who, having been duly sworn according to law, deposes and says that he is the Publisher of "Electrical Engineering," and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit.

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Name of	Post office address
Publisher, Frank A. Lent,	258 Broadway, New York
Editor, Geo. A. Wardlaw,	285 Broadway, New York
Managing Editor, None.	
Business Manager, Frank A. Lent,	258 Broadway, New York

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

Frank A. Lent, 258 Broadway, New York

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also in cases where the stockholders or security holders appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

FRANK A. LENT, Publisher.

Sworn to and subscribed before me this
27th day of September, 1918.

WALTER HALLIDAY,
Notary Public Kings Co., 182; Kings Co.
Register No. 9090. Certificate filed
New York Co., 9175.
My commission expires March 30th, 1919.

ELECTRICAL ENGINEERING

VOLUME LII | DECEMBER, 1918 | No. 6

Impulse Gaps for Lightning Arresters

IMPULSE gaps for lightning arresters are recommended for use in connection with lightning arresters which protect stations of large capacity operating at 11,000 volts and higher. The impulse gap excels every known gap in assisting arresters to give protection from lightning and other high-frequency or high-voltage disturbances. The impulse gaps, as listed herein, are for use in connection with electrolytic or other three-phase (grounded or ungrounded neutral circuit) lightning arresters now in service.

The Westinghouse impulse gap protests the insulation against high-frequency or steep wave-front surges of high potential at a lower voltage than does any other known gap.

Operation.—The old-fashioned, plain horn gaps had considerable time-lag, allowing a high-frequency surge to rise to a much higher voltage than would a low-frequency surge before discharging and giving protection. The development of the sphere gap partly prevents this situation by eliminating the time lag so that all frequencies are discharged at the same voltage. The new impulse gap has a negative time lag; that is, the higher the frequency the lower the voltage at which the gap discharges. Thus the impulse gap automatically selects the dangerous surges and gives protection more quickly than any other known form of gap.

The impulse gap not only incorporates all of the virtues of the horn gap and the high-speed sphere gap, but also possesses the property of selecting high-frequency or steep-wave-front surges and discharging them at a lower voltage than the normal voltage setting of the gap. It should be particularly noted that the impulse gap is the only device which will protect insulation against a steep-wave-front surge of reverse potential, that is, a sudden drop in voltage. The high-frequency discharge voltage may be as low as two-thirds, or even one-third, of the normal frequency value. It is, therefore, possible to use a gap setting that will permit of the desired degree of protection against dangerous surges while not permitting too frequent discharging on minor surges at normal frequency.

The high speed of the sphere gap as compared with the horn gap is due to the elimination of the time required to build up a sphere of equal potential surface at the discharge part of the horn gap. The sphere of equal potential surface and practically eliminates corona and reduces field distortions when the gap is set equal to, or less than, the sphere diameter. By the use of the sphere gap the voltage to ground, or the break-down voltage, at any frequency does not materially exceed the 60-cycle discharge voltage of the gap. However, the sphere gap does not give the desired protection against steep-wave-front, or high-frequency surges, due to its inability to discharge these disturbances at lower voltage than the normal frequency setting of the gap. It is necessary to set all arrester gaps for a sufficiently high normal frequency setting of the gap can be had without the corresponding disadvantage of reduced protection, since the high-frequency break-down value of the gap is much lower. This is because high-frequency discharges start from the auxiliary electrode and have only one-half of the gap to jump. The latter electrode, also, is so shaped that, although the gap is one-half of the main gap, the break-down voltage is only about one-fourth as great: that is to say, high-frequency surges not only delayed in discharging, as with plain horns, by the need of building up a static field; but instead, discharge at a voltage even lower than the normal value of the main gap, since they automatically select the auxiliary gap of much lower voltage break-down.

The impulse gap uses a circuit that, at normal frequency, is balanced as to voltage, but becomes unbalanced and starts a discharge in the case of any high-frequency surge. At normal frequency there is no difference of potential between the mid-point of the condensers and the auxiliary electrode midway between the auxiliary horn and sphere gap. A high frequency, however, passes freely through the condensers and piles up its full voltage across the resistance, that is, across one-half of the total gap. This gap, therefore, breaks down, resulting in the total voltage being impressed on the remaining gap, which breaks down in turn, dissipating the disturbance to ground. The breakdown of each half of the gap is facilitated by the fact that the auxiliary electrode is small in size (having needle gap characteristics) so that the discharge voltage of each half of the gap is about one-quarter, rather than one-half, of that of the total gap between the spheres. It should be especially noted that the danger to apparatus from steep-wave-front surges, particularly of reverse potential, may be out of proportion to their actual magnitude, due to the inductance of apparatus, which not only produces a high voltage across the first few turns of the winding of any apparatus, but also a much higher voltage to ground than the normal voltage of the impulse, due to the addition of induced or reflected voltage to the normal voltage of the impulse. If the apparatus is to be protected with a gap and lightning arrester, the gap should be one that will select and discharge the high-frequency disturbances at a voltage lower than the normal voltage of the gap. The impulse gap accomplishes the desired result.

The necessity of selective action in the gap is emphasized by the following possible combinations of the impulses and line voltage. (Assume that an ordinary sphere gap to ground is set to discharge at twice the line voltage.)

Case A.—The voltage of the line does not affect the action of the impulse, and the impulse must reach twice the line voltage before the gap protecting the apparatus will discharge.

Case B.—The voltage of the impulse must reach only the same voltage as that of the line before the gap discharges.

Case C.—The voltage must have a value three times the line voltage before the gap discharges. In this case it is to be noted that conditions are such that the high-voltage stress is present not only to ground, but also between turns of windings of apparatus. Adequate protection against this condition demands the use of a gap which is very sensitive to steep-wave-front surges. If the impulse is oscillating, the second half cycle may cause a discharge, but the time for protection against the destructive effect of the first half cycle will have passed.

It is to be noted that with the impulse gap, the discharge begins at a lower voltage than with a sphere gap, and hence operates more quickly than a sphere gap.

Construction.—The impulse gap consists of standard (Faradoid and pillar) porcelain insulators (two of which are used as condensers), unbalancing resistor, auxiliary electrode or tickler, a sphere gap, an auxiliary horn gap, a short circuiting clip, a charge-and-discharge resistor, and a supporting framework. The framework is equipped with feet which can be mounted upon an existing structure if the purchaser supplies inverted feet or other standard pipe connections and fittings.

Heating of Buried Electrical Cables

Sir Richard T. Glazebrook, in a recent lecture before the Royal Institution in London, made a strong plea for the establishment of a national laboratory for industrial research. After dwelling upon the great need for continuous research, he outlined the principal objects for a national association, and the lines that it could follow. Sir Richard made the following statement: A research has been in progress for some time at the laboratory into the heating of buried cables carrying electric currents. In connection with the wiring rules committee of the Institution of Electrical Engineers much has been done to determine the temperature to which the cables used in house wiring are raised in various circumstances, and to fix the safer currents to be used in each case. Our knowledge of the temperature reached in cables when buried in the ground is very scanty and somewhat conflicting; much depends on the nature of the covering used to protect them, and possibly something on the nature of the soil. Cables laid in ducts again differ from those protected merely by the ordinary forms of lead or other covering, and yet the life of the insulation depends in great measure on the temperature reached when the current is flowing and thus regulates the carrying capacity of the cable. Thanks to the co-operation of supply authorities in many parts of the country much valuable information has been collected, and, though the research at the laboratory proceeds but slowly, results of great importance are being obtained. Such a research needs large appliances, and currents up to 8,000 amperes or 10,000 amperes will be employed. It needs also the resources of a fully-equipped physical laboratory in order to measure accurately the temperature differences due to varying conditions; when complete it will be of value to all supply companies. This is true of many other electrical tests and experiments; the results are of wide application; it is desirable that they should be widely published.

New Wireless Offices in Manchuria

Consul A. A. Williamson, of Darien, Manchuria, reports that the existing wireless office located at Shatotzu having been found inadequate to meet the increasing requirements, an extension has been planned on a considerable scale. The site for the new dispatch station has been fixed at the old west fort on Hoshang Island at Liushutun, while the southeastern base of Darien Fuji (Miniature Fuji), just above the last bend of the Hoshigaura suburban tramway, has been chosen as the site of the receiving station. Surveys have already been made. The estimated construction cost is put at 400,000 yen (about $200,000) each. Work is to be commenced in the next fiscal year.

Largest Portable Substation

A COMPANY that has in its possession a portable substation is always prepared for emergency cases, as it is in the enviable position of being able to render instant assistance or relief to any other station that may be temporarily out of commission or called upon to carry a load beyond its capacity. As the production of direct current involves only the transferring of the substation to the place where it is needed and connecting it to the high-tension line, it means just a short elapse of time before it is in active operation. Such flexibility of service renders unnecessary the installation of spare equipment in each of the permanent substations.

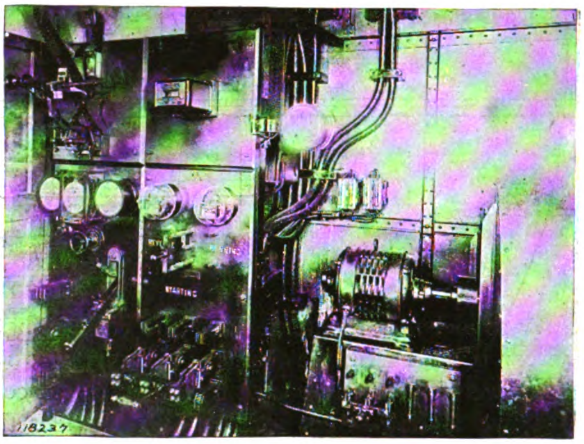
The largest portable substation that has yet been produced is owned by the Long Island Railroad Company. Its normal capacity is 1,500 kw. and it contains a 1,500-kw., 650-volt, d.-c., 25-cycle Westinghouse rotary converter; three 500-kva. combination oil-insulated, self-cooled and air-blast, single-phase, 25-cycle outdoor transformers; complete switching equipment and auxiliary apparatus. The transmission voltage is 11,000 volts, but the substation is arranged on 33,000 volts, which may be used in the future. The car is so constructed that it can be used for both service indoors and outdoors.

The over-all dimensions of the car was restricted and this caused many manufacturing difficulties. Its length was limited to 38 feet, due to the fact that the permanent substations are equipped inside with railroad sidings on which the portable substation is located when operating in multiple with the permanent units. Due to traffic regulations, the width was restricted to 10 feet. A height restriction was also recognized by the builders. Notwithstanding these restrictions the apparatus of the substation had to be so distributed as to allow plenty of space within the car for proper attention to the converter and switching.

Portable Substation Ready for Operation

The most difficult problem was that of the transformers, when it was necessary to bring the height and floor space within the required limits. Forced air cooling is provided in addition to the self-cooling properties of these units. A small motor-driven fan, housed inside the main cab, which also contains the converter and switchboard, supplies the air which is discharged into a duct surrounding the lower part of the transformer, where baffle plates and guides so direct the air that an even distribution is obtained on all sides. Through a duct whose minimum height is 18 inches the air is carried to the top of the transformers. The normal radiation of the case is thereby increased over 25 per cent, permitting a material reduction in size of tanks.

With the addition of a leveling device, the converter installed, is entirely standard in construction. The function of the leveling device is to keep the machine level in case the car is standing with its floor at an angle. Four trap doors in the roof provide the ventilation. Each of the four doors is provided with a watertight, removable cover which is kept in place during outdoor operation. When the covers are removed, as they are for outdoor service, a total opening of 75 square feet is provided. Holes through the floor inside the converter bedplate provide ventilation in addition to the air which enters the doors and window.



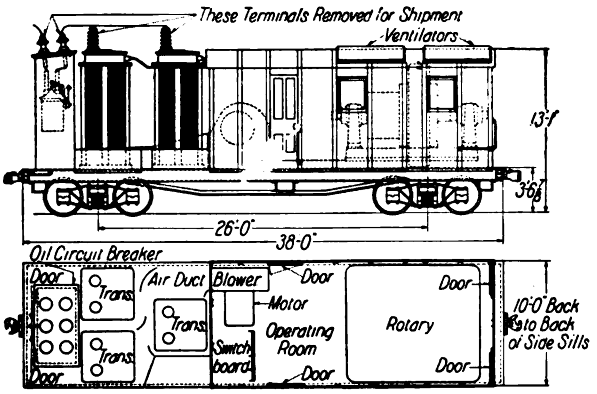
Substation, Showing Switchboard and Blower Motor

The roof of the cab over the machine is composed of a removable section built upon a framework. This construction is necessary in order to place the converter in the car, or remove it so as to insure no injury to the apparatus. As an example of the close spacing, there was ⅜ inch clearance on each side between the bedplate and the eaves of the car when the machine is being lowered into the car and position.

With the exception of using a Burke horn-gap, high-tension switching, the switching equipment practically follows the standard used for portable substations. The car is provided with an oil circuit breaker, which is located in a separate housing at the opposite end of the car from the main cab. The direct-current terminals are located on opposite sides of the car in order to more conveniently make connections with the d.-c. bus of the permanent station.

The arrangement allows for four or five men to be with the operator without interfering with his work, as far as space is concerned. The apparatus is so arranged as to concentrate all available space near the center of the car and so provide ample room for him.

The car built by the Railway and Industrial Engineering Company is of the most rugged construc-



General Layout of Portable Substation

tion. A solid box girder extending the entire length of the car is built with the frame. The girder is reduced to twelve inches over each truck, but at the center it is twenty-four inches depth. This provides the necessary stiffness. The cross bearings are so located that they support the heavy equipment, making it independent of the ¼-inch steel floor which covers the top of the entire framework. Jacks can be used at each corner to steady the car during operation. It has been found that this is unnecessary as the method of supporting the equipment and the manner in which it is balanced gives operation which is practically free from vibration. The view accompanying this gives an idea of its appearance and the layout of the apparatus.

The permanent substations of the Long Island Railroad Company are constructed with a railroad siding entering each building. At the time when one of these stations is about to be subjected to a long period overload which is beyond the capacity of its converting apparatus, the portable substation is conveyed into the building, connections made to the high-tension line and the converter paralleled with the permanent units. The portable, in a like manner, is available to take the place of any permanent unit which may be temporarily unusable. It can also be conveyed to any desired point along the railroad, where the high-tension current is available and used as a separate substation during rush hour or holidays.

Electrical Material for Brazilian Government

There has been received by the Department of Commerce a sample board containing samples of the various iron, steel and copper wires used by the Department of Telegraphs, Rio de Janeiro, Brazil, which it is necessary for the department to purchase abroad. Accompanying the board are three tracings of the posts that have been standardized by the Department of Telegraphs, one tracing of the arms and pins, and five photographs showing iron arms and fittings, wooden arms and fittings, porcelain insulators and pins, and miscellaneous tools.

Up to the present time all the material except the wire, and the greater part of that, has been bought in Europe from firms who solicited the business through their connections in Rio de Janeiro. The Brazilian Department of Telegraphs desires to purchase in the United States if it can obtain the material required, and an opportunity is thus offered American firms interested to compete for business that heretofore has been closed to them. In taking this matter up it should be noted that the only condition under which dealings can be had with the Department of Telegraphs is that the manufacturer offering his goods be in a position to deal with the Brazilian Government direct and not through agents or commission houses, so as to give the Government the benefit of the customary terms of payment obtaining in ordinary business transactions.

The samples, tracing, and photographs may be seen at the New York office of the Bureau of Foreign and Domestic Commerce, Room 734, Custom House. Refer to file No. 40134.

The Economical Electric Vehicle

A report by Mr. S. E. Britton, the City Electrical Engineer for Chester, England, constitutes an excellent testimonial of the efficiency and economy of the electric vehicle for municipal duty. Two electrically-propelled tipping wagons have been employed in the collection of house refuse since the summer of 1915, and up to the end of 1917 they had traveled 13,688 miles, and collected and carried 5,974 tons of house refuse. In addition, they performed innumerable other services in connection with the electricity works, the transport of scrap, munitions, etc. The cost, including wages, repairs, insurance, electrical energy, tires, and other incidentals, works out at 9.19d. per mile. These vehicles have performed the work of six horses and men, which, it is estimated, would have cost $7,530, the cost of the electric vehicles being only $2,720. The saving is obvious, and indicates a successful future for the electric vehicle in this connection.

Electricity Has Won the War

By Sidney Neu.

ELECTRICITY has played no unimportant part in the winning of the war. Only on the battlefield has the work of the electrical engineer not been apparent—poison gas, liquid fire, shrapnel, explosive shell, machine guns, rifle bullets, bayonets, and men that fought like demons, showed no sign of the presence of electricity. Yet were it not for electricity and man's control of its use, these forces of victory had not been.

Think back to the gunsmith of a century ago. Could he have armed an army of four million men in eighteen months? With four million men withdrawn from production, could any army have been equipped? Electrically driven machine tools made possible what human sweat and muscle never could have accomplished. Unheard of tons of steel have been required, and those best able to judge have said that without electric drive to speed production in the mills we should have fallen short.

Uniforms were needed to clothe the men who fought. They could not go naked while weavers leisurely wove the cloth, cutters shaped it, and tailors sat cross-legged slowly stitching seams. Electricity was called on to do these things with speed, and the uniforms were made—breeches, shirts, leggings, shoes, underwear, hats, belts, millions of them. Of these things, some were doubtless made by steam power unaided, but where production was the swiftest and therefore the most effective, electric drive was responsible.

The chemicals that speeded the shells on their way, that burst the shell to fragments, that made the very air untenable for the foe, owed their production in the tremendous quantities required to electricity. Electrochemical processes fashioned some, electric drive furnished the controllable mechanical power for making others.

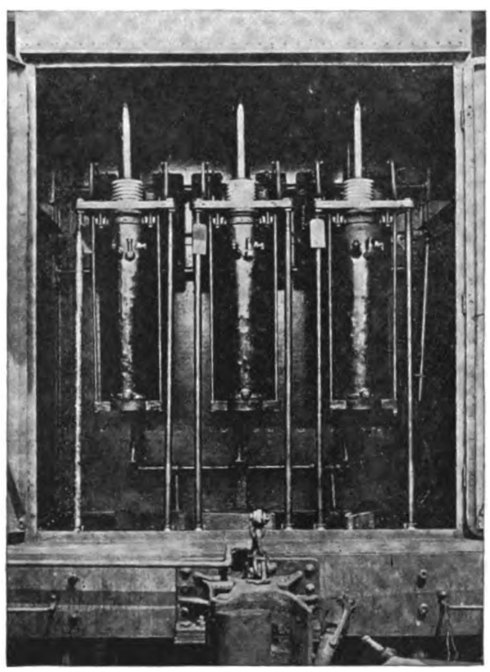
The army and the nation needed food and electricity produced it. Fertilizers produced by electrochemical means made the earth productive, electric drive threshed much of the wheat, prepared the meat, operated the packing plants, ground the flour, entered everywhere into the production of food to make human labor less and to release more men to carry fear to the hearts of barbarians.

In its gentler aspects electricity appeared even on the field of battle, guiding armies, battalions, even individual shells. The airman by his wireless telephone and telegraph guided the gunner far to the rear, who would otherwise have been blind. The commander watched through his wire and wireless network the progress of his fighting units miles away, kept them correlated into one vast machine that acted as a whole, not as a multitude of unrelated parts.

Billions of billions of electric sparks daily ignited the cylinder charges of motor trucks, lorries, airplanes, motor cars, motorcycles and the victorious tanks. Without electricity for ignition these engines would have been unheard of. Electricity enabled the ships at sea with their precious freight of American manhood to keep each other in touch, to avoid the hidden dangers that menaced, to signal back as each arrived, "We're here, and safe!" The ships themselves—did not electricity produce them? Their plates were rolled and shaped and machined in electrically driven machinery. Electric cranes transported their parts. Electric compressors furnished the power behind the busy riveters.

Speed won the war when it was won and saved millions of human lives and untold additional human suffering—America's speed. The world marvels at America's speed and even America marvels. America was capable of this unheard of speed because America has made electricity its servant. Many men have been needed to accomplish what has been done in preparation, but at least twice and probably three times as many men would have been needed had not electricity been ready to help; and there were not that many men.

Electric light in battlefield searchlights patrolled the sky and no man's land, guarding against surprise. At home protective electric lighting dispensed with many human guards, who thus could lend their hands to much-needed production. Within the busy plants men



Railway Portable Substation
End of car open, showing the Westinghouse oil circuit breakers

worked through the long hours of night as swiftly as by day, because electric illumination was at hand. So short was the man power that even with electricity's help women were required to lend their aid in making ready our fighters' equipment. Without electricity women's help would have been but feeble. It is because electric drive tames rough forces and makes cumbersome machinery so simple to manipulate that it was possible for women to do what only men had done before. Work with machinery had been considered man's exclusive sphere because it had been rough work, heavy work. Electricity has made it such light work that it no longer fatigues the frailer sex.

Nor is this alone electricity's part in putting women at the lathe, the punch press and the planer. It has simplified the home so that she can be spared. We forget the duties that women formerly had in the home. She was spinner and weaver and tailor, she was laundress and housemaid, baker and cook, milkmaid and charwoman. Electrical machinery and electrical transportation have taken many of these duties out of the home. Those that are left, washing, ironing, sweeping, cooking and sewing, electricity has so lightened that women have been able to take their part in saving the world for those that dwell in it. Where many women were needed in the "good old days" to keep one household running smoothly, one alone now finds time to spare.

Trace back to its source any thing or factor that has helped to end the struggle, and electricity is found, not once but many times to have touched it and hastened it on to consummation. Truly, electricity has won the war, electricity guided by American brains, led on by American energy, crowned by American valor.

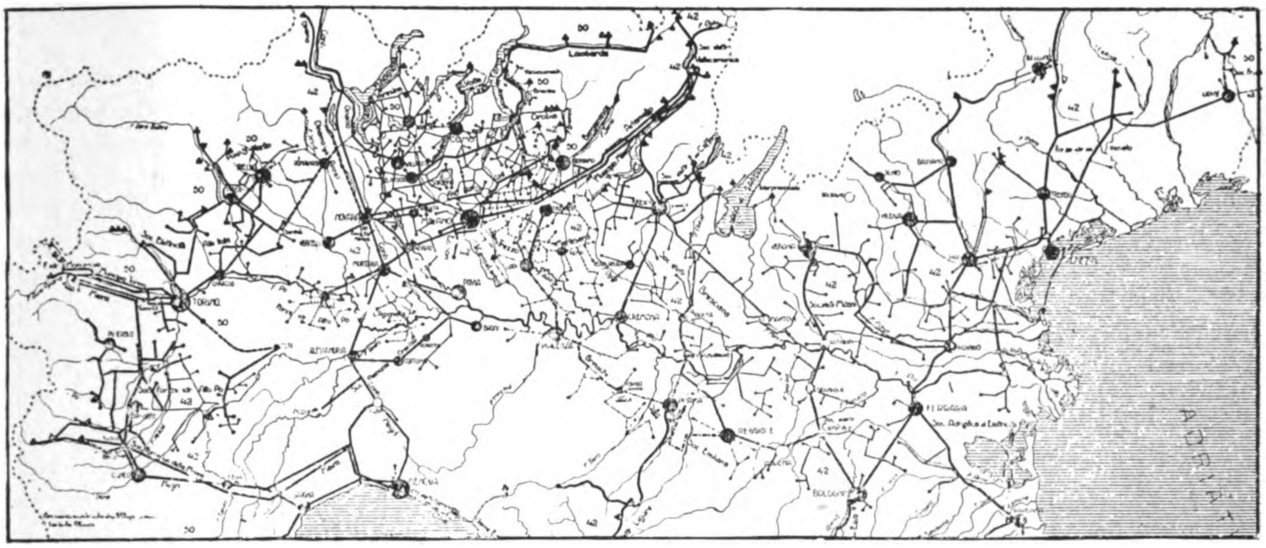
Development of Hydroelectric Power

IT is an idea of the general public that Italy has done comparatively little in the development of electrical power. However, the contrary is the fact, as we may gather from the accompanying map of Northern Italy, which we reproduce from "Annali di Ingegneria e Architettura." This shows the centers and trunk lines of Electrical Power Systems, and it will be seen how close a network they spread over the entire country. We reproduce the map, not as a mere curiosity, but because we believe it has a most pertinent bearing on the great problem of after-war reconstruction that is now before us. When we entered the war we were suddenly called upon to build up vast new industries for the production of munitions, supplies, implements, textiles, and a thousand and one things, the pressing need for which we had not realized. The location of these industries was largely determined by available power, and there was a tremendous shifting of population and most uncomfortable congestion. If there was spread over our states a close spider web of great electrical mains similar to those shown in the Italian map, we could make better selection of industrial locations, and scatter them according to a wise economic plan. In this way we should avoid an upsetting of the labor market and the shortage of housing accommodations. Great plants that were outside of the bounds of cities and towns could have more room for development and could keep their tax rates down.

Bearing directly upon this question is a most suggestive and exhaustive study of "Power: Its Significance and Needs," by Chester G. Gilbert and Joseph E. Pogue, of the Division of Mineral Technology, United States National Museum. A brief summary as to their conclusions on the development of electrical power follows.

The use of power not only leads to centralization of work, but the form in which power is available determines the type of industrialism or civilization that develops. Considering energy apart from its sources, we find that this force has come into use in three mediums of expressions—liquid, gaseous, and non-substantial—typified in hydraulic power, steam power, and electric power. These steps in energy usage represent progressive stages in facility of employment and indicate an evolutionary trend underlying the industrial unfoldment to which they have given rise. Thus the use of hydraulic power marks the period of individualism which prevailed the world over until the eighteenth century, and still holds in all but the so-called civilized nations; the application of steam power instituted a change so profound as to merit the name, "The industrial revolution," and colored the whole face of modern civilization during a stretch of time, extending to the present, which may be termed the formative period of industrialism; while the introduction of electric power brings forward a third advance in power usage offering to the maturing aspects of industrialism a special service needed to carry forward its complex and constantly enlarging activities. Just as steam power opened up the coal fields of the world and freed the employment of power from the geographic restrictions inherent in the use of the pressure of falling water, so electricity reinstates water power on terms of equality with coal, offers the means for the transmission of energy devoid of bulk, and affords a readiness of subdivision and ease of application that considerably enlarges its range of applications.

Thus the third and current stage in the growth of power utilization, and that is to say, of industrialism, is marked by the introduction of water power on terms of parity with coal, by the establishment of facilities



MAP OF NORTHERN ITALY SHOWING CENTRAL STATIONS AND ELECTRIC TRUNK LINES

for extracting energy from coal at the mines and transmitting it to the points of use, and by the development of means for greatly facilitating the range of service that energy may be called upon to render. It will be observed that although the three lines of advantage have been open for some years, the first has met with but partial acceptance, the second has been entirely ignored, while only the third has enjoyed any considerable measure of service. This status of affairs, of course, is the outcome of commercial selection, but it is desirable to examine whether industrialism can continue to grow in adequate measure without utilizing more fully and comprehensively the opportunities held out by electricity.

The United States places special emphasis upon the use of power. With national prosperity, abundance of resource wealth, and dearth of labor, American industrial enterprise has naturally turned to the creation of labor-saving machinery and provided for its efficient employment through the medium of standardized volume-production. Thus the fabric of American industrialism is colored by the machine process and the large-scale operation to a degree not equalled elsewhere in the world; while mechanical appliances and mechanical service have reached out into domestic life in a pervasive manner. These conditions have created and sustained a scale of living without parallel amongst other nations. To support this situation, this country consumes nearly half of the world's output of coal and over half of the total production of petroleum, not to mention the employment of water power, natural gas, and minor sources of power.

This unprecedented consumption of power, of course, places a heavy strain upon transportation, both directly by virtue of the bulk of the power materials to be moved—coal alone represents over a third of the country's freight—and indirectly in respect to the haulage of materials and products involved in the industrial processes. The responsibility thus falling upon transportation is added to in further degree by the size of the country. The presence of a population scattered over a vast area, with a standard of consumption cut to the measure of a concentrated industrialism, attaches the element of distance to the factor of bulk and imposes an accentuated dependence upon adequate carriage. Thus in two respects the transportation problem in the United States is unique.

But national dependence upon transportation, so highly developed by virtue of the advanced state of industrialism and the areal extent of consumptive demand, is increasing. The rapidly enlarging use of power and the growing burden of commodity haulage arising in consequence, to say nothing of the claims of foreign trade, give no prospect of letting up. Every time an individual adopts a mechanical appliance or purchases an article hitherto made at home or gone without, thousands of others are doing the same thing. Society will not turn back now; presently it can not turn back any more than it can to-day weave its own garments by hand. The convenience of to-day is the necessity of to-morrow. If we project the present trend of requirements even 10 or 15 years into the future, we begin to gain a true perspective of the imposing weight of the transportation problem that industrialism faces.

Since transportation is called upon to bear a heavier responsibility in the United States than is the case elsewhere in the world, it should be observed that there is an element of weakness in the functioning of transportation which becomes the point of break under strain and therefore merits particular attention in this country. This is the matter of differential elasticity as between the operations of industry and transportation, which prevents an equalized stretching of the two. For example, when a ton of material passes through a manufacturing plant it means, with due qualifications, that the railroads have hauled a ton of raw material from far and wide and will move a similar weight of products away for distribution. Thus each increment to the volume of manufacture creates a twofold addition to the volume of transportation. Induce a stress of industrial expansion and the stress communicated to transportation is correspondingly magnified. The fabric is mechanical in each case; but the fabric of industry is woven with the maximum of elasticity, while the fabric of transportation is inherently more rigid. Thus one of the knottiest problems in the whole advance of American industrialism has been involved in the necessity for providing the requisite capacity on the side of transportation. The problem is serious enough at best. But when the item of power in the form of freight-hauled coal is added, the requirement calling for additional elasticity in the mechanism of transportation is almost doubled a second time, and the situation becomes well-nigh impossible to meet. So long as power is provided by means of freighted coal in its present heavy proportion, the transportation of the country is bound to cause serious trouble, if not to break down, during every period of sudden industrial expansion.

The principle of multiple production and the principle of electricity are the two most important economic forces that have come into play during the current industrial order. Nothing since the introduction of steam power can be compared with either of them in significance. Both are radically at variance with the established order; both have a special bearing on the power supply as affording untold possibilities for marked betterment. Neither has won recognition in this field provocative of notable change in the basic conventions of procedure. Here each alike has been ignored, except in so far as its advantages have gained lodgment within the establishments of precedent. Of the two electricity has made the greater headway; multiple production has not yet found an opening outside the confines of the coke industry and has succeeded in preempting only half of that field. Neither electricity nor by-product coal utilization has entirely been neglected, but the real possibilities for the common good so bountifully contained in each have never been cultivated in the least.

In the realm of power these two great agencies of economic advance are exactly complementary. Together they present a solution for the transportation aspects of the power problem, not to mention their bearing in other regards. The principles of multiple production enables the full utilization of the whole range of values transported in the form of coal. Electricity makes it possible to transmit *energy* where energy alone is required and thus frees the ordinary channels of transportation of a needless burden of bulk haulage. The first would determine the amount of coal needed and insure the adequate employment of that amount; the second would make it unnecessary for the railways to haul more than the amount thus determined. The outcome merely waits upon the application of these two economic forces in effective coordination.

Before the advent of electricity energy was inseparable from a material expression, and the economics of power usage grew up under the exigencies of this dependence, as illustrated in the distributive use of coal. But now a command of the electrical principle makes it possible to deal with energy freed from substance. This not only concerns coal by providing the means for extracting the energy at the point of production, instead of at the many points of use, to the gain of efficiency and the saving of transportation; but it applies also to water power, a resource hitherto fallen into disuse because of its inability to cope with coal, but reintroduced by electricity upon more advantageous terms, to the practical gain of a new energy resource. In spite of the fact that electricity has been in common and growing use in this country for many years, it has effected practically no change in the basic conventions of coal usage and has led to the development of a small fraction merely of the available water power.

Since electricity has rehabilitated water power, thus making available two energy resources where there was only one before, it is desirable to determine the resource status of water power as compared point for point with coal power, for the two are coming, of necessity, into competition, and unless water power in its new habiliment can stand on a reasonably equal footing the outcome of the competition is bound to fall in favor of coal, as occurred before when steam power drove hydraulic power to the wall. In which event water power, in spite of its ethical advantages, would have no special significance for the present.

In respect to the size of the resource reinstated by electricity, there can be no fault to find. Efforts to determine its magnitude have led to estimates placing the possibilities of hydroelectric development in the neighborhood of 200 million horsepower, of which some 50 million is capable of use without special provisions for storage. Expressed in another manner, the water power of the United States, converted to electrical energy, is more than capable of turning every industrial wheel and illuminating every street and building in the entire country. Also the resource is country-wide in distribution. The apportionment amongst the various sections is by no means even, but the supply is more widely and equably spread than is the case with the coal fields; and the regions distant from the sources of coal are all bountifully favored with water power. Thus New England, the South Atlantic States, the Southwest, and the Pacific slope, together embracing over half of the potential water power of the country, are all practically without coal and bear testimony to this complementary distribution of power resources.

But in spite of the advantages of size and wide distribution enjoyed by water power, this resource has not been able thus far to enter into serious competition with coal. Only some 10 per cent of the total expansion in power consumption in recent years has been in the direction of water power. The present production of hydro-electricity in the United States represents roughly the equivalent of 40,000,000 tons of coal, whereas nearly 400,000,000 tons of coal goes into the production of steam power and carboelectric power. The water power developed to date is around 10 per cent of that readily available; scarcely 3 per cent of the total open to development under elaborate arrangements for storage.

The favorite explanation for this laggard growth on the side of water power ascribes the whole trouble, either directly or inferentially, to the handicaps imposed upon private initiative by the inadequacies of Federal legislation. The facts do not bear out such conclusion further than to accredit this factor with contributive importance. Federal permits are requisite to the development of 75 to 80 per cent of the potential water power of the country, the balance being accessible so far as Federal permits go. About 4 per cent of the restricted portion and about 25 per cent of the part outside Federal surveillance have been actually put to work. The discrepancy of 21 per cent between the two is impressive, but even granted that this is attributable wholly to Federal interference, which is not the case, it will be seen that the non-development of three-quarters of the potential water power of the country remains to be accounted for on another basis. In other words, the quality of Federal legislation, even under sweeping concessions to its untoward effect, provides but a minor element in the complete explanation.

The distributive generation of electric power was natural enough and the only practical procedure so long as the use of electricity was small. But that time has passed. Electricity is now a commodity in everyday use, with a large and steadily growing aggregate demand; to adhere to the original practice bespeaks obsolescence. Such escape as has been made from the confines of stagnation has been almost wholly in the direction of hydroelectricity. So, in spite of the great amount of talk and publicity that centers around the water-power issue, there is more evidence of basic progress on this score than may be found on the side of coal power. All that may be fairly said in dispraise of the progress of this country in respect to water power is likewise true as regards coal power. In fact, this country does not face a water-power problem as such; the issue is more broadly a power problem, of which water power constitutes only one important segment.

The influences holding back water-power development are of a threefold order. These do not operate separately, but in conjunction with one another. Water power development stands in need of special consideration; instead, it meets with special opposition. There is none to work in its behalf except those with special objects in view, and the recognition of this quality in their efforts has gone to establish opposition. The contention in this wise has grown to be organized on both sides, with each alike oblivious to the real community of interests involved and legislative action caught fast in an entanglement of compromise. In all three respects the situation is in a deadlock and the likeliest chance of a break toward progress lies in the entry of a new standard in the field, a standard under which the rights and best interests of all concerned can have the assurance of fitting recognition.

The carboelectric issue, on the other hand, is far less advanced and correspondingly less complicated. It has scarcely progressed beyond the general setting of inertia which characterizes the failure to locate power stations at the source of fuel supply and still determines their establishment distributively at the points of use. There have been no special interests involved to stimulate any particular activity otherwise; there has in consequence arisen no basis for the provocation of organized opposition or legal byplay. The hydroelectric issue has been seen to stand in need of a new standard; the issue of carboelectricity has not even been popularly recognized. Ordinarily, under such conditions, sporadic activities appear over the even surface of apathy as precursors to an organized effort to follow. In this case there has been an obstacle to check such sporadic beginnings. It is the obstacle of initial cost expressing itself in the matter of electric transmission lines.

Purchased Stock of Incandescent Lamp Company

The capital stock of the Franklin Electric Manufacturing Company, of Hartford, Conn., has been purchased by the Westinghouse Lamp Company. The Westinghouse Lamp Company announces that the corporate identity of the Franklin Electric Manufacturing Company will be continued and that manufacturing operations and sales activities will be conducted under management of the present personnel. The only notable change among the officers of the Franklin Electric Manufacturing Company has been the election of Mr. Walter Cary as president, succeeding the late Jonathan Camp. Both the Franklin Electric Manufacturing Company and the Westinghouse Lamp Company are manufacturers of incandescent lamps.

As to Electric Power in Mines

The approach of peace has materially altered the plans of the Production Bureau of the United States Fuel Administration for conserving electric power used at coal mines. It has been planned to establish a field organization throughout the coal producing fields of the country in connection with obtaining increased efficiency in the use of electric power in coal production. The returns to peace conditions will make this organization, which was outlined in a statement recently issued by the Fuel Administration, unnecessary, and the work will be undertaken on a restricted scale.

Three-Phase Currents in Mining Work

THE United States Fuel Administration had planned, through its production bureau, for a conservation of electric power used at coal mines. The idea was to establish a field organization throughout the coal-producing fields of the country in connection with obtaining increased efficiency in the use of electric power in coal production. The return of peace conditions will make this organization, which was outlined in a statement recently issued by the Fuel Administration, unnecessary, and the work will undoubtedly be undertaken on a restricted scale.

Great Britain has made extensive use of electric power in its collieries, and a recent issue of *The Quarry* discusses one feature of this that has proved a certain source of trouble. The writer declares that three-phase currents have come to stay, so far as mining work is concerned. The extreme simplicity of the squirrel-cage induction motor, the entire absence of a commutator in all forms of induction motors, except a few very special designs, and the great convenience with which large amounts of power can be transmitted over long distances, and their pressures converted to any figure that may be desired at the points of consumption, he says, have given the three-phase service an enormous pull over the continuous current service, which was first used for lighting and power in mines. Moreover, the use of three-phase currents for the main power system does not preclude the use of continuous currents where these are necessary or advisable, and it is also perfectly feasible to run any continuous-current generators, that are already on the ground, by three-phase motors, and so to continue the use of the continuous-current plant, while economizing in the cost of generation and bringing the whole system of transmission and distribution into one power house.

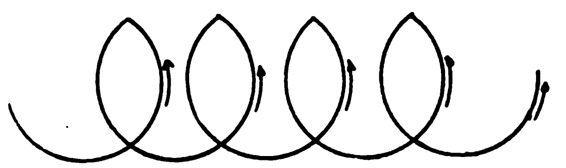
But the development of the distribution of power by three-phase currents has gradually revealed a source of trouble, the cause of which may be summed up in the necessity for the use of the power factor in all calculations where alternating currents are employed. It will be remembered that the simple calculations for power that are employed with continuous currents have to be modified, when alternating currents are employed, by the addition, to one side of the equation, of cosine ϕ, known as the power factor. As the power factor is always less than unity, this means that the actual power transmitted from a generating station, or received by an electric motor, is less than it would be, for the same pressure and current, if continuous currents had been employed. In a few cases, with alternating currents the power factor is very near unity. With incandescent electric lamps, for instance, it may be as high as 0.95, which practically makes no difference in the calculation. On the other hand, cases have been reported of induction motors working with as low a power factor as 0.5, while a very common figure for the whole of the service at a colliery is 0.7. These figures mean that a motor having a power factor of 0.5 is only able to deliver less than 50 per cent of the apparent power that the electric currents deliver to its coils; and in the case of the complete system which has a power factor of 0.7, the generating station is able to deliver less than 70 per cent of its apparent output. With a generating station, for instance, designed to furnish 1,000 kw. with unity power factor, something less than 700 will be furnished at 0.7 power factor. The reason for the output being less than 70 per cent is that, in addition to the actual lowering of the output on account of the power factor, there is a wattless current—also equal to 70 per cent of the output—that circulates through the coils of the armatures of the generators, delivering additional heat to them, and lessening the useful current that can be allowed to be delivered by them. It will be remembered that the output of any generator or any motor is limited by the heat liberated by the current circulating in their coils. If currents above a certain strength are allowed to pass through the coils, there is a danger that the heat liberated will damage the insulation from the increased temperature, and from the pressure that the expansion of the conductors exposes it to.

The power factor may be of two kinds, due to a lagging current or a leading current. With three-phase currents, of course, there will be three lagging (or three leading) currents. In colliery work a leading current is not often met with, but is a great boon where it is; but in large distribution services, such as they have in America, where very large areas are covered, the leading current is very often an important factor in the transmission. In California, for instance, power is transmitted 154 miles from a large power plant at Big Bend to Oakland, opposite San Francisco. The power is transmitted at a pressure of 100,000 volts, and provision is made for 10,000 kilo-volt-amperes at Oakland. When the transmission lines were connected to the busbars at Big Bend, before connection had been made at Oakland, the circuits being quite open at that end, a leading current of 48 amperes was found to be flowing into the transmission line.

In colliery electrical installations it is the lagging current and the lagging power factor that form the trouble. As will be explained later, leading currents are being artificially introduced into mining installations in order to neutralize the lagging current. A leading current having a power factor of 0.7 would bring the resultant power factor up to unity and release the locked-up power in generators and motors mentioned above. The leading current in the Big Bend-Oakland transmission system must be a real boon to the engineers who are working the electrical supply from the sub-station at Oakland if they have many induction motors in service.

The lagging current, the lagging of the current behind the pressure which causes it, is due to electro-magnetic induction between the wires on the generators, motors, etc., in which the currents are circulating, whilst the leading current, the current being in front of the pressure that causes it, is due to electro-static induction in the condensers, of which the conductors carrying the transmission currents form part. There is a lag and a lead with continuous current, but they are of no consequence, because they only slightly delay the starting up of the apparatus that is using the current, the delay being so small that very sensitive instruments would be required to show its presence.

Fig. 1.



When an electric pressure is applied to the two ends of a conductor, a current does not instantly circulate through the conductor, even when it is a straight over-head conductor, apart from every other. If sufficiently sensitive apparatus is available, it can be shown that a certain definite but very short time elapses between the closing of the circuit, the application of the pressure to the conductor, and the circulation of the current through the whole length of the conductor. It has, on the one hand, to create a magnetic field round every portion of the conductor before it can pass on, and also to charge every portion of the electro-static condenser. When the circuit is opened, the energy that was taken from the current to create the magnetic field and to charge the condenser returns to the conductor, circulates through it, and creates a temporary pressure, leading to the sparking and other troubles with which all are familiar when a switch is opened or a cable is broken.

When the current circulates through a coil of wire, as it does in the case of the electro-magnets forming the armature coils and the field magnet coils of generators and motors, a new factor is introduced, called self-induction. It will be remembered that when two conductors are arranged side by side and parallel with each other, if a current commences to circulate in one direction through one of the wires, a current in the opposite direction will immediately commence in the other conductor. In a coil of wire, such as that upon the armature of a generator, the adjacent turns of wire act as independent conductors. In Fig. 1, calling the turns that are on the same side of the coil 1, 2, 3 and 4, when the current commences in 1, a current will commence in the opposite direction, in 2, also in 3 and in 4; but it must be remembered that turn No. 2 forms part of the coil with turn No. 1, and the reverse current in turn No. 2 will lessen the strength of the current flowing in turn No. 1—that is to say, in the whole of the coil. What happens between turns 1 and 2 happens between all the turns. As the current commences to flow through any individual turn, currents in the opposite directions commence to flow in all the other turns near. The resultant action is very complicated, as the reverse currents also act inductively upon the conductors in which the primary currents are circulated, tending to increase them. In addition to the above, the lines of magnetic force created by the current have an important effect upon the inductive action between the currents circulating in the coils. The same action takes place between the different turns of the coils when any change takes place in the strength or direction of the currents. Any increase in the strength of the current in one turn of the coil causes a tendency to a reverse current in all the other turns, whilst any decrease causes a tendency for currents in the other turns in the same direction as that in the primary turn. Remembering that alternating currents are continually changing in value and in direction, it will easily be understood that those circulating in each turn of the coil are constantly inducing currents in the opposite direction in all the other turns, and that the direction and number of the lines of magnetic force in the magnetic circuit for which the coils are furnishing current will also be constantly changing in value and in direction. The net result is that the passage

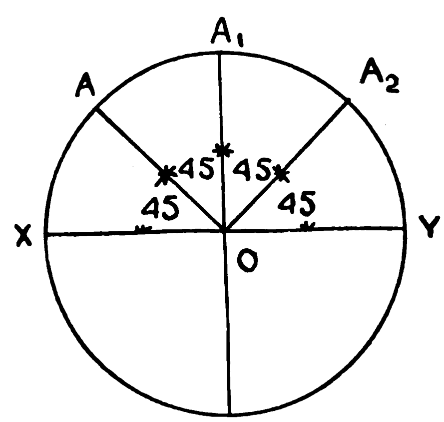


Fig. 2.

of alternating currents through the coils is delayed after the pressure giving rise to them is applied to their terminals, and the delay is increased by every additional turn in the coil and by every change in the strength and direction of the current. The self-induction of a coil with a large number of turns is very much greater than that of one with a smaller number, and it also varies directly with the number of cycles, being greater with a service of 50 cycles than with one of 25, and greater with one of 100 than with one of 50. This is why the periodicity of power services is being reduced. It is this self-induction that causes the current to lag, and brings the power factor into the power equation. Fig. 2 is an elementary diagram showing how the lag of the current behind the pressure affects the power equation. The sines of the successive angles swept out by the radius of a circle, such as O A as it revolves around the center O, may be obtained by dropping perpendiculars from the ends of the radius in whatever position it may be at any instant on the base line X O Y. The values are given in any table of sines. In the diagram the radius is supposed to revolve from the position OX to OA; then to OA_1, then to OA_2, and then to OY. At OA and OA_2, the radius makes angles of 45 degrees, with both the base line and the perpendicular OA_1. The positions OX and OY represent the zero values at the commencement and at the end of the first half of the cycle; the position OA_1 represents the crest value, the maximum value to which pressure or current attain in the first half of the cycle. It will be remembered that the effective, virtual or working pressure with alternating currents has a value of 0.707 of that of the maximum or crest pressure. In the diagram, the lines mentioned represent successive values of the pressure and current. At the commencement, OA represents the pressure, OX the current, 45 degrees behind; when the pressure has moved on to OA_1, the current will have reached OA, still 45 degrees behind; when the pressure has reached OA_2, the current will be at OA_1. It will be remembered that the power delivered to any electric current is found by multiplying the pressure by the current. In the first position the pressure is represented by the value 0.707 of the maximum, whilst the current is represented by 0, so that the power delivered is 0. In the next position the pressure is represented by 1, and the current by 0.707, so that the power delivered will be 0.707. At the next position the pressure is at 0.707, and the current at 1, so that the power is again 0.707. In the next position the pressure is 0, and the current is 0.707, so that the power delivered is 0. These positions are merely taken as illustrating one case, and a few definite positions therein. The case where the current lags 45 degrees behind the pressure is taken because it is a common one in colliery distribution plant, the power factor being 0.7. It will be seen that when the pressure was 0, at the commencement of the cycle, the current was –0.707, and that as the pressure increases, the value of the current also steadily increases, being always less than the pressure until the pressure passes the crest. By taking a large number of values, of both pressure and current, throughout the cycle, it will be found that the resultant value of the factor that has to be applied to the equation is the cosine of the angle of lag, in this case 45 degrees, and, as shown by the table of cosines, its value is 0.707, or, shortly, 0.7. The examination that has been made of the case of the current lagging 45 degrees may be made for any other angle, and it will be found that the larger the angle between the two, the smaller is the amount of useful power actually delivered.

Demand for Electrical Machinery in Switzerland

Consul Philip Holland writes as follows from Basel, Switzerland: The demand for electrical machinery and equipment was heavy throughout the year. As the use of gas was cut to less than half of the normal needs, and wood and coal were scarce and dear, efforts were made in private homes and in industrial plants to replace heat and power with electricity. Raw materials, especially electrotype copper, could not be had in sufficient quantities to meet the demand and prices rose to many times the normal. Large electrical machines could not be sold or delivered without Government permits. Electrical insulations, especially high-tension insulations, were in demand. These were manufactured and sold profitably in the district and also exported to France and Italy. A new industry for manufacturing electric heaters was established and was able throughout the year to dispose of its product. This heating apparatus is constructed of composite stone, with inside wiring, and heats during the night at a low current rate. The industrializing of the small villages has created a heavy demand for small motors. In almost every village in this district there is some kind of factory which gives employment to the inhabitants between the crop seasons.

Consul W. P. Kent writes from Berne: The shortage of coal, essential to Swiss industry, has caused the exploitation of the Swiss turf fields and increased the use of Swiss wood. Industrial plants have sought to replace steam power by electricity, as have also the railways, small sections of which are being electrified. The electrification of all lines is planned, but owing to the shortage of material, especially copper, such works progress slowly.

Coal Saving by Eastern New York Power Companies

Coal saving at the rate of 5,000 tons a month has been effected by six power companies of Eastern New York through the operation of a plan of joint operation and the use of water power heretofore wasted, undertaken at the suggestion of the Fuel Administration. This record in coal conservation was effected without a change in existing equipment or additional cost to the power companies, and the success of the plan has been so marked that the companies interested are anxious to continue it.

The companies which combined and carried out the plan through a joint committee made up of their regular organizations, serve what is known as the "Capital District," including the cities and towns of Albany, Troy, Schenectady, Amsterdam, Mechanicsville, Cohoes, Saratoga, Glens Falls and adjacent territory. In the hands of the joint operating committee and using the available resources of the six power companies a two weeks' test was begun on October 23. In that period electric energy equal to that generated by the burning of 2,450 tons of coal was developed from existing equipment, and the natural river flow which otherwise would have gone to waste. The generating companies were thus able to market heretofore unused power, and the coal-burning companies were able to get power at a saving over their own costs.

Following are the companies co-operating in the joint operating plan: Adirondack Electric Power Corporation, Glens Falls, N. Y.; Cohoes Power Company, Cohoes, N. Y.; General Electric Company, Schenectady, N. Y.; Hudson Valley Railroad Company, Mechanicsville, N. Y.; Municipal Gas Company, Albany, N. Y.; Schenectady Power .Company, Schaghticoke, N. Y.

Some time ago the Fuel Administration, with the co-operation of the power companies, made a thorough investigation of power conditions in Eastern New York. As a result of this investigation, the power companies were asked to combine in a program of joint operation, a plan made possible by connecting transmission lines already in existence, and the substitution of water for steam power. This was promptly agreed to, the available resources of the companies were placed in the hands of the joint committee and an operating department appointed to carry out the distribution of water power.

Using the existing equipment and organizations, and without additional labor cost, a two weeks' trial was commenced. At the end of that period, "there was such unanimity of thoughts, says the report to the Fuel Administration, "that the question of continuing did not enter into the discussion of the joint committee, but simply the endeavor to secure the success of the scheme by agreeing to the costs of power sold by the hydro-electric companies to the coal-burning companies in place of burning coal."

Electric Drive in Silk Mills

By Charles T. Guilford

THE silk industry in America may be said to have started about 1826, at which time silk culture was attempted with some degree of success. This period was brief, lasting only about ten years, but long enough to bring into existence silk throwing, spinning and weaving, which has grown steadily ever since. Permanent manufacturing was established by the end of this period and its growth is shown by Government statistics, as follows:

In 1849 the value of the silk products in the United States was $1,809,000 and represented 67 factories. This grew in 1859 to 130 factories, and again fell off in 1869 to 86 factories. From this time on, the growth was uniform and rapid, until in 1914 the value of the silk products reached the figure of $254,000,000, representing 904 factories with an aggregate of 117,000 h.p. Assuming that the rate of growth has continued during the past four years in the same ratio as from 1909 to 1914, the value of the products would be to-day $288,-000,000 with an aggregate of 128,000 h.p.

At the present time the silk manufacturing industry includes the manufacture of finished silk products, such as woven fabrics, braids, trimmings, sewing, embroidery and floss silks; machine twist, thrown silk and spun silk. The power used in silk mills in the early days was the same as that used by most pioneer textile industries, viz.: water power. On this account, mill sites were selected on or near streams giving the necessary power.

With the development of the industry, along with other industrial enterprises, available water sites were taken up and new enterprises or extensions of the old ones were obliged to resort to power produced by the steam engine. This power has, until recent years, been supplied by a power plant built as part of the mill and operated by the mill owners. Both the waterwheel and steam engine transmit their power through shafting pulleys and belts to the machines to be driven, but water power, although more uniform in speed than steam power, has been superseded largely by the steam engine because of the lack of a uniform and sufficient supply of water for increased business.

The steam engine has been the principal source of power in silk mills for many years, but is in turn giving way to the steam turbine or to power bought from a central power station. In either case the motive power used at the mill is electric with the motor to transmit it to the machinery. The speed thus obtained is uniform instead of pulsating, as with the steam engine, and can be maintained at a fixed maximum.

On account of modern development and efficiency, the central electric power station is able to supply power to mills at a quality and rate superior to that developed at the ordinary mill power plant and is, therefore, destined to become the sole source of power for these plants. The business of the central station is to produce power and give first-class, continuous service. They, therefore, are specialists in this line, and since they produce power in large quantities, with up-to-date and efficient machinery, they are able to give better service at lower rates than can be obtained at the individual mill power plant. Some of the advantages of the central station are as follows:

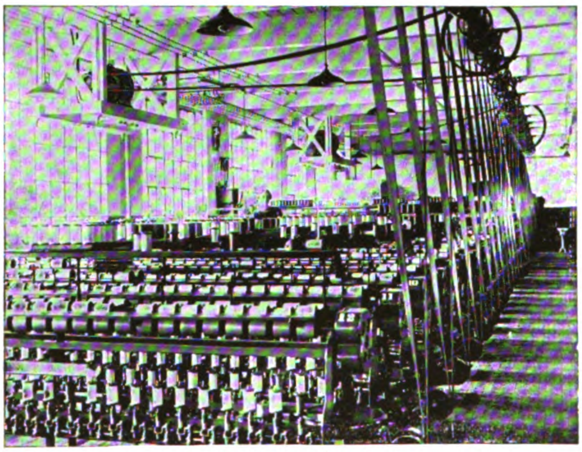
1.—Low Cost of Power. Most central stations have equipped their plants with apparatus especially adapted to take on mill loads and have, therefore, adopted as part of their business campaign among mills a schedule of power rates which are lower than the cost of power produced at the ordinary mill power house with steam engines.

2.—Uninterrupted Service. One of the most important requisites for a mill is that the power service should be continuous and available at all hours. The modern station has provided auxiliary machinery, switchboard protective devices, lightning protection for transmission lines and transformers so that former causes of interruption of service rarely occur. In addition, the service is available night and day, noon hour and Sundays, which is frequently necessary and always desirable at the mill.

3.—Overload Capacity. The matter of temporary or permanent overload in a mill, often causing loss of speed and hence loss of production, is amply provided for by the reserve power of the large units at the central station. Overload is automatically taken care of by the station and the mill has the privilege of adding or cutting off at will.

4.—Location of Mill. As the central station can bring its electric line to any location within its district, the manufacturer may locate solely with reference to the convenience of manufacture of the goods, and the site convenient for water power, facilities for getting fuel supply, condensing water, etc., are factors which may be eliminated.

5.—Decreased Insurance. As the substation for power supply to a mill is located outside of the mill in a specially constructed house, and as electric lines, motors and switches are all thoroughly protected with devices approved by both fire and liability insurance companies, and as steam engines and boilers are eliminated as risks, insurance—including fire, liability, steam engine and boiler—is materially reduced.



ELECTRIC DRIVE IN SILK MILL
A group electric motor drive applied to first time single deck and 2-C spinners

6.—Cleanliness. As the central station service consists of transformers, wires and motors, all of which are non-dirt and non-smoke producers, the mill is rid of dirt from coal-handling smoke from the boiler house, dirt, dust and oil from large transmission shafting, pulleys and belts.

7.—Power Supervision Simplified. The general supervision of the mill power plant, buying of fuel and supplies, making repairs and the necessary clerical work and bookkeeping are done away with.

The application of central station power through the electric motor is the most modern and efficient method for driving silk machinery and it possesses certain distinct advantages over any form of drive yet devised. The motor which is best adapted for this work is the alternating current, constant speed motor. Its advantages are:

1.—Uniform Speed. This motor will maintain a uniform maximum speed and will transmit this to the machines without change during the entire time of operation. This speed is not dependent upon the operator, but is automatically controlled by the uniform speed of the generators at the central power station. The result to the silk manufacturer is, therefore, an increased production of goods and a better quality of goods than can be obtained with the steam engine or gas engine drive.

2.—Cleanliness. In the case of individual drive, all shafting is eliminated with the result that dirt or oil throwing is absent.

3.—Facility of Increase. If additional machinery is to be installed in a mill or if it is desirable to rearrange present machinery, both may be done with motor drive without reference to the power plant or mill shafting drive. Power supplied from the central station makes it possible to install motors of the exact size for the additional machinery and to place them and the machines in any desired location.

There are three general methods of driving silk machinery by electric motors:

1.—By one motor to drive the entire mill, if a small one, or several motors, each to drive a section of the mill.

2.—By motors, each arranged to drive a group of machines of similar type or so-called "group drive."

3.—By a motor to drive each individual machine or so-called "individual drive."

The first method possesses one distinct advantage over the steam engine, viz.: it gives to the whole system of drive a uniform, constant speed, which results in more and better production. This method, however, is seldom used, as it still requires all transmission shafting, belt and pulleys throughout the mill.

Group Drive.—The second method, or "group drive," possesses the advantages of low first cost and the elimination of the main transmission lines, hangers and belts. With this method, the mill is usually divided into sections comprising part or all of the machinery required for one process. It is specially adaptable for machines which require a small amount of power. In this case, a motor is conveniently placed so as to reduce the shafting and belts required to a minimum. This has the advantage also of permitting part or all of a process to be run as required and of preventing a shut-down of more than a small part of the mill due to accident. This form of drive has been adopted in a number of throwing plants, ribbon and broad silk mills.

An example of a ribbon silk mill using group drive is here given: Before adopting electric drive for this mill, tests were made to determine the costs of power under the existing conditions and under the proposed conditions of electric drive, with the following results:

Estimated yearly cost of heat, light and power under existing conditions	$7,239.70
Estimated yearly cost of same with proposed electric drive	5,993.60
Yearly saving	$1,246.10
Estimated cost of motors, control and wiring complete	$3,926.00
Estimated return on the investment	31.5%
Actual cost of motors, control and wiring complete	$3.926.00
Salvage value of old apparatus	1,500.00
Net cost of installation	$2,426.00
Actual yearly saving (checked by meter readings was slightly less than estimate of $1,246.10)	$1,246.10
Actual return on the investment	51%

In addition to the above, speed tests were made both before and after the installation of motors to determine the relative production. The records taken over a long period of time showed an average net result in increased production, due to the electric drive, of 7 per cent.

This mill had one 10-h.p., 860-r.p.m. motor in the finishing room; four 5-h.p., 860-r.p.m. motors for warping; eight 5-h.p., 1,140-r.p.m. motors for weaving; one 3-h.p., 1,140-r.p.m. motor for winding; one 3-h.p., 1,140-r.p.m. motor for doubling, and two ¾-h.p., 1,140-r.p.m. motors for winding. In addition, there was one ½-h.p., 1,140-r.p.m. motor in the carpenter shop.

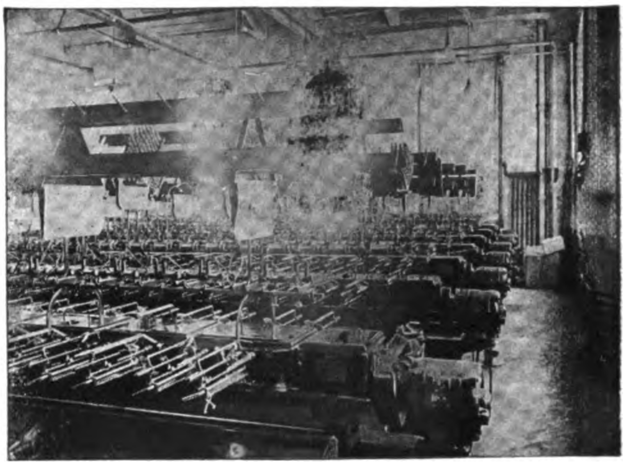
In a throwing mill having group drive, the motor equipment was as follows: Two 50-h.p., four 35-h.p., one 25-h.p. and one 15-h.p., all with 1,170 r.p.m., and two 5-h.p., 1,735-r.p.m. These operated 1,612 spindles. The power consumption was as follows:

1917	Kw. Hours	15 Min. Max. Demand	Net Bill
January	74,000	192	$644.60
February	68,800	192	616.00
March	77,700	210	687.22
April	66,800	216	634.70
May	70,200	210	645.97
June	66,100	198	608.57
July	59,000	204	576.95

A broad silk mill having group drive had the following motor equipment: One 20-h.p., 1,160-r.p.m.; two 15-h.p., 1,155-r.p.m.; one 7½-h.p., 1,740-r.p.m., and one 5-h.p., 1,140-r.p.m. These operated 373 looms, 24 winders, 21 warpers and 4 finishers. There was also one 4-h.p. motor for freight elevator.

Individual Drive.—The third method, or "individual drive," is the most satisfactory and is being adopted for most of the new mill installations, and also in a large number of cases in changing over present machinery. The definite advantages due to this drive are as follows: Increased production, cleanliness, absence of belts and line shafts, flexibility of location of machines.

This method has met with marked success in silk weaving, and instances have shown that an increased production of from 5 to 15 per cent has been realized, due to the uniform, maximum speed which is only possible with this form of drive. This increased production, of course, means increased profits for the mill and may be illustrated by the following example, which is one of a number of test cases:



INDIVIDUAL ELECTRIC DRIVE
A modern silk mill equipped with individual Westinghouse motor drive applied to silk winders

In this particular mill, the estimated value of the output of a loom for a year was $5,500, made up as follows: Material, 50 per cent; labor, 20 per cent; overhead, 15 per cent, and profit, 15 per cent.

The increased production in this mill, due to individual loom drive, average 8 per cent. This gave, then, 8 per cent of $5,500, or $440, increased production on each loom per year. The cost of this increase would be 20 per cent for labor and 50 per cent for material as above, or:

$$.20 \times \$440 = \$88.00$$
$$.50 \times 440 = 220.00$$
$$\text{Total} \ldots\ldots \$308.00$$

The net gain per loom per year would then be $440 less $308, or $132.

This net gain per loom would, in nine months' time, pay for an entire individual motor drive (necessary to run the looms) completely installed and ready to run. After this, the gain would represent a net profit to the company—and in this mill of 1,000 looms—800 of which are readily changed to electric drive—would represent the handsome net gain each year of $105,600.

Photometry as a Commercial Aid

PHOTOMETRY is to the illuminating engineer what the rule is to the carpenter, the scales to the grocer, or the thermometer to the chemist. It has made possible the vast accumulation of data on which the science of illuminating is built and furnishes a means whereby the accuracy of the theory is checked. Photometry and illuminating engineering have advanced hand in hand. The advances made in illuminating engineering have been made possible chiefly by the use of photometry and on the other hand photometry has been developed to meet the growing demands of the engineer.

The first literature on the subject was a book published by Lambert in 1770, said Mr. George C. Cousins, in an address before a recent meeting of the Toronto members of the Illuminating Electrical Engineers. Until recent years photometry was used only to measure the candle power of light sources, but its use is now very extensive and includes many uses not thought of until recently. The earliest experimenters in photometry realized that the strength of light could not be measured directly but that the intensity of one light could be expressed in terms of that of another which thus becomes an arbitrary standard with which the unknown light must be compared. This is the principle of all practical photometry at the present time.

Photometry is used at present mainly for the measurement of candle power, flux, illumination intensity and surface brightness. This classification does not include spectro-photometry and objective photometry, the one being a rather specialized branch and the other a method by which the human eye is eliminated as the measuring instrument. The eye simply reads the result of the measurement by observing the position of a pointer on a scale. Objective photometry is based on the principle that under certain conditions small currents will flow from certain metals when exposed to light. These currents are proportional to the intensity of the light causing them and are used to deflect a mirror of a galvonometer or electrometer, the magnitude of the deflection indicating the intensity of the light. This has not yet graduated from the experimental laboratory and it is necessary for us to fall back on the eye as the final referee; upon its ability to judge equality of brightness, or to detect small differences of brightness, depends the success of a determination. The eye is effective in making such a determination with any degree of accuracy only under precise conditions. The two lights being compared must be of the same color when presented to the eye. If a difference of color exists in the lights themselves some means must be used to change one or both. The most commonly used method is the use of colored glasses to absorb some of the excess color of one light. The transmission of these glasses must be known and compensated for in the interpretation of a result.

In a laboratory where conditions are under good control a flicker photometer may be used to measure lights of different color. This presents the two colors alternately at such a rate that the resulting sensation is that of a single color, which is a blending of the two. The speed of the alternations must be such that the flicker disappears when the photometer head is at a certain point between the two lights and reappears with a slight motion one way or the other. In other words, when both lights are of the same intensity at the photometer head the flicker disappears and the slowest speed that will accomplish this is the most sensitive for the instrument.

A discussion of photometry naturally leads to a discussion of light sources and each has its effect on the other. Some types of photometers are suitable for the measurement of some light sources and not for others. The advent of the gas-filled lamps caused more extensive changes in the practice of photometry than any other single event for a great many years and it might be well to consider the differences between the vacuum and gas-filled lamps that necessitated such changes.

Before gas-filled lamps appeared on the market the vacuum lamps were commonly rated according to their mean horizontal candle power and this rating gave a very fair means of comparing different lamps of the same type. However, for many years lamp and illuminating engineers, especially the latter, had realized that this rating was not altogether satisfactory. In order to use existing lamp data in illumination calculations it was necessary to convert the value of candle power, which is the intensity, into one of total light flux, the unit of which is the lumen. This conversion is done by determining the ratio of mean spherical to mean horizontal candle power and then multiplying the mean spherical candle power by the factor 12.57 (4) to obtain the lumens. This ratio of mean spherical to mean horizontal candle power is constant for vacuum lamps of each type, but its determination is a long, tedious job. In spite of its short-comings, however, the candle power rating had become so deeply rooted that it was too big a task for any isolated body of engineers to make a change.

Now when gas-filled lamps were measured for mean horizontal candle power in the ordinary way some very peculiar results were noticed. With the lamp stationary, the candle power was lower and the current higher than with the lamp rotating at the ordinary speeds, at the same voltage. This higher efficiency while rotating is caused by the gas in the bulb being thrown outwards by centrifugal force to the walls of the bulb. This left the filament in a more rarified atmosphere and of course was not cooled to the same extent by the gas as when stationary. The temperature increased, which in turn increased the resistance, and the current consequently decreased. At every change in speed there was a change in efficiency. A peculiar feature of this is that starting with the lamp stationary and slowly increasing the speed of rotation the efficiency at first decreases, then increases, and at one speed is the same as the stationary efficiency. This speed is usually about 20 to 40 r.p.m.—not enough to overcome flicker. This condition put a serious damper on lamp rotation. It was found that in some lamps there were fairly large differences in candle power in different horizontal directions and the candle power in one direction might not be anywhere near the m.h.c.p. Again it was discovered that for lamps of the same make and construction there were considerable differences in the spherical reduction factor, and that the spherical reduction factor varies during the life of a lamp. Here is another fundamental difference between vacuum and gas-filled lamps: in a vacuum lamp the filament material as it is evaporated travels in straight lines to the bulb the same as the light and the result is that at any state of lamp life the blackening at any portion of the bulb is proportional to the amount of light passing through that portion. This results in the spherical reduction factor remaining constant throughout life. The gas in the gas-filled lamps rises as soon as it is heated by the filament and these currents of gas carry the evaporated filament material to the upper part of the bulb and the mean spherical c. p. decreases more rapidly than does the mean horizontal c. p.

In view of these difficulties it was quite evident that a new method of measuring was needed. Here was a condition that made necessary the adoption of a rating based on the total flux of light from the lamp, the method that had been advocated for years but which lacked a condition of necessity to compel its adoption. At that time there were several different types of integrating photometers in use in various laboratories, but none gave such promise of adaptation to the peculiarities of the gas-filled lamp as the sphere and its use has become universal. The sphere can also be put to many different uses as will be described later.

Now for routine photometry. The measurement of vacuum lamps should by precedence come first. This branch of photometry is about the simplest of any. A vacuum lamp does not mind what position it is burned in and has no definite peculiarities that demand extra precautions in its measurement. Vacuum lamps are the most suitable lamps to use as standards and this results in a good color match. In our own laboratory acceptance tests are made on vacuum lamps on the m. h. c. p. basis. The lamps are measured for c. p. and watts and target diagrams are made on which the rating of each lamp is shown by the position of a dot on the diagram. The comparison device used for this work is the old familiar Bunsen screen. Speed is of more importance than a high degree of accuracy and the Bunsen screen permits speed of operation with a minimum of eye-fatigue. As lamps are being so measured, one lamp out of each tray of 50 that is near the average watts and c. p. is selected to be further measured for life test, with more care as greater accuracy is required. For this purpose a Lumner-Brodhun photometric device is used and is capable of very high accuracy. Life testing of stock lamps is done at rated efficiency and the voltage is adjusted to produce the required efficiency.

The photometer on which this testing is done is not unlike others built for the same kind of testing, but a brief description of it may be of interest. The comparison lamp is at the right end and the test lamp socket at the left; the distance between them is 100 inches. A batch of lamps being measured may include a range of from 10 to 100 watts and with such a wide range one candle power scale cannot include all and we have found it necessary to use three. These are calculated for 16, 32 and 48 c. p. comparison lamps respectively. If three comparison lamps of these c. p.'s were used it would necessitate that each be calibrated separately and this requires considerable time. In order to overcome this we use one lamp that normally burns at 48 c. p. and it is calibrated by using standards of 22, 36 and 100 c. p. These are placed in the test lamp socket one at a time, the photometer head is set at the rated c. p. of the standard and the voltage across the comparison lamp is adjusted until a balance is obtained. With the standards mentioned these balances occur at the ends and near the middle of the c. p. scale and the average voltage of the comparison lamp is taken as its working value. When it is desired to use the 32 c. p. scale with this lamp, a rotating sectored disk is placed between it and the photometer head. This particular disk cuts 1/3 of the light and the effective c. p. then becomes 32. In a similar way the 16 c. p. scale is used with a sectored disk that cuts off 2/3 of the light. By this means we have a range of from 6 to 125 c. p. with one calibration of the comparison lamp. The change from one scale to another involves but a moment of time. This range includes all the vacuum lamps likely to be met with. In operation the photometric observer sets the voltage of both lamps and observes the c. p. The other operator reads the current or watts and does the recording. The test socket is made in four sections held in position by an endless spiral spring so that when the socket is rotating lamps can be placed in or taken out without stopping it.

After all I have said about the lumen rating you may be wondering why our tests are made on the c. p. basis. This is because our specifications have not been changed since the lumen rating has come into general use and these specifications are based on the c. p. rating. Also our c. p. photometer is capable of more rapid use than the spheres.

The integrating sphere photometer for the measurement of light sources is based on the theory that with an interior white diffusing surface the brightness at any point of the sphere wall is proportional to the m. s. c. p. of the source of light within. This theory is strictly true for an ideal condition when no foreign body to the light source is present in the sphere. To measure the illumination on the sphere wall a small portion of it is removed and a test window of diffusing glass substituted. A photometer track is placed so that the light passing through the test window is balanced against that of a comparison lamp which has been calibrated with the sphere. It is necessary that none of the light from the test lamp shines directly upon the test window and this necessitates a screen being placed between the lamp and the window. This screen constitutes a foreign body and is a source of error. The lamp socket and other necessary fittings add to it. The screen divides the sphere into three areas; the first surrounding the test window receives, only reflected light; the second forming the greater part of the sphere receives both direct and reflected light; and the third, opposite the test window, is entirely screened from it. The errors caused by this condition can be minimized by using a screen as small as possible and placing it so that the shaded areas are as small as possible. In spheres where the screen is small in diameter compared to the diameter of the sphere and the precautions stated are taken the errors are usually of negligible proportions. A sphere paint of very high reflection factor also tends to keep down errors.

The most effective safeguard against large errors is probably the use of the so-called substitution method of calibrating the sphere. This simply means having the standard lamps as near like the lamps to be tested as is convenient and placing them in the position during calibration that will later be occupied by the test lamps. In this way errors of the instrument are largely compensated for in the calibration. Each sphere has its own constant which is affected by the reflection factor of the surface and the size and location of the screen.

The measurement of the m. s. c. p. or the lumens of a lamp is a comparatively simple matter but when larger units such as reflectors or globes are measured, to determine the losses due to them, the conditions become more complicated and require a more intimate knowledge of sphere photometry. More screens are necessary and the sphere must be calibrated with all the apparatus, including the test unit, in place, where it will be during the test, and the standard lamp must be left there, extinguished, during the measurement of the test unit. To measure the test unit the lamp to be used in it is measured in its normal position but without the reflector or globe in place, the auxiliary is put in place and another measurement made. The second will be smaller than the first by an amount equal to the loss caused by the reflector or globe. Globes for street lighting are sometimes purchased under specifications that place a limit on the absorption. This is very easily measured. Our large sphere is provided with hinged trap doors in the top through which large units may be lowered and the opening closed up if desired. Or an arc lamp may be measured with the upper casing outside the sphere.

Illuminating engineers frequently need data on the reflection factor of wall papers, paints and other surfaces that absorb light. This is measured in a small sphere. A surface whose reflection factor has been determined must be used as a standard with which to calibrate the sphere.

A mirror or a surface of magnesium carbonate or other similar surface is suitable for use as standards. Standardizing such a surface is rather a long job, requiring the measurement of the reflection of a great many angles. With a standard surface placed in the sphere and turned away from the test window a beam of light is directed into the opening at the top so that it falls on the standard. A measurement is then made from which the flux of light entering the sphere is calculated. The standard surface is removed and the test surface put in its place. From a measurement with this the amount of light reflected from the sample is calculated.

The transmission of transparent and translucent materials is made by causing the light to shine through the opening in the top of the sphere and then measured. This gives the value, which is 100 per cent., all of the light having passed through the clear opening. A sample placed over the opening will absorb and reflect some of this light, the remainder being measured and the result expressed as the percentage of the light transmitted. If a sample so tested is of a diffusing characteristic it is necessary to state the characteristic of the beam of light because a concentrated beam will give a different result to a beam of diffused light. However, to test different samples the results can be compared if tested under similar conditions. Also if two sides of a sample are not similar the results may not be similar and a statement should be made as to which side is turned toward the light. This is shown by a test of ribbed window glass which transmits 90.3 per cent. with the opposite side out. Clear window glass transmits 87.3 per cent.; wavy wired glass clean transmits 75.2 per cent.; a dirty sample transmitted 38.4 per cent.

A person confronted with the task of selecting diffusing globes has to compromise between two opposing factors, transmission and diffusion. Both are highly desirable, yet one is obtained at the expense of the other although not necessarily to the same extent with different makes. The transmission is measured by the sphere photometer and the diffusion by a different means. There are different ways of expressing the degree of diffusion, but one in common use is to measure the distribution of brightness across the projected area of the globe. If a globe has a lighted lamp inside it has the appearance of a disk and if the diffusion be perfect it will be uniformly bright all over its area, otherwise the center will appear brighter than the rest. If an opaque screen with an opening in the center is placed in front of the globe the candle power per square inch of the globe area exposed can be measured. This opening may be square inch area and should be fixed and the globe arranged so that it can be moved across the photometer track, measurements being made at convenient intervals. These results plotted in the form of a curve show the variation in brightness from the center to the edge. This method can also be used with flat samples of material.

Another very important use of photometry to illuminating engineering is the measuring of the distribution of light from various lighting units. There are many forms of photometers for doing this but most of them make use of mirrors to direct the light from different angles from the units into the photometer axis. The one in use in this laboratory has two mirrors mounted at suitable angles on the one frame which can be rotated about the test unit so that candle power measurements can be made at different angles in the vertical plane. The distance from the light center of the unit to the photometric device is 10 feet, and the c. p. values are expressed as apparent c. p. at 10 feet. The word apparent is used because the light from a large unit does not follow the inverse square law at such a short distance. The 10 feet distance is commonly used in American laboratories.

In interpreting the results of tests the absorption of light by the mirrors must be taken into account. This may be done by calibrating the comparison lamp with the standard on the track and then in the distribution head and calculating the absorbtion from these results or by placing the standard directly in the distribution head and adjusting the voltage across the comparison lamp until a balance is obtained. The latter method requires a little less time. The most suitable method to use depends on whether a direct reading c. p. scale is used or the c. p. is obtained by reference to a table or by calculation.

It is common practice to make c. p. measurements at each 10 degrees around the unit. This method should not be blindly followed as some units change in c. p. so rapidly in some zones that very erratic results may be obtained.

In summarizing the results of distribution tests the lumens in the principal zones are calculated for both the bare lamp and the lamp equipped.

So far we have considered photometry in the laboratory. There is another very different branch that takes us out into streets, stores, offices, factories and anywhere where illumination is to be measured.

Of course work of this kind must be done with portable photometers. These photometers are usually built for a very wide range of work, such as measurements of c. p. in any direction, foot-candle and surface brightness. To make a survey of illumination the area selected should be representative of the conditions, as regards the surroundings, that prevail throughout the installation. The area is marked off into squares and a test station located at the center of each. In offices desk tops are 30 inches above the floor and measurements are usually made on this plane. In factories the bench height or machine height is the reference plane. Street lighting may be measured on the roadway or at some plane above it. There is no standardized method of making such surveys and much of the value of the test depends on the judgment of the one conducting it. Since the Commission started designing and installing street lighting our measurements have been made on a plane 30 inches above the road. This has become a sort of standardized method with us to enable comparisons to be made. Sometimes vertical illuminations on an adjacent wall is required and in interiors the brightness of fixtures and the ceilings against which they are reviewed or the brightness of reflections from polished surfaces.

On the Battle Line with the Telephone

"Twenty-four times the telephone line running between a front-line observation post and an American battery was cut by the German gunfire, and twenty-four times the Signal Corps man went out through the storm of shell and bullets and repaired the breaks. Again the wires were shattered, and afterward, when telling of it, he was asked, 'What did you do?' He smiled and answered, 'Why, I put it up again.'"

That is the sort of stuff that makes the American Signal Corps the sterling organization that it is, and the story is only one of many, both heroic and humorous, that Mr. Henry J. Carroll, of the New York Telephone Company, told during the illustrated lecture he gave before members of the New York Jovian League at their monthly luncheon in the Hotel McAlpin.

The talk was entitled "On the Battle Line with the Telephone," and was illustrated by many remarkable colored slides made from official photographs. Telephone wires on the ancient Parthenon in Athens, a captured German rifle plunged into the ground and made to serve as a telephone pole, central offices far under the ground, telephones in observation posts in No Man's Land in France, high in the Alps and on the Sahara Desert—these are samples of the character of the illustrations used by Mr. Carroll.

In his talk he told of the first military use of the telephone, during the Boxer rebellion, by American Signal Corps men, and of how the Germans took advantage of the lessons our men taught then and during the Spanish American War. After showing some German and Austrian telephone stations and describing the way the enemy used this device, Mr. Carroll told in picture and story, of the telephone operations of our Allies, featuring the war service of this American invention in American hands both at home and "over there."

American Telephone Lines in France

The Signal Corps of the U. S. Army in France has already constructed telephone lines in that country—part cable and part open wire—equivalent in length to the telephone line between Chicago and New York, according to the *Western Electric News*. The length of line has been increased as our troops advanced eastward and the consolidation of positions warranted the building of permanent lines.

Of course, the present system isn't just one straight line. It comprises main lines between important centers and ramifications to depots, ports, camps, etc. Like all American long-distance lines, those in France are used for simultaneous telegraph and telephone transmission.

These lines will probably become a part of the French national system when our troops leave France.

Electrically Heated Ovens

THE electrically-heated oven claims all of the advantages now recognized as having been obtained in the application of electricity to industrial plants in the various forms of power, i. e., economy of operation; reliability of service; increased production; ease of operation and safety.

The inner walls of an enameling oven, which is essentially a heat insulated room, consists of thin sheet metal and the insulator may consist of powder, blocks or bricks. In the cases where powder or blocks are used, the insulator must be placed between an inner metal lining and an outer lining, thus practically constructing one sheet metal box within another. An insulator is placed in the space between the two. The wall is built up around the inner metal lining in the same manner that masonry brick is laid, when insulating brick is used.

Up to the time that electricity came into use for enameling, almost no attention was paid to the kind of thickness of insulation, or oven construction in general, so far as retaining the heat in the oven was concerned. The reason for this was that gas being a very cheap fuel, it was not considered necessary to go to any particular expense to obtain an oven having good heat-insulating qualities. It was very seldom that one would see an oven with two inches of insulation, one or one and one-half inches being the rule. Moreover, this insulation was of a very poor quality.

There was another feature pertaining to oven design which had been absolutely neglected, and that is with reference to the amount of metal connecting the interior of the oven to the exterior surface, or as it is now termed, the amount of through metal.

A person is apt at times to underestimate the effect of through metal, in conducting heat from the interior to the exterior of an oven. The sectional area of the metal extending through the oven, even in the earliest types of ovens where no attention was paid to through metal, would appear to be relatively small in proportion to the insulating surface. However, this is true, but there is another property which shows up this difference in relative area exposed to the interior and exterior oven surfaces, i. e., the thermal conductivity of the material. With a conductivity of 500 for iron and .5 for a high grade insulation, the relative conductivity would be 100 to 1, or with equal sections and length exposed to the same temperature through the wall as a high grade insulating material. The effect of through metal is apparent and the necessity for eliminating it is readily understood because one square inch of metal extending from the interior to the exterior surface of the oven will conduct as much heat away to the atmosphere as 7 square feet of the highest grade insulation obtainable at this time.

The ovens may be classified under four general divisions as follows:

Kiln-type oven hand-operated; kiln-type oven truck-operated; semi-continuous conveyor-type oven; continuous conveyor-type oven.

The hand-operated kiln or box oven, consists of an insulated room into which the work or the parts to be baked are carried by hand and hung up in place on suitable racks or hooks.

The truck-operated kiln or box-type oven consists of an oven similar to the hand-operated on trucks which are wheeled into the oven and which remain in the oven with the work.

The semi-continuous conveyor type oven consists of an oven having doors at both ends, with an overhead conveyor running directly through the oven. This conveyor usually consists of a continuous chain which passes through the oven and returns over the top of the oven. With an oven 20 feet long, the conveyor would extend in a horizontal plane at least 20 feet on either end of the oven. A batch of work is dipped in the enamel and hung on the conveyor to drip for approximately 15 or 20 minutes. After this period the conveyor is started and the work moved into the oven. During the time that it takes the first batch to bake, the second is being dipped and hung on the conveyor. When the first batch is baked the conveyor is started up, the first being carried out and the second batch put into the oven. A third batch is then dipped and hung on the conveyor while the second batch is being baked, and the first batch removed from the conveyor. The operation is continued indefinitely.

A continuous conveyor type oven consists of an oven having a conveyor running through, which operates continuously and not intermittently, as in the case of the semi-continuous conveyor type. The work is hung onto a moving conveyor or chain and carried directly into the oven. The speed of the chain, the length of travel and the temperature of the oven must be such that by the time the work reaches the exit the enamel has been thoroughly baked. Ovens of the character requires the doors open continuously. In order to prevent heat losses through these openings and to keep the smoke and vapors from filling the enameling room, the oven must be constructed so as to obtain an air seal around the opening or an exhaust fan used at the proper point of the oven to secure an air balance, and at the same time provide ample ventilation.

In a number of the ovens now in use, no attention has been paid to insulating the floor, which is a very serious mistake, especially in view of the desirability of obtaining uniform temperature throughout the oven. Thought is being given to this matter as to the most practical and desirable way of accomplishing this result since the majority of the ovens have floors of concrete, which is not to be classified as a heat insulator. The thermal conductivity of concrete will vary in accordance with the proportion and kind of material used in mixing, but for the average floor it will be approximately five, or a conductivity of ten times that of an insulated wall of the same thickness. The greater thickness of a concrete floor off-sets in a measure the increase thermal resistance of the oven walls, but not sufficiently, in the latest type of ovens, this loss is being taken into consideration and the floor insulated to a thickness equivalent to half of that of the oven walls.

The hand-operated kiln-type oven is the most inefficient type of oven used. Due to the fact that the work must be carried on by hand, the oven cannot be at a very high temperature during the loading period. Also, after the baking has been completed the oven doors must be opened and the oven allowed to cool down to about 150 degrees F. before the workmen can enter the oven for removing the work. Before the oven can then be loaded, ready to be put into operation again, the temperature is down to that of the room. This means that in almost every case this type of oven must be heated from approximately room temperature up to maximum baking temperature for every bake that is obtained.

With the truck-operated kiln-type oven, the doors may be open a much shorter period than where ovens are hand-operated, from 5 to 10 minutes being ample time after the doors have been open for removing the trucks and running other trucks into the oven.

The semi-continuous-conveyor oven is about on a par with the truck-operated oven insofar as the efficiency of the oven itself is concerned. Since the work progresses through the oven, both ends of the oven must be laid wide open when loading, with the consequent result of a large cooling effect. Ovens of this type will drop from 450 degrees to 250 degrees while this change is being made. The total weight of the conveyor in proportion to the amount of work entering the oven per bake is probably not as great with this type of oven as in the case of the truck-operated oven, hence the efficiency of operation is improved in this particular. The overall efficiency, however, is approximately the same as the truck-operated oven.

The continuous conveyor-type oven is the most efficient type of oven and is coming largely into use in the automobile industry. The oven operates continuously at one temperature, requires a minimum of ventilation and a conveyor of minimum weight. The net result of this is that the latest designs of continuous conveyor-type ovens have an efficiency in excess of double the amount obtained by the best semi-continous conveyor-type oven.

The efficiency of the above types of ovens (Westinghouse), expressed in pounds of work or finished products, per KW. hour consumption for ovens of the latest of each of the respective types, having the highest grade insulation, proper ventilation and intelligent operation of the oven, is herewith given:

Kiln-type oven, hand-operated: 6 to 8 pounds of work per kilowatt hour.

Kiln-type oven, truck-operated: 10 to 12 pounds of work per kilowatt hour.

Semi-continuous conveyor-type oven: 10 to 12 pounds of work per kilowatt hour.

Continuous conveyor-type oven: 25 to 30 pounds of work per kilowatt hour.

The Society for Electrical Development

At a recent meeting of the Board of Directors of The Society for Electrical Development, the possible future activities of the Society were given careful consideration; the fact that the war had virtually ended the day before changed the entire aspect and the new conditions had to be considered. In the General Manager's report, it was suggested that the Society's activities to educate the public to an appreciation of the advantages of electric service should be continued, and that the Society could do a valuable work along the lines of helping the reconstruction of the electrical industry upon a peace basis. This would include a number of very important items and carefully prepared propaganda. To do the work thoroughly well would cost money, and the Society would have to have the fullest support of the electrical industry.

The Directors expressed their approval of the work which has been accomplished. They recognized the fact that ever since the Society has been actively at work, war conditions have existed. The real active work commenced in July, 1914; the European war commenced the end of that same month; so that from the very beginning conditions have been abnormal. With the coming of peace, the opportunities for constructive work are presented, and the possible value of development work is increased tenfold. The opinion was expressed by the Directors that the Society is a necessity to the industry, but that heretofore it has been very difficult to secure recognition of this fact, and it was decided that steps should be taken to bring to the attention of everyone interested in the success of the industry the value of the Society and the necessity for their co-operation.

Electric Vehicle Transportation

ONE of the chief reasons why the electric vehicle is a proven success lies in the fact that in design, as well as in operation, it is simplicity personified, writes A. Jackson Marshall, secretary of the Electric Vehicle Section of the National Electric Light Association. For its motive force it does not require the "thousand and one" parts involved in the internal reciprocating combustion engine, together with its multitudinous necessary connections and accessories, in the manufacture and assembly of which much accurately machined steel and skilled mechanical labor are employed. The propelling force of the electric vehicle is the simple electric motor with its one moving (rotating) part—the armature.

In the electrically equipped gasolene car the electrical equipment is far more extensive and intricate than that employed in an electric vehicle. To the uninitiated this statement on its face may appear strange, but a little thought will dispel any doubt as to its accuracy. The equipment of an electric vehicle consists of a battery, motor, controller. By moving a lever to designated points various strengths of electrical force are applied to the motor, which cause the vehicle to move forward or backward at will, at different speeds desired. To stop the vehicle the lever is moved back to a neutral position, and brakes are applied. Design is reduced to the fewest units, and operation to the fewest and simplest operations, making minimum demand on mind and muscle.

The electrical equipment of a gasolene car, in addition to its reciprocating engine, water-jacket, radiator and fan, gears, levers, carbureter, oiling systems, etc., consists of a battery, motor, and controller for starting and lighting. In fact, this electrical group is virtually an electric-vehicle equipment in its entirety in miniature. Think for a moment and realize what this means—a relatively small, incidental feature of the gasolene car employs the all-essential equipment of the electric vehicle. The visualization of this fact will clearly indicate the remarkable simplicity of the "electric."

But the electrical equipment of the gasolene car does not stop with the "battery, motor, and controller." The most involved and intricate electrical equipment is yet to come. No doubt you have guessed it—ignition, without whose "spark of life" the gas would not fire and explode in the engine cylinders. Some gas cars use electric batteries for ignition, usually the same battery supplying the motor for starting and lighting. Some use a magneto, and some cars use the dual system of battery and magneto. Not a little electrical wiring is necessary for the several "leads" and connections, and the "timing" must be calculated to a nicety if desired results are to be obtained. Reference has been intentionally omitted to electrical gear shifts, magneto control, etc., sometimes employed in gasolene cars, as such evidence is not necessary to establish a case of great simplicity for the electric vehicle. So while a gasolene car may be so styled, it embraces in its design and operation extensive electrical features and equipment of a more involved and intricate nature than is found in the electric vehicle, which in turn is much more independent, not finding it necessary to "borrow" from its "brother."

Simplicity of design and operation of the electric vehicle is important in two main directions. First, in manufacture. Steel and other material are saved, as is also their preparation by skilled mechanics employing machinery capable of producing much-needed war equipment. Second, in operation. Young men, old men and women, not possessed of mechanical knowledge, successfully operate electric vehicles, thus releasing skilled chauffeurs for more important war operations. Third, in maintenance. Absence of many parts that wear, and require adjustment and repair, makes it unnecessary to employ the services of skilled mechanics and material in order to keep the electric vehicle in service. Fourth, low operating costs. It therefore will be seen that in design, manufacture, operation, and maintenance of the electric vehicle, from its inception to its application, it is very moderate in its demands on materials, equipment, and skilled manpower so urgently otherwise required these days. And when it is realized that 90% or more of all urban transportation work can be more economically and efficiently dispatched by electric vehicles than by any other means, it will be seen that the "electric" is contributing in no small way to help win the war.

In closing, just a brief statement regarding the present electric vehicle situation in respect to usage. Electric commercial vehicles are employed extensively by many large industries such as, for example, express companies, laundries, bakeries, department stores, breweries, public service companies, packing-house organizations, municipalities (by street, refuse, fire departments, etc.), coal merchants, hospitals (ambulances), ice dealers, dairy products, railroad and steamship companies, etc. In fact, some of the largest vehicle fleets in operation are composed chiefly of electric vehicles, in many instances the results of repeat orders extending over a long-term of years, which is probably the highest endorsement possible of this modern mode of transportation. Incidentally, electric vehicles are possessed of extremely long life, there being many such vehicles in daily active service which were installed ten, fifteen, and twenty years ago. Electric industrial trucks and tractors, employed extensively by the railroads and steamship companies, in addition to their use in factories, warehouses, etc., are in great demand; in fact, the demand is far in excess of the supply. The electric vehicle is making rapid headway not only in this country, but in many foreign countries as well. In fact, the rate of increase in many countries, for example in England, Norway, Sweden, Holland, Spain, France, Japan, Italy, Australia, New Zealand, in South Africa and South America, etc., is such as to warrant the prediction that with the return of peace this mode of transportation will be found to be occupying a position of very great importance and influence in this and other countries, where considerably augmented electric vehicle manufacturing facilities are either now in course of actual installation or being planned on a large scale. Irrespective of what conditions may ultimately obtain in the matter of the supply of gasolene, those who have made a searching, unbiased investigation of the broad subject of mobile transportation, especially as it applies to urban territories, can readily justify their belief and prediction that the future will witness the universal adoption of the electric vehicle in that class of transportation which may be described briefly as frequent stop-short haulage—which probably represents 80 or 90% of the transportation requirements encountered in urban territories.

The electric vehicle of to-day has reached a very high state of perfection, and may be depended upon to efficiently and satisfactorily discharge its assignments at a cost per ton-mile considerably below that of any other mode of transportation. This fact is known and appreciated by many large and progressive organizations, extensive users of the "electric," who have approached their transportation problems scientifically, and as the principles of transportation engineering are more extensively employed in approaching this major phase of industry the electric vehicle will quite naturally be the transportation medium selected. The electric vehicle courts investigation and intimate and detailed comparison with other modes of transportation.

An Electric Piling Machine

In order to understand this calamity, a little mental setting-up exercise will make it clear. Given 800 barrels of 140-pound jute sacks of flour or wheat to be piled 16 feet high, by the good old back-twisting method; 6 pilers can do the job in 10 hours; banking on the supposition, of course, the 6 pilers are always available. How long will it take one piler?

Sixty hours.

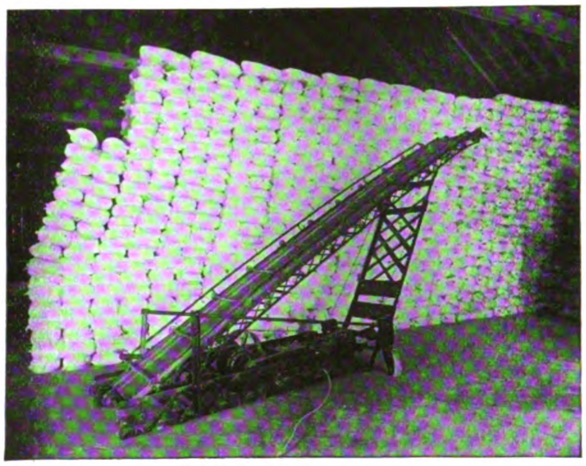
Right!

Easier yet! How many pilers will it take to pile this same flour in one hour?

Sixty pilers.

Right again! Kindly bear this in mind: that it takes 60 men one hour to pile 800 barrels of 140 pound sacks of flour. That is, it does, providing the conditions stated above are given.

In 1917 these conditions were actually given at the Pasco Flour Milling Company's mill at Pasco, Wash. But this company, usually progressive in finding and



Electric Piler in a Flour Mill

installing labor-saving devices, to-day is performing the same operation with 4 men working 4 hours, using the new Piling Machine shown in the illustration. In terms of man power, it takes 16 pilers one hour, as against 60 pilers by the old method. This machine, then, has actually strafed forty-four men.

The machine looks considerably like an incline in a modern department store. It is manufactured by the Brown Portable Conveying Machinery Company and is operated by a 3-h. p. type CS Westinghouse motor. These machines are portable, and are adapted to a dozen different kinds of material, from handling sugar to baled hay.

This machine here also displaced an old block-and-tackle method formerly used to hoist empty sacks to the space above the rafters in the warehouse. It is also used for unloading wheat from cars into the warehouse. Two men on a pile and four chuckers can handle 400 sacks per hour.

Thought Spies Were Signalling

I heard of an interesting episode the other day connected with the earlier days of air raids, when both police and public were hot on the scent of alleged spies in London, says an English exchange. All sorts of reports were rife concerning flash signalling from buildings all over London, and among others a block of offices on the south side of the Thames, occupied by a perfectly reputable business concern, fell under suspicion. According to the police, and also the sworn testimony of residents in the locality, there had been for some time past distinct flashing or intermittent switching on and off of electric lamps at certain unshielded basement windows visible from above. Inquiries were made, but the evidence all pointed to the fact that the premises were untenanted on the nights on which the offenses were alleged to have been committed.

Still the alleged signalling went on, and finally the police paid a special visit to the premises and asked to be conducted to the quarter whence the flashes had been observed. The windows in question belonged to an underground staff lavatory, only used during the daytime, and the manager, in showing his visitors round, switched on one of the pendant lamps to illustrate the only possible source of illumination which could have been held responsible for the trouble. He was discussing the phenomenon with the visiting inspector, the light being still glowing, when suddenly it was automatically extinguished, and after a very brief interval again blazed up, and then once more extinguished, without the controlling switch having been touched. Thus the problem was solved. These lampholders had certain loose connections, highly susceptible to traffic and other vibrations of the building. Whilst the lavatory was in use after dark, the lamps would automatically go out, and the last user, realizing this failing, and not appreciating the possibilities, omitted to switch off the current. The lamps remained off until some latter vibration restored the circuit, broke it again, and so on throughout the night.

Electric Companies of Cadiz

According to a report from Consular Agent James Sanderson at Cadiz, Spain, the public utilities in that city have been hard hit by the war. The gas companies, he says, have found it impossible to charge the consumer the whole of the extraordinary increase in cost. Cadiz companies have had recourse to the use of wood and the residue of olives, after the extraction of the oil, for the production of gas, which has consequently been of a very inferior quality. The adoption of such methods of manufacture has, however, provided some measure of defense for the companies' interests. The two gas companies at Cadiz are likewise the makers and suppliers of electricity to the city. The prices of electricity have also risen very greatly above pre-war rates, but owing to a much smaller quantity of coal being needed to produce this illuminating power, this branch of their industry has not been so seriously affected. The pre-war prices for electricity for lighting were $0.25 per kilowatt, present price, $0.32. Prices of electricity for industries were $0.12 per kilowatt before the war, and $0.26 now.

Electrification of Swedish Railways

The Swedish railway committee was instructed by the King of Sweden in the end of 1915 to investigate the practicability of electrifying the railways of the kingdom. The potential water power of Sweden is immense, of which 4,000,000 turbine horsepower is now being developed. The great reduction in the supply of coal and the increase in the cost has accentuated the importance of developing Sweden's water power. This development has naturally been hampered during the war by the absence of metals necessary for the manufacture of turbines, dynamos and other machinery and wires for power transmission.

It is calculated that had Sweden's railways been electrified before the war their cost would have been paid for by the money that has been expended in the present year for coal, says a recent article in the "Social Demokraten." Seven power stations are available, namely, Lagan, Göta Alv, Motala Ström, Daläven, Indalsälven, Emeá Alv, and Luleá Alv. The supply of power is under governmental control. It is calculated that power for agricultural purposes could be delivered from the railway supply. Details as to the plans for electrification are not available.

Will Manage Two Utilities

H. L. Treeman has been promoted by The J. G. White Management Corporation, New York, from industrial engineer of that organization to the position of manager of the electric department of the Eastern Pennsylvania Railways Company and the Eastern Pennsylvania Light, Heat and Power Company, of Pottsville, Pennsylvania. Both of these utilities are operated by the management corporation. Mr. Treeman was graduated from Oklahoma Agricultural & Mechanical College in 1909, with the degree of bachelor of science, having specialized in mechanical and electrical engineering. He is a member of Theta Xi fraternity.

He was associated with the Edison Electric Illuminating Company of Brooklyn as power engineer for a number of years. In 1915 he left the services of that company to accept the position of industrial engineer with The J. G. White Management Corporation.

ELECTRICAL ENGINEERING

With Which is Incorporated the

SOUTHERN ELECTRICIAN and the ELECTRICAL AGE

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EVERY one knows that electricity played a most prominent part in the war, but just how prominent few of us take the time to consider. Sidney Neu, editor of *Contact*, goes so far as to say that it was electricity that won the war, and he makes out an excellent case, as will be seen by his article in another column. In thousands of different ways, altogether too numerous to catalogue, electricity aided our soldiers in their great fight for the right. The full story cannot be told yet, although hints of new applications of electricity are constantly leaking out, such as the maintaining of telephonic communication with aeroplanes. There is no doubt the entire subject will eventually be written up adequately and at length, and it will prove a most fascinating record.

THE most recent bulletin of the American Chamber of Commerce for Italy, published at Milan in September, shows that the war has not had a bad effect on the value of electrical securities. The shares of the three leading electric companies, as of the date June 30, are quoted as follows, the values being in lire: Edison, 1914, 472; 1917, 541; 1918, 650. Vizzola, 1914, 780; 1917, 840; 1918, 950. Conti, 1914, 312; 1917, 354; 1918, 479. This increase in price was greater than in almost any other line of industrial securities. This particular bulletin is devoted especially to the cotton industry in Italy. Concerning the use of power, the Chamber of Commerce says: "It has always been difficult to obtain reliable statistics as to the employment of motor force by the cotton industry. However, from data obtainable, and including all spinning, weaving, finishing, printing, etc., it would seem that there is employed about 250,000 h. p., much of this being hydraulic. From waterfalls that exist in Italy, there can be developed 5 to 6 million h. p. The cotton industry is aware of this and is now transforming the power used into hydraulic. There is reason to believe that this tendency will, after the war, become more general." After Italy's sufferings from fuel shortage during the war, it is certain that this country will immediately begin the development of its many splendid water powers.

AN English architectural paper, in discussing reconstruction problems, thinks that one of the most important features to be considered in the adoption of a housing programme is the elimination of waste. It announces that it is in contemplation to divide the whole of England up into sections, in each of which a great central electricity supply plant will be installed. The mains from these stations will supply whole districts with electrical energy which can be used in the form of heat, light or power. This in the first place will affect the location of manufactories and works, and as a corollary the location of the housing of the workers employed in them. It will doubtless be profitable in many cases to erect works in country districts, and the effect of the scheme on building must be at present largely conjectural. Then the writer says: "But we know that if this comes to pass the construction and arrangement of our houses will be largely revolutionized by the adoption of heating and cooking by electricity, by the elimination of chimneys and coal cellars, and the simplification of service. It is not likely that women who have been employed in war work will be satisfied to use antiquated methods involving additional labor when newer and better ones have become possible. In addition we shall in many cases utilize communal systems for the supply of hot water, nor can anyone say to what extent the municipal kitchen may not be adopted in many districts for economy of labor and material." There never has been a time that afforded the electrical industry such an opportunity as the present for development. We are going to undertake building on a scale never before known, because of the tremendous shortage in public, business and domestic housing. This, in itself, would give a fine opening for electric installation of all kinds. But there is more than this to be taken into account. The lack of help throughout the war inclines us to the use of every labor-saving appliance that will do all that is claimed for it. The fuel shortage, from which we are not yet free, gives a strong appeal to the electric current from the central station. We have dreamed of Utopia in which electricity would be a servant ever at hand and for all purposes. Now there is every chance to realize this dream.

THE Acting Director of the Council of National Defense, Grosvenor B. Clarkson, has just made his second annual report, reviewing the work of the Council during the fiscal year ending June 30, 1918. This is full of suggestive facts, telling the manner in which one of the most peaceful nations in the world prepared itself for war, and so acquitted itself as to bring eternal glory to our land and people. Nothing could be more striking and creditable than our industrial mobilization, in which every line of business activity took part, without compulsion and in a pure spirit of loyalty. Mr. Clarkson says: "From the outset the purposes of the Council and the subordinate committees of the Council was to offer a channel through which the voluntary efforts of American industrial and professional life could be focused. The story of the way in which the members of these committees, practically all of them serving without compensation, rallied to aid in the common cause and the extent of the practical accomplishment of their voluntary service has probably not been equaled anywhere. The general spirit underlying these original committees was fundamentally that of business organizing itself in aid of the Government. Lack of time for complete organization by industry made impossible the formal election of the members of these committees by the industries which they represented. In choosing the membership the Council sought for a representation from the industry as wide as practicable. It is probable that at this particular stage in the progress of the war no plan could have produced such effectual results in so brief a time as this voluntary system was able to show. The natural processes of administrative evolution gradually eliminated the old large committee system in the case of the Industrial committees and substituted for it a closely knit scheme of sections under the general head of the War Industries Board, in which each section head had general authority over dealing with the industry with which he was particularly familiar. At the same time the industries of the country were rapidly organizing to assist the Government in carrying on the war and were creating representative war-service committees of their own, thus simplifying and strengthening the method of cooperation of business with the Government." The same spirit of hearty cooperation will be shown by all industries to meet the problems of reconstruction and readjustment.

Standard Forms for Electrical Contractors

In order to do as much as possible to standardize the methods of electrical contractors in soliciting business the Society for Electrical Development, New York, has issued simplified estimate and proposal forms. There are also typical floor plans, which serve as a chart in planning wiring and locating outlets. The reverse side of the sheet is headed "Convenience Outlets for New and Old Homes." Brief but convincing arguments are given in favor of outlets; it serves admirably as a guide for the salesman in shaping his selling talk. Below that follows an itemized list of the several electrical appliances suitable for use in each room of an average well-equipped home. The uniform proposal blank is simplified to the last degree, is easily understood by the customer, and makes the matter of rendering the proposal delightfully simple. The unique feature is the fact that this blank becomes a formal contract between the customer and the contractor without any other necessity than the customer's signature. The standardized estimate blank is entirely in keeping with the best record-keeping requirements.

Meter Repairwomen More Efficient Than Men

The Tacoma (Wash.) Gas Company's women meter repairers are made the subject of a half-column article in the November 3d issue of the Tacoma *Ledger*. Foreman William Dayton is quoted as saying:

"Why, the women helpers for the men doubled the output of repaired meters in two days. We have two women here who have gone farther in six months of service than male apprentices went in a year and a half.

"I think it stands to reason that the slender fingers of a woman can insert and remove the packing in the meters better than the thick fingers of a man. Be that as it may, the women have been mighty successful in our shop, and they can handle now almost every step in the rehabilitation of a gas meter for use."

Electric Irons in the Service

In the cantonments, on shipboard and with General Pershing, "overthere," the boys in the service are finding out the real worth of the menial labor-saving appliances that heretofore they had not recognized as essentials. Among the many appliances and devices that the soldiers and sailors have tried out, the electric iron, without a doubt, is the nearest to their hearts. To the great majority of these khaki and blue-clad lads, the pressing of their own clothes is a new experience, and yet in order to have clothes that are well pressed and a credit to the wearer, they are compelled to spend many hours each month in pressing their uniforms. In many instances, a dozen or more chaps have chipped their two-bits together and have bought an electric iron.

Here and There in the Electrical Field

It is stated that the British Columbia Government may shortly undertake the electrification of the North Vancouver section of the Pacific Great Eastern Railway. There is said to be sufficient water power obtainable at three points to electrify the entire road to Prince George, although such an expenditure is not warranted at the present time.

W. P. MacDonald, of Wapella, Sask., is planning the installation of an electric lighting plant at that place.

Mr. J. K. Mahaffey, who has been representing the Edison Storage Battery Company in Washington in connection with Government business, has been appointed District Sales Manager of the Pittsburgh District.

A 2,000-kw. hydro-electric station of excellent design and construction is being built on the Madawaska River at Edmundston, N. B. This development is intended to supply power for a large sulphite mill also under construction at the same place for Fraser Companies, Ltd.

Middleton, Nova Scotia, recently bought a water-power plant about three miles from the town, which had been inoperative for some time. With a few minor repairs and the building of about 3 miles of transmission line, this development was put into service at once, replacing a gas-producer generating station. In addition to its former lighting load, the town is now supplying industrial power, and recently connected up the largest individual power user in the community who formerly had steam equipment.

Motordale is the new name of the New Germany, Carver County (Minn.), postoffice, according to Postal Bulletin of November 14. This community receives its electrical requirements from the Northern States Power Company.

During the week ended November 15 the sales department of the Minneapolis General Electric Company accepted new power contracts aggregating over 2,300 horsepower in motors; the larger ones being listed herewith: 1,900 horsepower for Western Crucible Steel Company, for 3-phase furnace; 152 horsepower additional at the American Barley Company's mill at Carver; 105 horsepower for the Culbert Milling Company. An electric bake oven is being installed for C. F. Witt, who will do all his baking electrically, current furnished by the Minneapolis General Electric Company.

F. E. Newberry Electric Company, through its San Francisco branch, has about completed the electrical installations in the new factory of American Can Company, at Oakland, Cal., in which General Electric motors, amounting to 300 h.p. were installed. Each machine is connected to an individual motor either by belt or direct coupling. In like manner, this firm has completed the wiring and motor installations for 800 h.p. in the Sperry flour mills at Vallejo, Cal. In this plant silent-chain transmission was adopted, and the safety switches of the Detroit type were put in.

The recent increase to the straight five-cent fare on the Regina Street Railway is, according to a recent statement, responsible for an increase of $20,000 in revenue for the first ten months of the year. Approximately the same number of passengers were carried.

It is planned to build a plant at Estevan, Sask., for supplying light and power to the cities of Weyburn, Regina, Moose Jaw and intervening points. It is believed this could be made a commercial success by the use of lignite fuel.

The Chief Inspector of the Toronto Hydro-electric System has asked the attention of electrical contractors to the need of allowing sufficient length on meter loops for power services. Each single wire should not be less than eighteen inches in length.

In a report recently submitted by auditors appointed to go over the books of the Ontario Hydro-electric Commission, it is shown that the total assets of the Commission amount to $28,950,803. Under this heading is included an asset of $15.070,307, representing the value of the Niagara system and the seven secondary systems in the province. On the other side of the ledger are cash advances by the province amounting to $17,037,074 on the various systems; $1,200,000 on Niagara power development; $583,131 due Central Ontario System; debentures re-purchase of Ontario Power Company. $7,984,000. Other debentures total $51,216; accounts payable $27,443. The liabilities also include reserves for sinking fund aggregating $238,531, and reserves for renewals contributed by municipalities and in respect of service and office buildings amounting to $1,139,258. There is a reserve of $137,701 for contingencies and the Commission owes to municipalities in respect of operating surpluses. $446,484. Another surplus is $83,509 arising from departmental operations in the service building. An insurance reserve of $2,451 completes the liabilities.

Edward D. Adams, Nicholas Biddle and Ogden Mills, New York, have incorporated the Niagara Falls Power Company, with capital stock of $26,000,000.

Ravenna, Mich., will install an electric light plant in the spring.

Luray. Kan., will install a municipal electric light system.

C. R. Conroy, L. H. Burdick and W. L. Boylan, have organized the Boylan & Conroy Company, of Geneva, N. Y., with $20,000 capital, to manufacture electrical specialties.

The United States Government, War Department. has awarded a contract to John Gill & Sons, Cleveland, Ohio, for the construction of an electrical feeder and distribution system at the naval training camp and hospital at Hampton Roads, Va. The department has also authorized the installation of a heating plant at Langley Field, Va., in connection with the construction of several new buildings, estimated to cost $79,000.

W. L. and M. A. Holahan, 44 West Sixty-fifth Street, and L. Holahan, 404 West Fifty-eighth Street, New York, have organized W. L. Holahan, Inc., with capital stock of $50,000, to do a general electrical engineering business.

Milliken Brothers Manufacturing Company, Inc., Woolworth Building, New York, has acquired the plant of the James H. Young Stone Company, 136th Street and East River, for a new fabricating plant for the manufacture of steel transmission towers, radio towers, poles, as well as the Standardized Truss Unit System for building construction, a patented method of all-steel building erection designed by J. E. Jennings, vice-president of the company. Additional property adjoining the plant has also been secured, and it is planned to erect an extension to be used for galvanizing operations. The new works will provide about 40,000 sq. ft. of manufacturing area, and will be fully equipped for all features of production.

The total coal output of the country this year is estimated at 700,000,000 tons. About 2½ per cent. of this is consumed in the production of artificial light. Electric lighting requires about 12,000,000 tons.

H. W. Bartlett, Inc., has been incorporated in New York, with $10,000 capital, to do a general electric engineering business. The incorporators are C. J. Beck, H. N. Bartlett and C. W. Bedell, 23 Mercer Street.

The Cook County Transit Company, of Lewiston, Mont., will construct an electric railway along the Yellowstone and Lamar rivers and Soda Butte creek, from a point near Gardiner.

Operation has recently been inaugurated at the first unit of new Government nitrate plant at Muscle Shoals, Ala., to be used for the manufacture of air nitrates. A total of 186,000 steam-generated electric horsepower will be required for the operation of the works.

The Branford Electric Company, of New York, has been incorporated with $10.000 to manufacture electric specialties. The incorporators are D. Sprague, E. L. Bell and M. J. Conklin, Yonkers.

The Morris Light & Power Corporation has been formed to build and operate an electric system in the village of Morris, N. Y.

A new ore body, to be known as the Big Dick mine, has been located northwest of Cuba City, Ill. Its electrical requirements will be supplied by the Interstate Light & Power Company, of Galena, Ill. (subsidiary of Northern States Power Company), through an extension connecting with the Zinc Hill Mining Company's lines. The extension will be financed by the mining company, and will be completed and the load served by the Interstate company in approximately ninety days.

The Committee appointed by the Mayor of Stillwater, Minn., to investigate the matter of increasing gas and electric rates, has submitted a report recommending that the Northern States Power Company be granted an increase of 33⅓ per cent. on gas rates and 10 per cent. on electric rates.

The County Council at Port Alberin, B. C., contemplate installing a water wheel and developing electric power.

The Cold Springs Rural Telephone Company, Ltd., with capital of $5,000, has been incorporated to operate in the township of Hamilton, Ont., and the Tara-Keady Telephone Company, Ltd., with capital of $5,000, to operate in the townships of Derby and Arran, Ont.

Electro-Magnet Electric Elevator Control

By T. Schutter

IN the past few years the method of operating and controlling electric elevators has taken many great strides forward, and one of the latest steps is the 6 F.D. electro magnet controller, by the Otis Elevator Company, of Yonkers, N. Y. When the old steam-driven elevator was displaced by the electric motor-driven one, it was operated by a mechanical switching device which was operated by a hand rope or cable. When this was pulled up it would close the switch and start the car or elevator in a certain direction, and if pulled in the opposite direction the switch would be closed in the opposite direction, thereby reversing the current through the armature and then the car or elevator would travel in the reverse direction from before. This type of mechanical device is still being used on some types of elevators to-day, but the more modern and up-to-date ones are

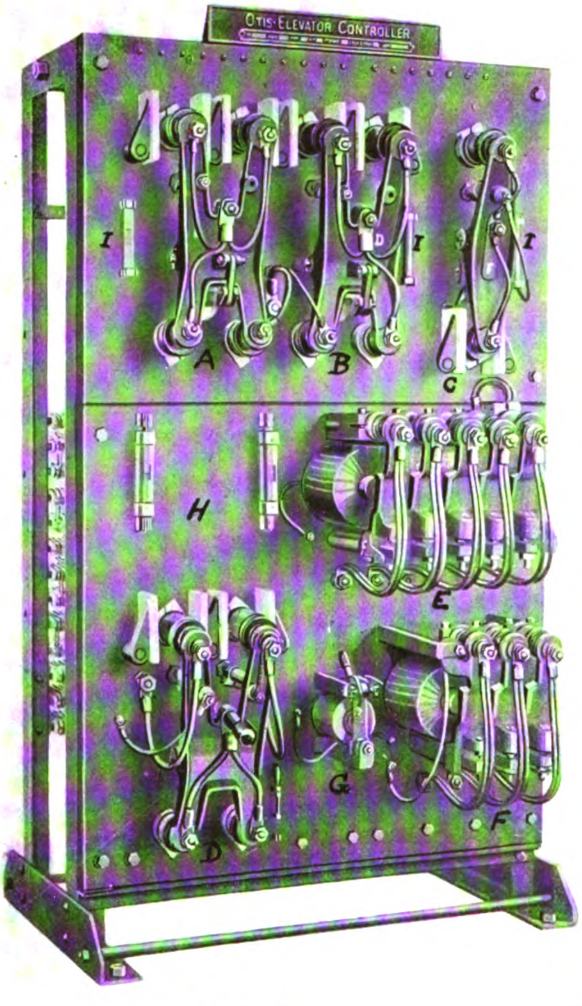


Fig. 1.—Otis Elevator Control

controlled by electro magnetically operated switches from a car or master switch, which is controlled by the car operator. On this style of controller there are two destinct circuits, which are known as first operating or auxiliary circuit; and second, the main or power circuit, Figure 1, is a photographic reproduction of a 6 F.D. electro magnet controller, with the following parts: A and B are the up and down switches or reversing switches as they are sometimes called; C is the fast speed switch; D is the main line or potential switch; E is the accelerating magnet; F is the stopping magnet; G is the auxiliary stopping magnet; H indicates the main fuses, and I the auxiliary fuses.

On this style of controller all switches are operated by electro magnets, and the switches which control the armature and field circuits have self-adjusting contacts, and the

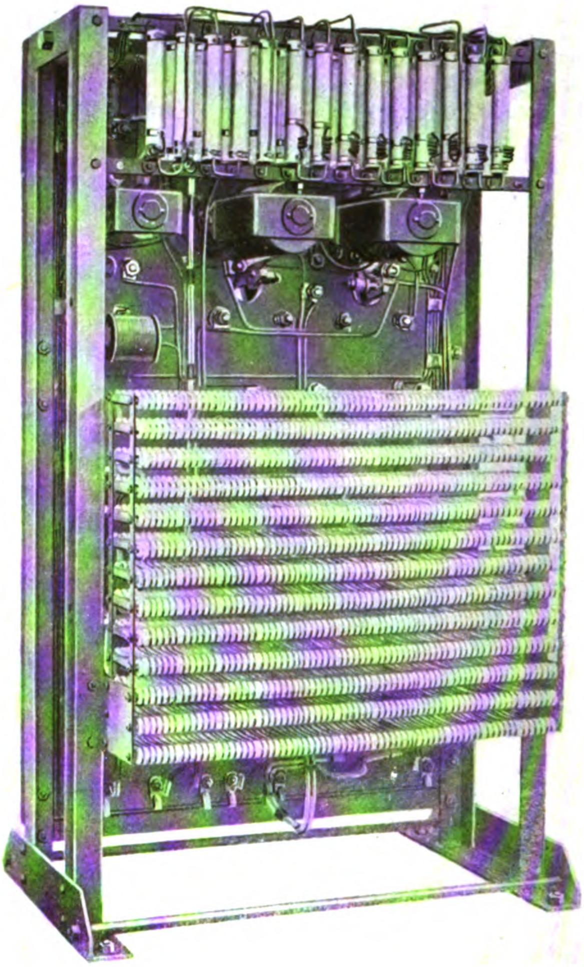


Fig. 1.—Rear View of Elevator Control

contacts are so mounted so as to prevent rebounding and to have a full contact surface at all times. The switches which carry the armature current are equipped with magnetic blow-out coils so as to prevent the arc from being carried between the contacts when the switches are opened.

The duties of the various switches and magnets are as follows:

Reversing Switches:—These make and brake the circuit and control the direction of rotation of the motor, and are operated from the car or master switch; they complete the circuits for the armature shunt and extra shunt fields and the brake magnet. As long as the switches remain open no other magnet coil or switch can be energized to operate.

Fast Speed Switch:—This is also under the direct control of the operator in the car by means of the car switch, and when it is operated it short circuits a portion of the starting rèsistance, and completes the circuit for the accelerating magnet, which will then gradually bring the motor to full speed, and it also opens the circuit of the extra shunt field.

The Main Line or Potential Switch:—This is nothing more than a circuit breaker, and is provided with a no-voltage release coil. Should the line voltage fail for any reason or fall below a certain amount, this switch will be released, and the brake shoes will be automatically set by heavy spiral springs. Again if the auxiliary circuit, of which this no-voltage release coil is a part, is interrupted it will also open and set the brakes. In either case when the line voltage is restored or the auxiliary circuit again complete, this switch will again close or restore itself, and the operator can then start the car from the car switch at will.

The Accelerating Magnet:—This magnet coil is oval in shape and the core over which it is placed will attract several contact arms, so arranged that one after the other they will be drawn up. This coil is connected across the armature, and as the voltage across the armature terminals increases this coil will lift up one arm after the other (each arm being set a little further from the core than the preceding one). As they close they cut out the starting resistance in three steps, and also the series field in two steps. When all the contact arms are closed the motor runs full speed as a shunt machine, which permits better speed regulation under varying loads. This shows that the speed regulation is independent of the car switch, and is entirely controlled by the fast speed switch.

Stopping and Auxiliary Stopping Magnets:—The stopping magnet is a coil constructed and operated the same as the accelerating magnet. It has but three contact arms, which are set the same as those of the accelerating magnet. This coil is also connected across the armature, but its circuit is not completed as long as the auxiliary stopping magnet is closed, which is controlled by the up and donw switches.

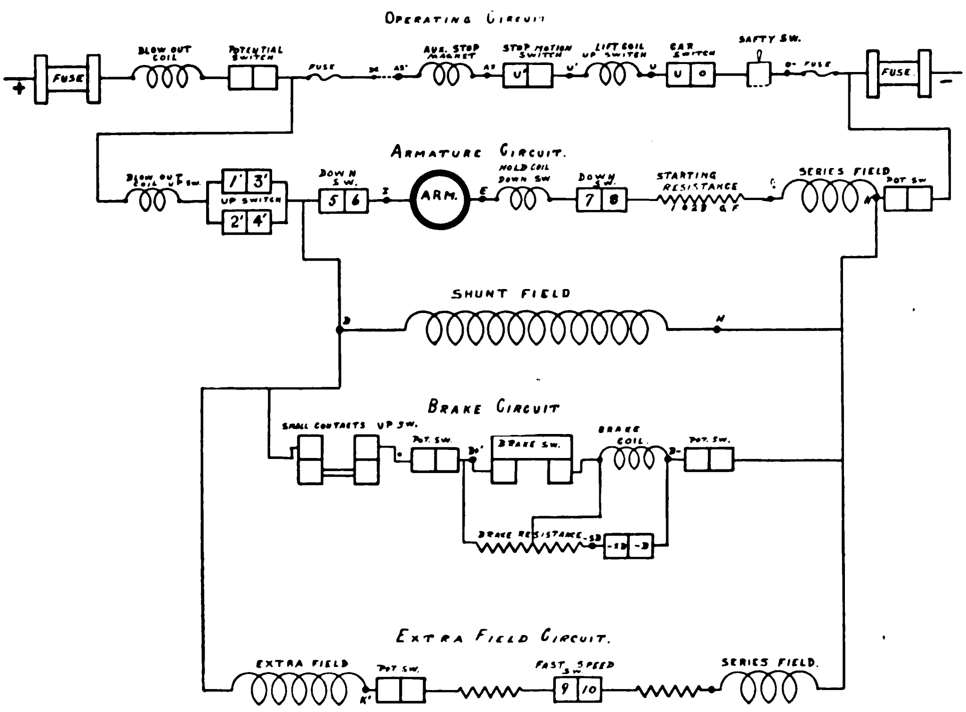


FIGURE 3

The auxiliary stopping magnet is energized by the closing of either the up or down switch and breaks the circuit of the stopping magnet.

The number of contact arms that are closed by the stopping magnet depend on the speed of the car and the counter-electro motive force generated in the armature. The contact arms that are closed cut out sections of the stopping resistance, which is in circuit with the extra shunt field. This method of dynamic stopping is only found on controllers made by the Otis Elevator Company, and covered by their patents.

The circuits which are controlled by the various switches are as follows, and the direction of the flow of the current is as indicated by the arrow heads, and their construction is as follows: The reversing switches control the direction of rotation of the armature, and are controlled directly from the car or master switch. They are constructed with spring self-adjusting contacts, so as to be sure of secure and full contact surface at all times. There are two sets of contacts on each switch, which are called the top and bottom contacts, and are numbered 1 to 8 on the down switch and 1′ to 8′ on the up switch. When the car is at rest the contacts, number 5 and 6, 7 and 8, are closed on the down switch; also 5′ and 6′, 7′ and 8′ on the up switch, as shown in Fig. 2; and the car or master switch handle is set neutral, as is also shown in Fig. 2. Assuming that the car is to be started on the up motion, the car switch handle will be thrown forward so that the lever X makes contact with contact U (see Fig. 2); the circuit which controls the lifting magnets of the reversing switches is closed, as shown by the straight line

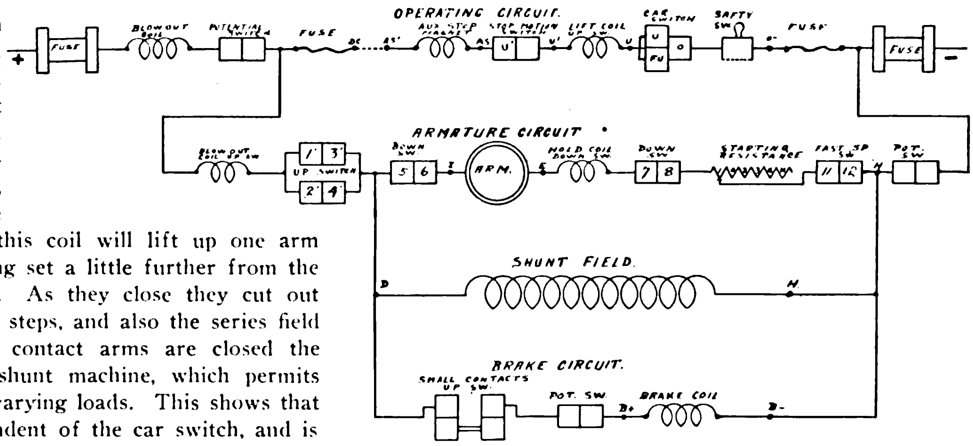


FIGURE 4

diagram in Fig. 3. This circuit is known as the operating circuit, and the direction of flow of current is as follows: From the positive main line fuse to the blow-out coil B C, and on to the positive side of the potential switch; from here to the positive fuse of the operating circuit, and on to terminal

D C on the controller board, then through the door contacts, which are located in the door frame at each landing, and back to terminal A S' and from here on through the auxiliary stopping magnet A S M, and back to terminal A S, on to contact arm U' on the stop motion switch, and back to terminal V' on the controller. From here it goes through the lifting magnet L C on the up switch and on to terminal U, which leads to contact V in the car switch, now in contact with lever X, connected to wire O, which connects to the safety switch in the car; from here to terminal O, then through the negative operating and main line fuse.

With this circuit closed and the lifting magnet on the up switch energized it will close the switch so that contacts number 1' and 3', and 2' and 4' are closed, and 5' and 6', 7' and 8' are open. The closing of this switch completes the armature circuit, shunt field circuit, brake circuit and the extra shunt field circuit. The direction of flow of current through the above four circuits is as follows:

Armature Circuit:—From the positive side of the potential switch to the blow out coils B C on the up switch, then to contacts 1' and 2', these are made with 3' and 4', and on to contacts 5 and 6 on the down switch, and from here on to terminal I on the motor, which leads to one of the brushes, through the winding on to terminal E on the motor and back to the holding coil H C on the down switch and on through contacts 7 and 8, also on the down switch; through the starting resistance S R to terminal F on the motor, through the series field to terminal H and back to the negative side of the potential switch.

Shunt Field Circuit:—From the up switch to terminal D on the motor through the shunt field winding to terminal H and back to the negative side of the potential switch.

Brake Circuit:—From the up switch through the four small contacts A on to the small contacts on the potential switch; from here to the terminal + B' on the top of controller board and on through the brake switch, through the brake coil to terminal -B on top of controller board and back to the negative side of the potential switch. The brake is also operated from the stop motion switch; a top is taken from terminal + B' through a resistance to terminal -SB on the controller board, from here down to contacts -S B and -B on the stop motion switch and back to terminal -B on the controller.

Extra Shunt Field Circuit:—From terminal D on the motor through the extra shunt field windings to terminal K' on the motor to the potential switch and on through the stop resistance to the lower contacts on the fast speed switch, from here back through the starting resistance, through the series field and back to the negative side of the potential switch from terminal H on motor.

With these five circuits completed, as shown in Fig. 3, the motor is running slow speed; to bring the motor to full speed the car switch handle is brought still further forward so that lever X makes contact on O-U and F U at the same time. When this is done the circuits will be as shown in Fig. 4, and the direction of flow of current is as follows:

The operating circuit from the positive fuse to the blow out coil (B C) of the potential switch and then through the switch contacts (Pot Sw) through the small fuse and on to the door contacts (D C) to terminal A S; then through automatic stop magnet (A S M) to terminal A S and on to contacts U' on the stop motion switch to terminal U'; then through the lifting coil (L C) of the up switch and on to contacts U and F U in the car switch, then through lever X to O through the baby switch to terminal O- to small fuse and out through the negative main line fuse.

When this circuit is completed the lower contacts (9 and 10) on the fast speed switch are opened and cut out the extra shunt field circuit and contacts 11 and 12 on the top of the fast speed switch are closed, also the four small contacts are made which then completes the accelerating circuit, thereby cutting out the most part of the starting resistance and the series field windings, so that the armature circuit is as follows: From the potential switch to the blow out coil (B C) and contacts 1'-3' and 2' and 4' on the up switch, on to contacts 5 and 6 on the down switch, to terminal I through the armature to terminal E and back to contacts 7 and 8 on the down switch, through a small part of the starting resistance, then through contacts 11 and 12 on the fast speed switch, and from here on to contact H on the accelerating magnet, and then through the potential switch to the negative line fuse.

The Shunt Field Circuit:—From the potential switch to terminal D on the controller board and motor, through the shunt field windings to terminal H on the motor and on to the negative side of the potential switch and the main line fuse. This circuit remains unchanged and is the same as the first setting.

The Brake Circuit:—This circuit is closed through the small contacts A on the up switch, also the small contacts on the positive side of the potential switch and from there to terminal B + on the top of the controller board; then through the brake coil to terminal B - and back to the negative side of the potential switch and the main line fuse.

With these circuits closed, as just described, the motor is now running full speed as a shunt machine. As the car approaches the upper end of the shaft the stop motion switch begins to act independently of the car switch and gradually brings the car to a stop.

When the operator in the car wishes to bring the car from the top of the shaft the car switch handle will be pulled backward and the various operations of the switches and circuits will be the same as when the car was on the up motion, that is the down switch will now be closed and the up switch opened.

New Power Scheme for Montreal

A second scheme for developing power on the Rivere des Praries, Island of Montreal, is projected, Messrs. J. R. Walker & Co., makers of sheathing felt, leather board, and friction board, having applied to the Quebec Government to construct a dam from the shore to Visitation Island, and a second dam from Visitation Island to Cedar Island. The power house is to be located on the Vincent de Paul side of the river. The company have a mill known as the Sault au Recollect Paper Mill. The scheme is understood to be in opposition to that of the Sault au Recollect Land & Power Company, which is backed by Senator M. J. O'Brien. The dam of the last-named company would be higher up the river, but would skirt Visitation Island.

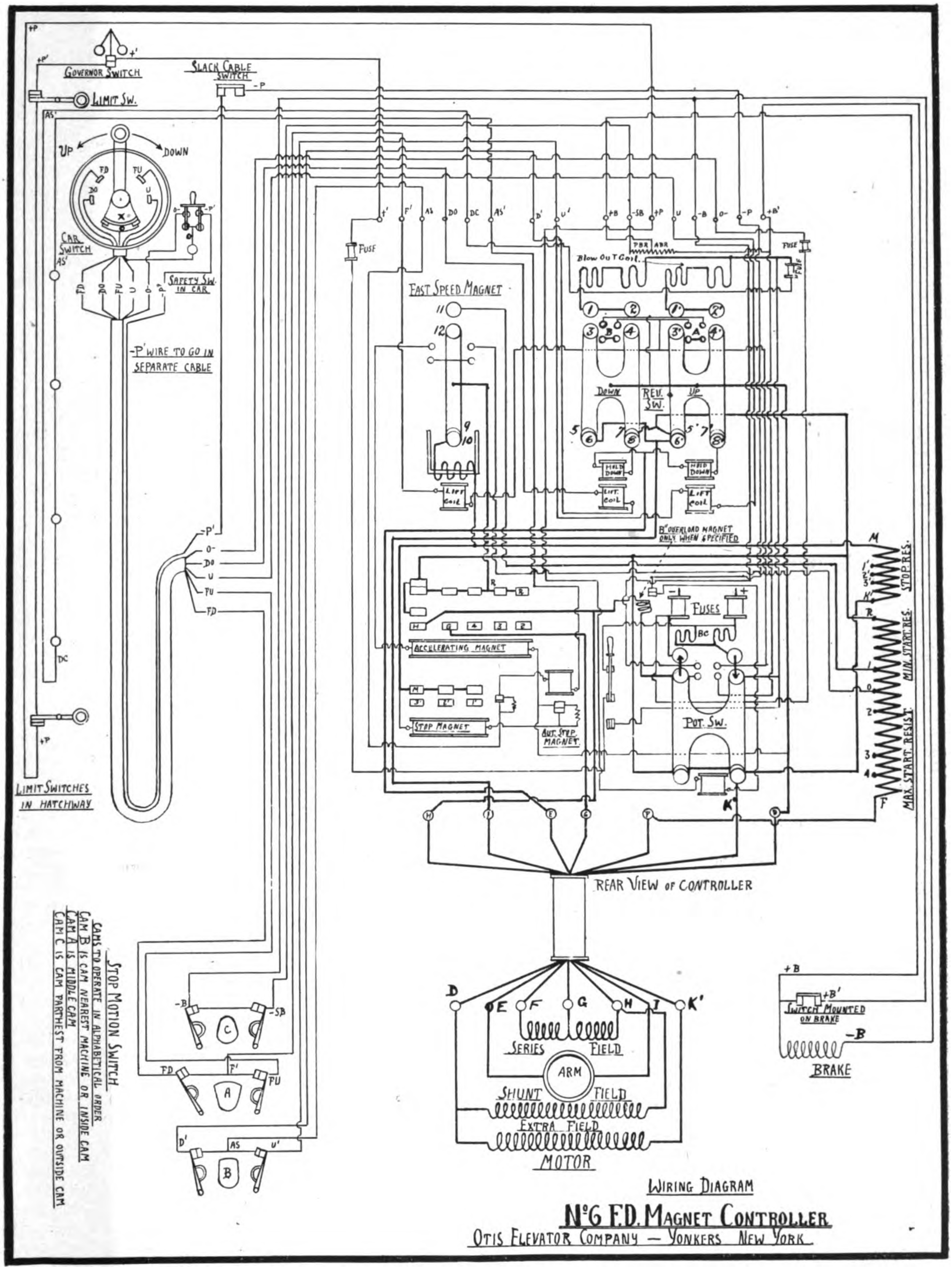
White Way Installation Completed

The White Way lighting installation on Garrison Avenue, Fort Smith, Ark., has been completed and placed in operation. The installation consists of 400 C.P. lamps, placed 100 feet apart on each side of the street. Ornamental brackets are used, attached to Bates expanded steel poles. Current will be supplied by the Fort Smith Light & Traction Company. The new installation is highly satisfactory and has been favorably commented upon by the press and public.

Answers to Correspondents

To the Editor of ELECTRICAL ENGINEERING:

Replying to the request in the November issue of your magazine to specify the proper winding for a ¼-h. p. 110-volt, 60-cycle, single-phase, A. C. motor, 1,750 r. p. m., I


Governor Switch
Slack Cable Switch
Limit Sw.
Up
Down
Car Switch
Safety Sw. in Car
-P' wire to go in separate cable
Limit Switches in Hatchway
Fuse
Fast Speed Magnet
Blow Out Coil
Down
Rev. Sw.
Up
Hold Down
Lift Coil
B' Overload Magnet only when specified
Fuses
Accelerating Magnet
Stop Magnet
Aut. Step Magnet
Pot. Sw.
Stop Res.
Min. Start. Res.
Max. Start. Resist.
Rear View of Controller
Stop Motion Switch
Cams to operate in alphabetical order
Cam B is cam nearest machine or inside cam
Cam A is middle cam
Cam C is cam farthest from machine or outside cam
Series Field
Arm
Shunt Field
Extra Field
Motor
Switch Mounted on Brake
Brake
Wiring Diagram
No 6 F.D. Magnet Controller
Otis Elevator Company — Yonkers New York

would say that in order to do this the following data should be supplied: Type of motor, i. e., repulsion start, or squirrel cage with teaser winding: length of stator core (punchings), inside and outside diameter of stator core (punchings), depth of stator slot, width of stator slot, top and bottom. I shall be glad to specify the proper winding if the above data are sent to me. Of course, the question could be answered in a general way by giving the theory of single-phase induction motor calculations, but I do not think that this is what your correspondent is interested in.

John F. Petrowsky.

486 North Sixth Street, Newark, N. J.

Trouble with Ice in Turbines

To the Editor of Electrical Engineering:

Referring to your article "Vertical Generators for Water-Wheel Drive," in your November issue of the Electrical Engineering. Turbine water wheels are undoubtedly an economic proposition, but out here in the Northwest, when the thermometer during the winter months frequently registers below the zero mark, water-driven turbines are frequently frozen to a standstill. There is plenty of water flowing to run the turbine, but a slush ice, that is not apparent, floats in the water when the temperature is below zero, and it sinks down into the blades of the turbine and freezes solid.

In my first experience with this slush ice, the water was delivered to the turbine in an open flume, then through a penstock of 35-foot head; but the slush ice dropped to the bottom of the penstock and the turbine was frozen solid. I then built a dam about 300 yards above the turbine and delivered the water through a pipe, the pipe being laid three feet under the ground, but the slush ice still came through and filled the pipe solid.

The only remedy I can see is to have individual penstocks for each turbine and a screen; in front of each screen a revolving churn that will throw out the slush ice and allow the water to enter the turbine. Of course, steam could be used to keep the turbines free of slush, but this would require the use of coal, and thus destroy the economic water power.

If you wish to publish this problem, perhaps some of the bright readers of Electrical Engineering may have something to offer on the subject.

J. M. O'Hara.

Family, Mont., Nov. 27, 1918.

Personal Notes

John H. Pardee, the newly elected president of the American Electric Railway Association, is president of the J. G. White Management Corporation, New York. He is a graduate of Hamilton College, and practiced law before he entered the public utility field as general manager of two companies at Canandaigua, N. Y. He joined the organization of J. G. White & Co., Inc., in 1907 as operating manager of the public utility properties controlled by that company. When the J. G. White Management Corporation was organized in 1913, Mr. Pardee was made president.

George B. Leland, general manager of the Stamford, Conn., Gas & Electric Company, will become president of the New England Section of the National Electric Light Association the first of the year. Mr. Leland is a native of Johnson, Vt., and has had many years' experience in the electrical and public utility fields.

Cyrus A. Whipple has recently been appointed power plant foreman of the United States Navy Yard at Bremerton, Wash. Mr. Whipple will have charge of all electrical, hydraulic, air and other power utilized at the navy yard and auxiliary stations. He is a graduate of the University of Washington and Cornell University, and has done much electrical engineering work.

I. H. Mills, who has been associated with the Westinghouse Electric & Manufacturing Company, of East Pittsburgh, Pa., for the past 23 years, has resigned to become Superintendent of the Sperry Gyroscope Company, of Brooklyn, N. Y. Mr. Mills began his career with the Westinghouse as a machine operator, and finally became Superintendent of the Small Industrial Motor Department.

Obituary Notes

Samuel S. Algire, for many years manager of the Farmers' Telephone Company, of Wolcottville, Ind., died there recently after a long illness.

John Nevin Perry, secretary of the Northwestern Supply Company, of Denver, died at his home in that city recently after a long illness. For many years he had been connected with the electrical supply business.

Captain Chester William Halstead, M. C., of Ridgetown, Ont., has been killed in action in France. Before enlisting, Mr. Halstead was manager at Ridgetown for the Bell Telephone Company. The official gazette, in referring to his gallant work at Paschendale, which won him the Military Cross, said, "His utter disregard for machine-gun fire inspired his men greatly. He, with his platoon, captured 77 prisoners and two machine guns, the latter being brought into action at once against the enemy. After the captured position had been consolidated, he went forward some 200 yards, where he met an enemy staff officer, whom, on his refusal to surrender, he promptly killed. He gave a splendid example of courageous energy and dash."

Made Works Manager at the Krantz Plant

L. E. Schumacher, who for the past eight years has been Chief Inspector of the Westinghouse Electric and Manufacturing Company, at East Pittsburgh, Pa., has been promoted to Works Manager of the Krantz Manufacturing Company, of Brooklyn, N. Y., the latest subsidiary of the former company.

Prior to his coming to the Westinghouse Electric and Manufacturing Company in June, 1900, he was employed at the Niagara Falls Power Company, which at that time was the largest electric water power installation in the world. His first duties at the Westinghouse Electric and Manufacturing Company were the erecting of switchboards. Two years later he was transferred to the Testing Department, where his previous experience was valuable in testing the various types of electrical apparatus. Later he was promoted to the position of General Foreman of this department. In 1908 he was made Assistant Chief Inspector, and in 1910 became Chief Inspector, which position he has held until now. He is especially prepared by his long experience in the manuture of safety switches, panel boards and floor boxes for his new position with the Krantz Manufacturing Company, as they make a specialty of these products.

Mr. Schumacher is a member of the Superintendents' Council, Past President of the Foremans' Association, Treasurer of the Athletic Association and Past President of the oldest tenpin league of Allegheny County, Pa., all of which are Westinghouse organizations. In addition, he was a member of the Edgewood Golf Club and of the Board of Governors of the Allegheny Mountain Division of the Amateur Athletic Association.

Vol. 52 DECEMBER, 1918 No. 6

ELECTRICAL ENGINEERING

A Monthly Journal for All Interested in the Practical Application of Electricity

Published at 258 Broadway, New York

Are Your Old Transformers Eating Up Profits?

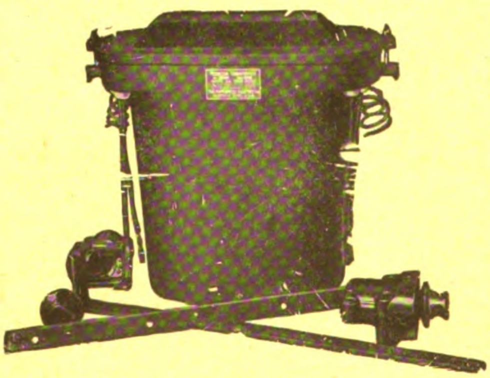
Tests recently made on a large distribution network show that transformers built a few years ago have so much higher iron losses than modern ones that handsome savings can be made by replacing and junking the "old-timers."

For instance, if a new 5 kva. transformer is substituted for one ten years old the saving in power will pay a 16% return on the additional capital investment. The iron used in early days aged so as to increase losses by 30 to 50%—a condition which has been removed by the use of silicon steel. Before deciding on your construction program, find out how many "profit-eaters" are on your lines. The field test is easily and cheaply made. Two men with a wattmeter can do it quickly by removing the primary fuses and reading the no-load losses from the secondary side. By comparing these with the guaranteed figures in the "Peerless" catalog, you can tell how many watts you are losing. Knowing your power cost, it's easy to see what you can save by installing

Age	Iron Loss	
	5 kva.	10 kva.
(years)	(watts)	(watts)
1-4	40	70
4-5	50	82
5-6	50	85
6-9	60	100
9-11	85	132
11-19	95	167

Data on Transformers of Varying Ages, 2200 to 220/110 Volts

PEERLESS TRANSFORMERS



Their silicon steel cores show practically no increase in losses—that means they will not "grow old" in service; no need to replace them except for accidents, or a growth of load.

The cool running of **"Peerless"** Transformers on no-load means that they have a greater reserve capacity during the short daily lighting peak. Their core type of construction aids the circulation of cooling oil and is better able to withstand the shock of lightning surges.

"Peerless" Transformers in sizes up to 10 kw. are contained in plain cast-iron cases, with pole-mounting hangers and primary cutouts furnished. Above 10 kw. the cases are of corrugated cast iron or sheet steel with all seams welded.

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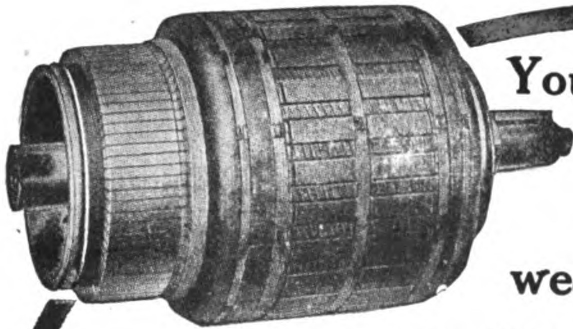

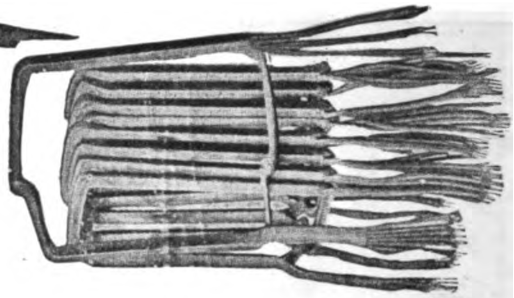

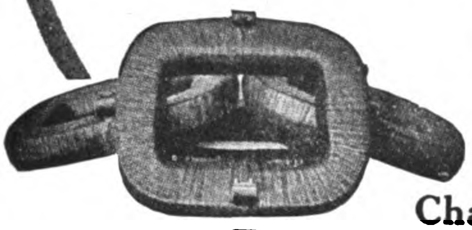

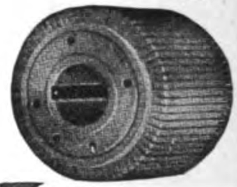

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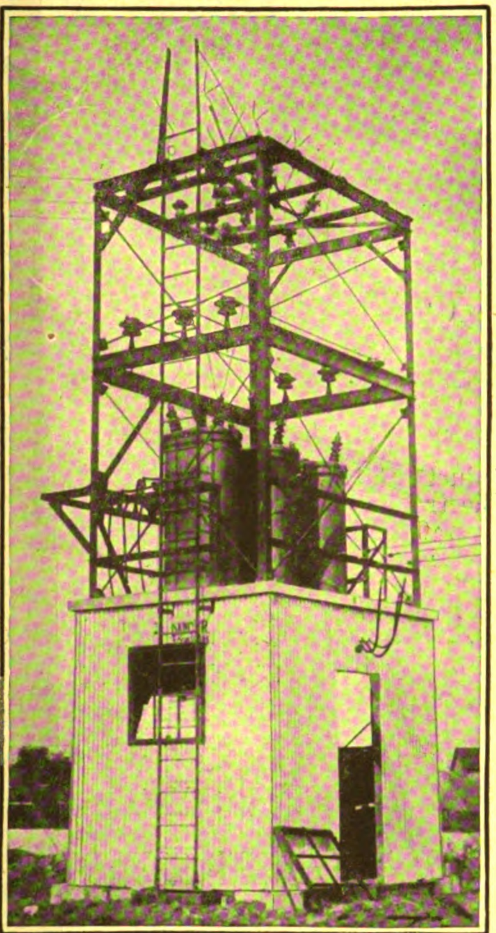

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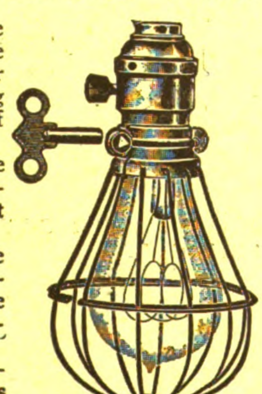

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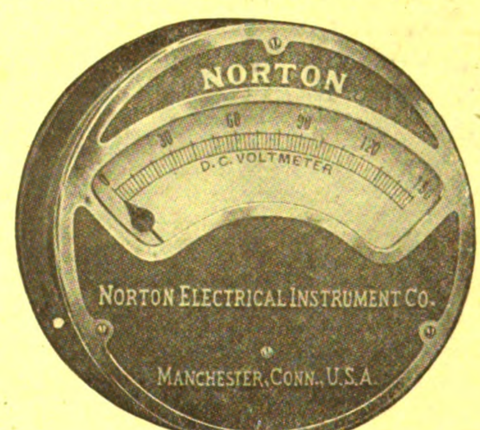

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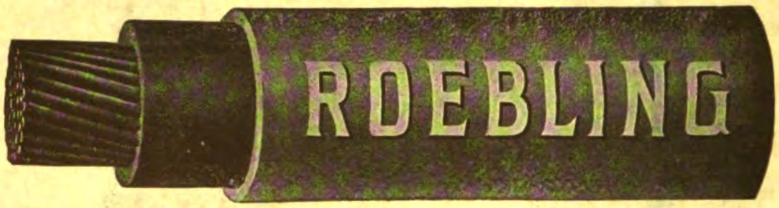

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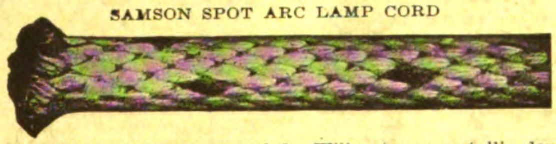

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Electrical Engineering

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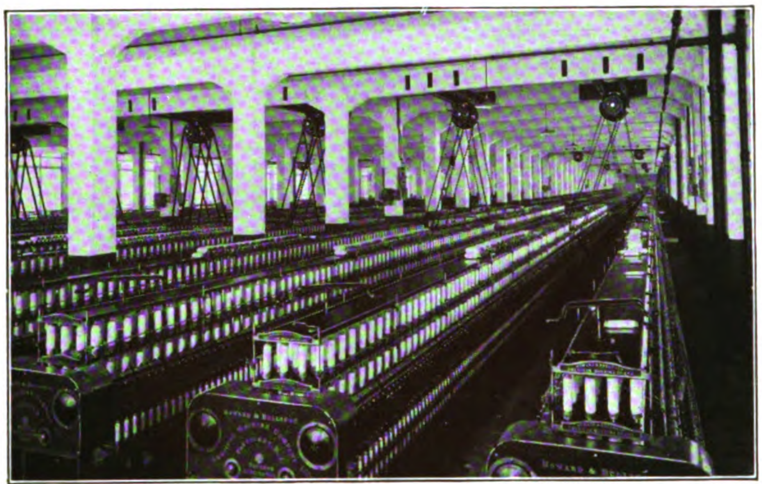

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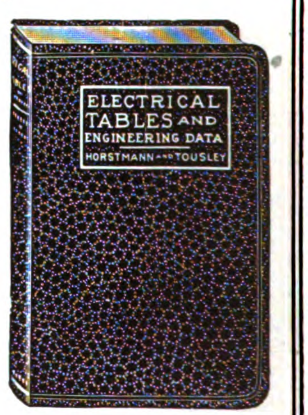

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258 Broadway New York

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ELECTRICAL ENGINEERING

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Municipal and Private Electric Lighting

A VERY exhaustive, valuable and interesting study of "The Results of Municipal Electric Lighting in Massachusetts" has been made by Edmond Earle Lincoln, Ph.D., Instructor in Economics and Tutor in the Division of History, Government and Economics, Harvard University. This is published in the series of Hart, Schaffner & Marx Prize Essays, which owe their existence to the enterprise of these Chicago merchants, who seek to encourage the study of economic and commercial subjects by American youth. (Boston: Houghton Mifflin Company. Price $3.00.) At the present time, owing to the operation by the Government of agencies of communication and transportation, there is a very general discussion of government ownership of public utilities. Aside from this war-time measure, electric lighting is the only business which has thus far been generally attempted by public bodies in the United States. As municipal electric lighting is now a well-seasoned business in this country, it affords the most fruitful field for an investigation of the results of public ownership. Mr. Lincoln, who holds a brief for neither side, chose municipal electric lighting in Massachusetts for investigation because of the fact that probably for no other public industry in the United States is it possible to secure even reasonably comparable data over a period of years, and adequate records for the purpose are to be found only in the State of Massachusetts. The first municipal electric lighting plant in the United States began to operate in 1881. Probably due to the fact that many of the smaller towns could not offer sufficient inducements to private capital, the increase in number of publicly owned stations was comparatively rapid. In 1892, as far as it can be ascertained, the entire number was 235, or 16.2 per cent. of all central stations in the country. Ten years later there was an increase of almost 250 per cent., to 815, or 22.6 per cent. of the total; while at the end of twenty years, in 1912, the number stood at 1,562, or 29.9 per cent. of the total, and increase of 565 per cent. for the period. The number of private plants, on the other hand, increased from 1,219 in 1892 to 2,805 in 1902, and 3,659 in 1912, a growth of 130 per cent. for the ten-year period and of only 200 per cent. during twenty years. These figures might prove misleading without some further explanation. On account of the frequent combination and amalgamation of private plants during the past fifteen years or more, the census reports at a given time fail to show the real addition in numbers over a period of years. Also, in some cases, data have been returned as if for a single station when in reality they covered a group of separate plants operated by a single management. While the number of municipal plants was increased by 310 during the period 1907-1912, a growth of about 25 per cent., the increase in the number of company plants between these dates was less than 6 per cent. This difference points to some rather important conclusions. The private plants appear to have been aware of the great advantages usually to be gained from consolidation and large-scale operation in the electric light and power business, and to have acted accordingly. The public plants, on the contrary, have, from the very nature of the case, been unable or unwilling to follow this policy. They have been prevented, no doubt, by local jealousies, by the fact that they are often widely scattered, and perhaps by legal difficulties.

Mr. Lincoln also calls attention to the fact that 170 private plants were transferred to public ownership before 1902; 113 additional transfers were made between 1902 and 1907, and 106 more between the latter date and 1912. On the other hand, while only 13 municipal plants changed to private ownership before 1902, and perhaps as many more were abandoned, there is a record of 38 more cases of this sort between 1902 and 1907; and a still more marked increase of 97 transferred and abandoned stations during the next period of five years.

As the book is a volume of nearly 500 pages, and is a thoroughly conscientious and comprehensive study, backed up in every instance with statistics, it is impossible to summarize it in brief. It may not be unfair to say that Mr. Lincoln concludes from his survey of the figures that public ownership, as compared with private management of the lighting business in Massachusetts, leaves much to be desired. Finally, Mr. Lincoln believes that, under such effective regulation of the electric light and power business as is found in Massachusetts at present, there is no reason whatever why a municipality should invest in an electric plant, certainly not in a generating plant. The book is one that no student of municipal administration can afford to ignore.

Electric Light and Power Stations in Wyoming

The number of commercial and municipal electric light and power stations in the state of Wyoming show a most decided gain since 1907, according to preliminary figures from the forthcoming quinquennial report, given out by the Bureau of the Census, Department of Commerce. This increase is almost wholly confined to the five-year period, 1912 to 1917, for which 23 new establishments were reported, 13 commercial and 10 municipal. All of the 20 establishments shown for 1912 were reported also for 1917. From 1912 to 1917 the total income increased $429,826, or 70.8 per cent., and the output of station 15,852,456 kilowatt hours, or 136.9 per cent. From 1907 to 1912 the corresponding increases were $289,515, or 91.2 per cent., and 6,081,483 kilowatt hours, or 110.6 per cent. Not only the number of employees, but their average annual compensation, have increased from census to census.

Electrical Industries and the Government

A new and powerful federation of American industries was created at the Reconstruction Congress of Industrial War Service Committees at Atlantic City. This association, made up of the nearly 400 War Service Committees that were formed under the direction of the Chamber of Commerce of the United States, was created by the Committees to act in the future as the spokesman for industry before the Government just as the Committees acted separately as the point of contact between industry and the Government during the war period. Speaking as it did, therefore, for the industries of the country, the resolutions that were adopted without a dissenting voice must have great weight. The convention went on record as opposing most unequivocally the government ownership and operation of telegraphs, telephones and cables, and it declared that the Congress of the United States should speedily enact legislation providing for the early return under federal charters to their owners of all railroads now being operated by this Government under federal regulations permitting the elimination of wasteful competition, the pooling of equipment, combinations or consolidations through ownership or otherwise in the operation of terminals, and such other practices as will tend to economies without destroying competition in service.

On two other important questions, the congress declared as follows: "Public utilities have faced difficult problems, which have been accentuated by conditions arising out of war. The development and efficiency of such a utility as local transportation has immediate importance for every community. It is recommended that the Chamber of Commerce of the United States should appoint a committee to investigate and study the question of local transportation as it relates to the control of rates and service, franchises, taxes, the attraction of capital into the business, and such other questions as the committee may find pertinent. Such a committee should report its recommendations to the Board of Directors of the National Chamber, and the Board should deal with them in accordance with the established procedure of the Chamber.

"Industrial activity is dependent upon the available supply of power. A bill which would affect the development of hydro-electric power upon waterways and lands which are subject to Federal jurisdiction is now before a committee of conference between the two Houses of Congress. It is important in the public interest that Federal legislation on this subject should be enacted without further delay. We accordingly urge that the conference committee arrive at an acceptable form of legislation in season for enactment at this session of Congress."

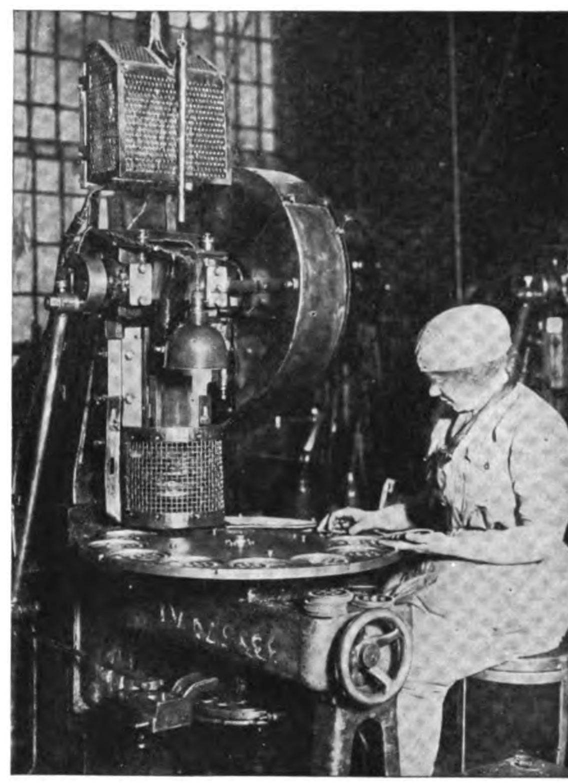
A City Created by Hydroelectric Development

As has been the case in most countries the efforts which industry has made in Norway to help itself and become independent of foreign markets have had great results, writes Commercial Attaché Edwin W. Thompson from Copenhagen. The enormous power in the hundreds of Norwegian waterfalls has been of invaluable importance. One of the main centers of this great industrial revolution is the district around "Sognefjorden," with its 100-mile water basin. None of the Norwegian fjords has such enormous water power as this one, and so, in recent years, one factory after another has been built there. The foremost of these is the enormous plant built by Norsk Aluminum Company, with the Hoyang Falls as source of power. During the past two years a new Norwegian industrial city has been built here, with many factories and good and satisfactory dwellings for the employees. When peace comes this will be an interesting link in the chain of Norway's tourist attractions. When all these plants are running normally they will be Europe's largest aluminum producers.

Women in Electrical Work

THE United States Department of Labor has just issued an interesting bulletin, describing British methods of training workers in war industries. A large number of them were employed in various branches of the electrical industry, and they seem to have more than made good. On the first engagement of women in electrical work, says the report, they were put to the machines in the shops, to general work (including armature work) in the electrical fitting shop, and to cleaning up and repairing a variety of electrical appliances. They worked under the instruction of skilled men, and from the onset their progress was encouraging. In July of 1917 the chief draftsman began a series of popular lectures to women on elementary matters affecting their work. One lecture was on materials; another on the cutting tools of machines, including drills; another on hand tools for metals; another on rules, micrometers, calipers, gauges and screws. The next series dealt with electrical theory. In one lecture an elementary explanation was given of force, work power and electrical energy; in another, the elementary notions of pressure, current and resistance; in a third, the laws of resistance; and others dealt respectively with the electrical circuit and its practical units, electrical power, and the effects of current in a circuit. One lecture then dealt with magnetism and its application to electromagnets; another with the general phenomena and construction of dynamos, and others with the construction and winding of coils and the construction of rheostats. Two lectures dealt with the principles of telephones and their application to various marine types; and the course was concluded by three lectures on electric lighting, dealing respectively with the electric lighting of ships and of shore establishments, and the construction, use, and abuse of electric cables and wires. Two supplementary lectures were given on special types of appliances. The lecturer was of opinion that some of the women did not look favorably on the course, and it is possible that it covered more than some of the hearers could reasonably be expected to assimilate. At the same time, no doubt is felt that the general efficiency of the women is due in part to what was taught them in this way, and, indeed, a considerable and perhaps a sufficient effect may be produced on the practice of shop when knowledge such as was conveyed by these lectures is distributed among the workers, who may be left to influence each other as far as is practically important, with much that they did not pick up individually in the class.

To whatever cause, however, the result may have been due, the progress made by women has been both wide and rapid. Their work in the shops at the present time includes lathe and machine work, engraving, and lacquering; armature and coil winding; making firing circuits, portable electric-light fittings, etc.; repairing and testing motors and secondary batteries, including cleaning and reaciding; repairing, calibrating, and testing electric meters; joinery; coppersmiths' work and zinc lining. They also clean, repair, and test range-finders, and do the whole of the work on bell, hummer, and various types of telephone circuits, working in the proportion of about five women to one electrical fitter as instructor. On the general establishment light and power system they take part in the care and maintenance of the machines, including motor generators and yard lighting, meter reading, the switchboard at the generating station, etc. A large number of them, by their own choice, are working on piecework.



SAFETY GUARDS FOR WOMEN WORKERS
All of the machines in the Westinghouse factories have every possible safety appliance

In the autumn of 1917 it was decided to introduce women on board ship to rewire electric light and power circuits, to do repairs or general installations, etc., work that was originally done by electric fitters and latterly by up-gradeed skilled laborers. Those who were intended to work on board ship were placed in gangs of about 20 women under two capable electrical fitters from the men in the department, and given a room in which parts of imitation bulkheads were fitted up, and the actual cables, lamps, switches, section and distribution boxes, etc., as used on board ship, were put into their hands. In that room they were taught to put up short but complete ship-wiring installation, including almost every particular process originally done by electrical fitters. From four to six weeks is found sufficient to fit them to be taken on board, and about another week, for those who had not worked on shipboard before, was required to give them sufficient local knowledge of ships to be able to master the relative positions of the various decks, compartments, etc. As a rule each gang was accompanied by the fitters who had taught them, and by a chargewoman whose chief duty was to see that they kept steadily to their work.

The work on board ship includes rewiring electric light and power circuits, repairing general installation, etc., and was originally done by men. A number of women are working, by their own wish, on piecework, and some have earned up to 90 per cent excess of their time rate. They work always in couples. The proportions in which women of various grades are put on to ship work are roughly 65 per cent fully trained and carrying out the work in all its branches; 15 per cent being trained preparatory to being drafted on board; and 20 per cent being entered for training. The whole of the staff of women is under the general charge of two inspectresses, one for those on ship board and one for the land shops and yard. These have no technical functions as electricians, but supervise the moral, physical, and general welfare of the women during working hours, and support the charge hands in keeping the work steadily going.

An Edinburgh firm has recently started training women in blowing electric lamp bulbs. These women have now had had three or four months' experience, and the firm reports favorably on the progress made. Some of them have turned out as many as 400 good bulbs per day. The process consists in "gathering" a sufficient quantity of glass from the pot of molten glass in the furnace; "marvering," or rolling the glass into cylindrical form; blowing the glass out partly, and allowing the bulb to lengthen by the action of gravity; completing the operation in a mold of the proper shape. The opening and shutting of the mold is operated by the blower's feet.

On account of the heat of the furnace in which the glass is made, and the necessary exposure to a very high temperature during gathering, the process has not hitherto been considered suitable for women. Screens, however, have been erected to prevent too much heat radiating to the workers.

In this country an immense number of women have been employed in the various electrical industries, called to it by the labor shortage, and it is unquestioned that many of them will remain after the stress of the war is removed. The general testimony is that the women have made good far beyond the most optimistic expectations. The Westinghouse Electric and Manufacturing Company, alone, employs 5,000 women. They are generally known as overettes, because they wear, for convenience and safety, specially designed feminine overalls. The methods that are followed in fitting the girls for their tasks are interesting. When the new employe leaves the employment office, she is not put at work for three weeks or more. She spends this period in a training school, her wages starting, however, on the hour she enters the works, i. e., she is paid while learning. In this school the fundamental principles and practice of machine operation are taught. Aside from the school's efficiency value to the girl as well as to the company, it has a certain moral or psychological effect. The novice is prepared gradually and thoroughly, so that when she is assigned to a machine, she feels that glow of confidence that moves mountains. It's a great asset, too, for the green employe; for it saves enduring a period of "blues" and discouragement that is often too much for the timid.

The first training course is given in what might be called a "Vestibule School." It saves the employe from learning a productive operation side by side with experienced labor, trusting to chance and friendship, or a sympathetic foreman, for instruction. She is not subject also to ridicule—a deadly poison to the timid. The training that has been given is necessarily short and intensive because of the imperative demand for help. A graduate machine tool maker devotes his entire time to this work, teaching the girls to read blue prints, to use the scale, the micrometer, how to set up machines, shop rules, discipline, the system of wages, and other basic practice. Special instruction is then given on lathes, drill presses, assembling, grinders, shapers, screw machines, milling machines and bench work. No specified time is set for the completion of the course, as occasionally a girl showing unusual aptitude is retained for more highly skilled instruction, and again some girls require more time to learn the simpler operations.

Just recently a class has been organized to train girls in lettering, tracing, mechanical drawing, mathematics and applied arithmetic. This course requires two years' previous training in high school work. Then this has been supplemented by a class for the training of shop clerks, production, time, cost and file clerks and inspectors. They are also paid a day rate while learning.

In addition to the Vestibule School, the Westinghouse Company maintains a so-called "Promotion School." The former school is for new employes, only. However, it is necessary to provide instruction for old employes who desire promotion or a change of occupation. If such is the case, they are placed in this promotion school on part, or even full time for intensive training. This school has the same economic training features as the Vestibule School, minimizing time in learning, and eliminating waste. The best feature of this school is the fact that the girls in the works know that by application and study, direct means are provided for advancement.

Leaving the Vestibule School, the girls enter the shops, capable of assuming considerable responsibility and prepared to operate a machine requiring skill. Perhaps the finest feature of the new work is the moderate physical exertion required. Of course, operations where heavy lifting is required cannot be done by them, but they excel in application and dexterity. Some seem to have a decided bent for mechanics. One girl has mastered ten different operations on a drill press and asked for a chance to learn more. She has also operated balancing machines, assembling ball racers and cones and brush holders. Generally speaking, all the girls excel in assembling operations where application and speed count.

Extra precautions are taken that every belt is guarded and that the most improved safety appliances are used on every machine. The overette costumes themselves are so designed that there is no danger of their clothing getting caught and causing injury.

Lunch rooms and rest rooms are provided, and a regular cafeteria is maintained where a complete meal may be purchased at cost prices. A separate relief department for women has been created, with a trained nurse in attendance. In conjunction with the Westinghouse Electric and Manufacturing Company, the Western Pennsylvania League of Women Workers has organized a large community club at Turtle Creek, a community adjacent to East Pittsburgh, which in addition to its recreational activities has initiated a plan for building dormitories for the girls. The Casino Technical Night School, though planned primarily for the employes of the company, extends admission to all, regardless of occupation, previous education, or present place of employment. The engineering course is open to women. It is designed to give a clear comprehension of the scientific principles upon which the practical work depends. Mathematics, drawing, physics, mechanics, English, chemistry and a knowledge of materials form the basis of the course. The latter part of the course specializes in electricity and steam.

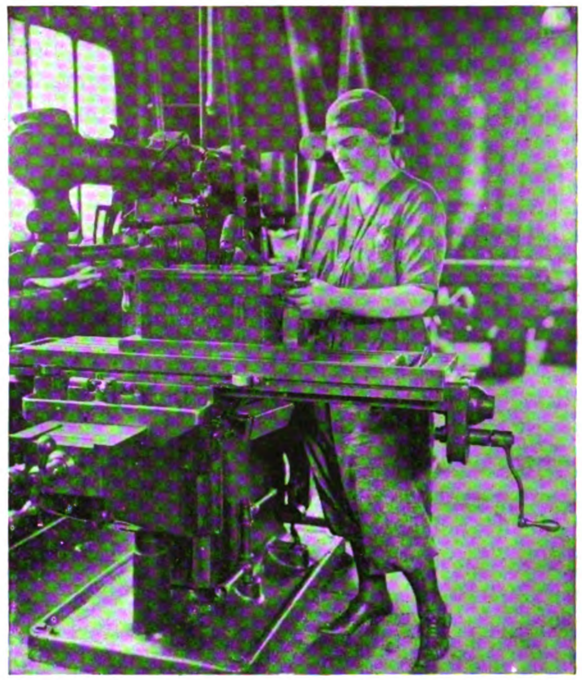
Electric Drive for Future Warships

Electric propulsion for our navy vessels has proved a great success, according to Secretary of the Navy Daniels, and all new capital ships of the American Navy will be equipped with electric propelling machinery. At a meeting of the House Committee on Naval Affairs, Secretary Daniels said that the new electrical engine had been installed and thoroughly tested on the dreadnought New Mexico, and that it was a wonderful success, furnishing American fighting craft with an engine superior to that in any other navy in the world.

It is contended that the new engine is more economical of fuel, develops greater power, is more mobile, and is less easily put out of commission by torpedo explosions than other naval engines. It is approved, the Secretary said, by all the great naval experts and advisers, including the General Board of the Navy.

The Secretary furnished to the committee a formal statement regarding the new engine, as follows:

"I recently paid a visit to the battleship New Mexico, which is the latest dreadnought to join the fleet and the first and only one of any nation to have electrically operated propelling machinery. On this account she has been an object of surpassing interest to the officers of our own navy, and to those of foreign navies as well, and to electrical engineers in general.



Girl Worker in a Westinghouse Factory

"You will remember that when we decided to equip the capital ships of the 1916 program with electric drive it was represented to this committee and to the Navy Department that we were making a great mistake and that we should think twice before embarking on such an unprecedented experiment. I did not regard it as an experiment, for we were in the fortunate position of being the only nation that had had any experience with this system of propulsion, and that experience was of such a satisfactory character that it would have been unpardonable if we had not profited by it to the fullest extent possible.

"The General Board was unanimous in advocating its adoption because of the superior military advantages that its use would secure, and Rear Admiral Griffin, Chief of the Bureau of Steam Engineering, not only saw no objection to it from a technical standpoint, but was strong in his advocacy of it. Added to this, the best advice that I could get outside the Navy Department was so convincing of the efficiency of electric drive that I had no hesitation in giving my approval to its adoption.

"Under the circumstances it was but natural that I should have awaited the trial of the New Mexico with interest to learn how well her machinery had functioned—I never doubted that it would prove a success. The result was satisfactory from every point of view and confirmed the judgment of all who were in any way concerned in its design and adoption. There was not the slightest mishap with any part of it; everything worked to perfection, and the crew was as enthusiastic over the performance of the machinery as is the department, proud in the possession of such an efficient dreadnought.

"The machinery was designed to develop 26,500 horsepower at full speed, which it was expected would give the ship a speed of 21 knots. She actually developed more than 31,000 horsepower, and maintained for four hours a speed of 21¼ knots—and this when running at a displacement 1,000 tons greater than her design called for. If she had been tried at her designed displacement, as is customary with all new ships, she would have made 21.5 knots, without any trouble whatever; and, what is still better, she could have kept up this speed as long as her fuel lasted, for, like all our later dreadnoughts, she is an oil burner, and there would be no reduction in speed due to the necessity of cleaning fires, which must be done in coal-burning ships after a run of four hours at top speed.

"When we entered into contract for the machinery of the New Mexico, we stipulated that, in addition to being capable of developing the maximum power, it should also give an economy at cruising speed very much superior to that obtainable with the turbine installations that we had previously used, and I am happy to say that this stringent requirement also was met. As a matter of fact, the New Mexico will steam at 10 knots on about 25 per cent. less fuel than the best turbine-driven ship that preceded her."

Placing Trained Army Men

America's greatest assets, the brain power and energy of her thoroughly trained young men, are the commodities in which the Professional Division of the United States Employment Service is dealing. Officers and men of the Army and Navy released from active service are being registered with the Division, and placed in touch with those employers who can best make use of their services.

The Professional Division deals only with those men who are well equipped by education and experience in their particular lines of work. The record of each men is carefully investigated before registration is permitted. Many university graduates in mechanical, electrical and civil engineering and in chemistry and other technical men with several years of practical experience have already registered. These men who willingly severed their business relations more than a year ago to give their services to their country are returning to civil life to find changed conditions. Although the industry of the country has great need of their services, neither men nor employers are able, without assistance, to discover each other immediately. To avoid delay in the readjustment processes, not only the labor of the country but also the highly trained directors of industry are being mobilized with the assistance of the Government. The aim is that each man shall fit in that part of our business organization where he can do his best work.

The task of dealing with thoroughly trained men who in many instances can command high salaried positions is requiring the assistance of those technical organizations which have heretofore placed university graduates and experienced men with employers. The Professional Division is seeking to co-operate with all such societies by referring properly qualified men to them, or by obtaining from them data on positions available.

The engineering field appears to present the largest problems of the Professional Division. Thus far, nearly one-half of all the applicants have been qualified for work in various forms of the engineering profession. The temporary lull in general construction work has in part closed one field which, it is believed, will be more available by the time the overseas forces begin a large scale of demobilization.

The Professional Division of the United States Employment Service has its New York Office at 16 East Forty-second Street. Its registrations of experienced men are increasing. Employers seeking such men are asked to inform the Professional Division of the precise nature of the positions which they have available. Only those men who are well qualified to fill such positions are referred to the employer.

Electric Industries of Sweden

One of the leading Swedish newspapers has the following to say concerning the electrical industries of that country: "During the war many Swedish industries have had great difficulties to contend with; for example, the separator industry with regard to shortage of material and restrictions made by the importing countries.

"Our electro industries are expecting better conditions with regard to manufacture and export. The shortage of metals will undoubtedly be improved gradually so that the markets that the war has closed can again be opened. Hopes may be directed toward the other European and transoceanic markets where Swedish manufacturers expect to have good chances on account of extended shipping possibilities and equalizing of exchange rates which, by the high value of the Swedish crown, has given us an advantage especially with regard to the American competition. There seems to be no fear of foreign competition in the matter of hydro-electric work, as the new law makes it easier to exploit water power within the country.

"The chemical industry during the war has rendered the country great services, such as extended manufacture of carbide and new explosives, without which it would have been very difficult to keep the mining industry going. Nitrogen manufacturers may expect strong competition from Germany, but the importance of this competition must not be exaggerated, as our companies have constructed their plants and the necessary electro-power at peace prices, and this is a great point in the competition."

Telephone and Wireless Transmission

WHEN the greater part of the civilized world became engaged in the greatest war of all history, those of philosophic tendency began to discuss the general effect of war upon human nature and activities. It was pointed out that the tremendous conflicts of the past had stimulated the imagination of mankind and had stirred all of the deeper feelings so that they were coincident with periods of unexampled intellectual effort. It is too early, as yet, for us to measure the effect of the war upon literary, poetic and artistic creative effort. But we can already begin to see that the world struggle has done more than several decades of peaceful progress for the development of industrial, applied and pure science. More than one of the great nations was cut off from its accustomed source of supply for the most important of raw materials, and so was forced to find native substitutes. Putting aside all consideration of the development of the strictly war-like arts, the perfecting of aeroplanes, submarines, artillery, explosives, poison gas and the like, who can measure what has been accomplished in chemistry, for instance? The making of dyes and the utilization of new sources for potash, to render ourselves independent of Germany's former monopoly, for instance, is a wonderful chapter of achievement. In no other war in the history of the world has electricity played so important a part. Naturally, then, we shall soon see numberless new applications of electric power, not, perhaps, the direct result of the contest itself, but due somewhat to the stimulation of research and inventive ingenuity by the war.

The entire electrical world was interested in the recent announcement from Washington of the perfecting of a new multiplex telephone and telegraph device, which the engineers of the Bell system believe is the greatest invention since the original discovery of the possibility of electrical transmission of sound. The apparatus has been in successful operation on circuits between Baltimore and Pittsburgh for a sufficient time to demonstrate that it is a complete commercial success. The new device makes it possible to carry on at the same time five different conversations—two one way and three the other, but not all in the same direction—over the one pair of wires of a single telephone circuit. In telegraphy, it makes such a circuit available for forty simultaneous telegraph messages. If desired, the circuit can be made to carry part dots and dashes and part spoken words simultaneously.

Mr. Theodore N. Vail, president of the American Telephone and Telegraph Company, in announcing the new discovery to Postmaster General Burleson, gives some interesting particulars. "With this new system," he says, "four telephone conversations over one pair of wires are simultaneously carried on, in addition to the telephone conversation provided by the ordinary methods. Thus, over a single pair of wires, a total of five telephone conversations are simultaneously ope-

GIRLS LEARNING TAPE-WINDING
A part of the practical training given women workers in the Westinghouse plant

rated, each giving service as good as that provided by the circuit working in the ordinary way.

"Heretofore the best telephone methods known to the art provided only one telephone conversation at a time over a single pair of wires. A number of years ago, we developed the 'phantom circuit' arrangement by which three telephone circuits are obtained from two pairs of wires, an important improvement of which we have made extensive use. Now by our new multiplex method, we are enabled to obtain five telephone circuits over one pair of wires—that is, ten simultaneous telephone conversations from the two pairs of wires which formerly could be used for only three simultaneous telephone conversations.

"This represents an increase of more than three-fold in the telephonic capacity of the wires as compared with the best previous state of the art, and a five-fold increase under conditions where the phantom circuit is not employed. In telegraphy, as well as in telephony, sensational results have been attained by the new system. By combining two telegraph wires into a metallic circuit of the type used for telephone working, and by applying our new apparatus and methods to this metallic circuit we have enormously increased the capacity of the wires for telegraph messages. As applied to high speed printer systems, we can do eight times as much as is now done, and as compared with the ordinary duplex telegraph circuit in general use, we can do ten times as much. Thus increased results are attained without in any way impairing the quality of telegraph working.

"Hundreds of the men of our staff have co-operated in the work, and it is impossible to name any one man who is entitled to even the major part of the credit for the result. Without, however, detracting from the credit due to any one of them, there are a few whose contributions to the system have been so distinctive that they should be named here. They are: O. B. Blackwell, G. A. Campbell, H. S. Osborne, J. R. Carson, Lloyd Espenschied, H. A. Affel and John Davidson, Jr., of the engineering department of the American Telephone and Telegraph Company, and E. H. Colpitts, H. D. Arnold, B. W. Kendall, R. A. Heising, H. J. Vennes, E. O. Scriven and H. F. Kortheuer, of the engineering department of the Western Electric Company, the manufacturing division of the Bell system.

"From the earliest days of both the telephone and the telegraph, there have been almost numberless attempts by inventors, scientists and engineers to develop methods for the multiplex transmission of messages. It was while working on the problem of multiplex telegraphy that Dr. Bell had his first conception of the structure of the original telephone. Now the organization which is continuously working to perfect the telephone and to extend its usefulness, has accomplished not only multiplex telephony, but also multiplex telegraphy and has solved the telegraph problem upon which Dr. Bell was working over forty years ago.

"While heretofore no substantial practical results had been obtained notwithstanding the efforts which have been directed to this problem, some proposals made by the earlier workers in this particular field have naturally proved suggestive in the successful solution of the problem. I have in mind particularly a suggestion made by Major General George O. Squier, Chief Signal Officer of the United States Army, about ten years ago and which at the time attracted very general attention. Furtherfore, while working in entirely different fields and with a different objective, Dr. Lee DeForest a number of years ago invented a wireless device known as the audion, which by our improvements and adaptation we have made an important part of our system."

Another announcement of improvement in electric transmission of sound has met with considerable skepticism, and adequate proofs of the actual accomplishment of what is claimed are yet lacking. Some time ago the statement was made that Roy A. Weagant, chief engineer of the American Marconi Wireless Telegraph Company, had succeeded in virtually removing static disturbances, the chief obstacle to the transmission of wireless waves. If this has been accomplished, there will be scarcely any limitations to wireless communication; we may even succeed in getting messages to and from the planet Mars, if that mysterious world is populated by intelligent beings. But in discussing the matter, nearly all of the scientists and electrical experts put great stress upon that very important word, "if."

Nicola Tesla, regarded by many as one of the greatest electrical wizards in the world, has been interviewed as to the claims put forth on behalf of Mr. Weagant.

"Why, I eliminated static effectually nearly twenty years ago," he said. "There is nothing new in this latest claim. If the wireless people applied my old principles, used my old apparatus the way it should be, static would not bother them. Static interference here is very slight compared with what it is in Colorado, as every wireless operator knows. Yet I overcame static completely at my experimental station in that State, erected in 1899."

"Have you been able to illuminate electric lamps by wireless currents?" Mr. Tesla was asked.

"I have given public demonstrations of that simple thing right here in New York City. I have held the globes in my hand. The current has been turned on, and the lamps lit."

"How about the transmission of high-power current?"

"Merely a matter of development. I have stated that it was possible, even easy, to build a power plant which could distribute 10,000 horse-power under a tension of one hundred million volts, which can be handled with safety.

"This energy could be collected all over the globe, preferably in small amounts, ranging from a fraction of one to a few horse-power. It could be used principally for the illumination of homes, as it takes but little power to light dwellings with vacuum tubes operated with high-frequency currents, and in each instance, a terminal, a little above the roof, will be sufficient."

Mr. Tesla said that standard time clocks all over the globe and similar apparatus could be driven and regulated by wireless. He said that when one recognized that this planet, in spite of its great size, was to electric currents nothing more than a small metal ball, it could easily be understood that all sorts of possibilities, of incalculable consequence, were rendered absolutely certain of accomplishment. With static eliminated, he continued, and the establishment of a number of wireless plants throughout the world, the problem of instantaneous world communication was solved. He declared that all that was needed was a cheap and simple device which could be carried in one's pocket, could be set up on sea or on land, and it would record the world's news, or such special messages as were intended for it.

Prof. M. F. Pupin, of Columbia University, himself a radio expert of the highest standing, is skeptical. "Whoever solves the static problem," he said, "would open up such possibilities in wireless telephony and telegraphy that he would be regarded by future generations as one of the world's greatest scientists. Such a discovery would do more to join South America to us in spirit and understanding than anything else could do. Any country newspaper in South America could stick up a tower, twenty feet high, and receive all our news. The same could be done all over the world. We could exchange thought with the whole world. That is civilization."

But Professor Pupin did not believe for a minute that Mr. Weagant had solved the static problem. In the first place, he said, the announcement should have been made in an orthodox scientific fashion at a meeting of scientists. He saw no reason why a demonstration should not be given at once. He said it could be done without disclosing the secret of the discovery, if the Government objected to making it public.

Overload and Reverse Power Relays

By A. E. Hester

THE art of protecting transmission lines by means of relays has advanced very rapidly during the past few years. Though a great many types of relays have been produced, but few have survived the acid test of service on modern power systems. The relay, though one of the most inconspicuous things in a power station, is nevertheless, one of the most important items in its equipment. Figuratively speaking, relays constitute the nervous system of that wonderfully complete body, made up of generating stations, substations and transmission lines. It is the part of the relay to detect and locate anything which tends to prevent any of these members from performing their proper function. When the trouble has been detected, apparatus which will isolate the faulty member from the remainder until the trouble has been remedied, must be set in motion. Thus the relay is called upon to display an almost human intelligence and must function with a speed which is scarcely within the power of man. These requirements have been complied with and it is safe to say that, as the art advances, much improvement will be made.

Many schemes have been used and, strange to say, the first has, up to the present time, given the most satisfactory service. In this scheme of protection an overload relay is used at the generating end of the feeder when applied to radial systems while on systems which include sections of parallel feeders, a reverse power relay is used at the substation end in addition to the overload relay at the generating end. At first overload relays only were necessary as feeders, were not operated in parallel, a spare line being left available in case the first one failed. Then the economy of having all the lines in service all the time was realized and as the demand for continuity of service could not be disregarded it became necessary to develop a reverse power relay for use at the substation end and operate the feeders in parallel.

Various types of both overload and reverse power relays have been developed, but the induction type has proven itself to be the most satisfactory, both because of its accuracy and permanence of celebration and because of the fact that most modern power systems use alternating current for the transmission of power. In discussing induction type overload and reverse power relays we will first consider what each is, its operation and construction and finally how both types are applied to various systems.

An overload relay may be defined as any relay, the contact mechanism of which is operative only when the current in the circuit, to which it furnishes protection, exceeds a pre-determined value. It would be remembered, however, that transmission line relays are rarely even used for overloads in the usual sense of the term but are called upon, usually, to operate on heavy short circuit currents amounting to many times the value of the normal load current.

The induction type overload relay, as the name implies, is merely an induction type ammeter, the movement of which is restrained by a spring. Until the current flowing in the relay windings exceeds a given value, this spring holds the movement at its normal position. Then, except for external influences, for all currents above this critical value the time of operation of the relay is inversely proportional to the amount of current flowing. However, it has been found desirable to have a minimum definite time in which the relay can close and the method of attaining this feature will be described later.

The relay consists, essentially, of an electro-magnet so wound as to produce a rotating field, a metal disc mounted, between the poles of this electro-magnet, on jewel bearings, a permanent magnet for damping the movement of the disc and a pair of contacts actuated by the movement of the disc. These parts are all mounted on a frame, the permanent magnet being placed diametrically opposite to the electromagnet on the disc. The whole is then mounted in a dust and moisture proof case, as shown in Figure 1.

The contact system is very simple, one being placed on the mounting frame and the other being carried by the disc. The current is conducted to the moving contact by the restraining spring, which is heavy enough to carry all ordinary tripping currents. For extremely high currents an internal contaction switch is provided, as will be described later.

The relay windings, as may be seen from Figure 2, are the same as used in the induction type ammeter, consisting of a primary winding, through which the actuating current flows, and a secondary winding, short circuited on itself and supplying the rotating field effect. Tops are brought out at different points on the primary winding and carried to a terminal block so that by inserting a screw in the proper hole in the block any desirable current setting may be attained. Any reasonable number of tops can be supplied, thus giving a larger range of current adjustment. Also in the secondary winding a small one to one ration transformer is inserted. This transformer, or torque compensation as it is termed, is so constructed that its core becomes saturated at a definite value of current and irrespective of the amount of current flowing in the primary winding, the current in the secondary cannot exceed a given value. Thus the torque on the disc is limited to a definite value and this in turn limits the time in which the contacts can close. In this way the minimum, definite time feature is obtained and is usually placed at about two seconds for the maximum travel of the moving contact.

The maximum distance through which the moving contact and disc can travel is limited to 180 degrees. The line setting is obtained by means of a movable lever which limits the disc travel and which can be set at any point in its arc of travel. This lever moves over a scale divided into ten arbitrary divisions and is provided with a stop against which the moving contact support rests. Characteristic curves taken for each point on the time scale are shown in Figure 3, and it will be observed that the time of operation for any load is proportional to the lever setting. A view of the relay showing the time setting arrangement may be seen by referring to Figure 4.

Thus we see that the time and current settings are each independent of the other and that there is a minimum definite time characteristic which precludes any danger of the relay operating on momentary surges and does not allow the time to drop below a minimum definite time on extreme overloads. These settings are very easily made as may be seen by the following example: Suppose we have a case in which we wish the relay to act in one-half second with a load of 500 amperes in the circuit which it protects, the current transformer having a ratio of 100 to 5. This gives us a secondary load of 24 amperes. With the contact screw in the terminal block at the 5-ampere tap 25 amperes would be 500 per cent. load current. Referring to the characteristic curve shown in Figure 3 we see that for one-half second on the 500 percent. line we will have to set the time lever at No. 2 on the time scale. Likewise any given time for any given load may be obtained.

When unusually heavy tripping currents have to be handled the relay is equipped with an internal contactor switch which shunts the tripping current by the relay contacts, thereby relieving them of the duty of carrying the heavy current. As shown in Figure 5 the operating coil in series audits its contacts in parallel with the relay contacts. It remains open until the relay contacts have closed and then it closes and remains closed until the pallet switch on the circuit breaker opens. Oscillograms show that it will close in every case before the tripping current has risen beyond the capacity of the relay contacts. Besides relieving the relay contacts of the duty of carrying the heavy current another advantage is gained in that if the load current falls to normal before the circuit breaker has opened the relay will not have to open the tripping circuit as the contactor switch remains closed until the circuit breaker opens. A view of this switch is shown in Figure 4.

A reverse power relay may be defined as any relay, the contact mechanism of which is operative only upon a reverse in the direction of flow of power in the circuit which it protects. The induction type reverse power relay consists of two elements, a current element exactly similar to the overload relay described above, which closes its contacts at a given time on a given load, and a wattmeter element which discriminates as to direction of power flow. These two elements have their contacts connected in series so that the tripping circuit is closed only upon a simultaneous overload and reversal of power. As may be seen from Figure 6, the winding of the wattmeter element is the same as those of the standard wattmeter. The wattage coil is composed of a great many turns of fine wire, while the current coils consist of a few turns of heavy wire. This, of course, gives the proper phase relations for a rotating field. The current coils are connected in series with the primary winding on the current element and the relay is connected to the circuit through the proper current and voltage transformers. As in the current element, the disc is mounted on jewel bearings between the poles of the wattmeter electromagnet and a permanent electromagnet is provided for damping. The contacts differ, however, in that they are both mounted on the frame and are closed, against the tension of a light spring, by the movement of the disc.

This movement is very small and no time element is provided, since an almost instantaneous action is desirable. Also no current adjustment is provided as this is taken care of on the current element.

In order to obtain a positive closure of the tripping circuit the internal contactor switch described above for the overload relay is included in each relay. As in the case of the overload relay this contactor switch relieves the relay contacts of carrying the heavy tripping current and is made with its contacts sufficiently large to carry very heavy currents. The method of connecting this switch in the tripping current is also shown in Figure 6, and it will be observed that its contacts are in parallel with the relay contacts. Both elements of the relay as well as the contactor switch are mounted in a dust and moisture proof case as shown in Figure 7.

Since this relay is merely an overload relay with a directional element added, it possesses all the desirable features described above for the overload relay. In summing up, these relays have the following advantages:

1. Can be set quickly for any desired value.
2. Are simple in adjustment.
3. Have a large range of adjustment.
4. Have time-selective inverse time element and definite minimum time function.
5. Can be set to operate as a definite time device, instead of an inverse time.
6. Individual time curves drawn on nameplate.
7. Have watthour meter accuracy and permanence of celebration.
8. By properly combining them absolutely selective action in tripping circuit breaker can be obtained.
9. Have rugged construction and are not subject to vibration.
10. When overload is suddenly removed it will not overtravel and make contact.
11. Have high resetting value. That is will reset current only slightly below 100 per cent. load.
12. Require small amount of power to operate.
13. Operate properly on low power factor.
14. Will not trip due to synchronizing and line switching.
15. Operate on low voltage, the reverse power relay selecting as to direction of power on as low as 2 per cent. normal average.
16. The reverse power will not trip the circuit breaker under normal conditions no matter what may be the direction of power flow.

No set rules can be laid down to govern the application of relays. Each and every power system has its own peculiarities, and the choosing and setting of relays must be governed by these. However, if a careful study is made of the system and the conditions existing on each section are thoroughly analyzed no great difficulty should be encountered in securing satisfactory protection on any power distribution system. The accuracy and permanence of calibration of the modern induction type relay insure satisfactory operation if proper application is made.

In laying out a protective scheme on any system a great many factors have to be taken into consideration. The characteristics of the line and each piece of apparatus, generating, switching, transforming and converting, should first be carefully studied as this is what determines the amount of short circuit current available. In determining this short circuit it should always be considered as due to the solid metallic short circuit with minimum generating capacity.

One method of determining the possible short circuit current is to observe the voltage drop between two stations at normal load. Then short circuit current $= \frac{\text{Normal voltage}}{\text{Voltage drop}} \times$ load current. This is only approximate, however, and is very likely to give high results.

Another method is to determine the total impedance, including that of the generator between any point where the short circuit value is desired and the generator. Then short circuit current $= \frac{\text{Star voltage}}{\text{Impedance}}$ This gives the instantaneous short circuit, however, and the sustained value is much less, usually about 2 or 25 times full load current.

Unless a special scheme is used for disconnecting a line on a high resistance ground, as would be necessary

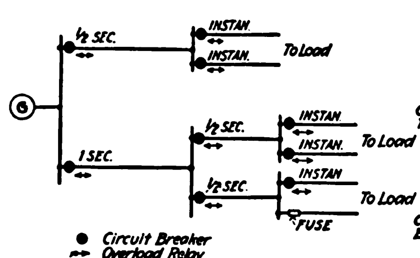


FIG. 1

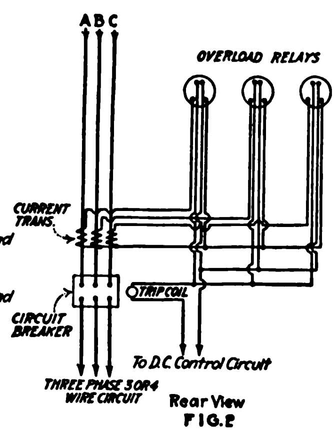


FIG. 2

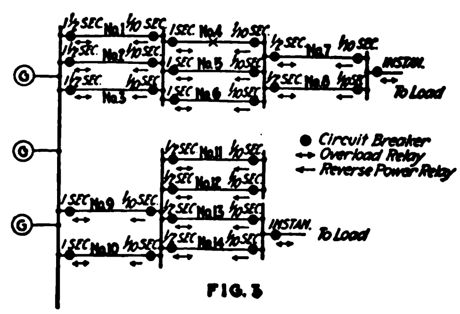


FIG. 3

in the case of a generator having its neutral ground through a comparatively high resistance, modern relays will not clean a high resistance short circuit. This is no disadvantage, however, as a high resistance short circuit will invariably develop into an arc before any damage is done, and since an arc has a very low resistance the effect of a metallic short circuit will be obtained and the relays will operate.

The various connections and combinations used on a system also deserve careful attention when laying out a protective scheme. First the number and location of the power sources should be taken into consideration. The main thing to be considered is whether or not there is more than one source. A layout which would be suitable for a system having one source of power might not be suitable for another having more than one source. Therefore we may discuss systems having one source separately from those having more than one source of supply. It should be borne in mind that we are limiting ourselves to three-phase distribution, as most modern systems are of this nature.

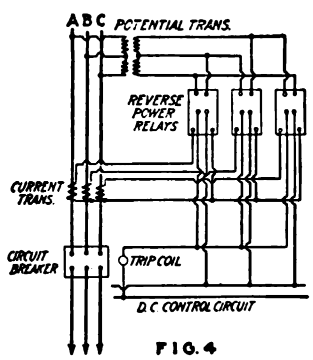


FIG. 4

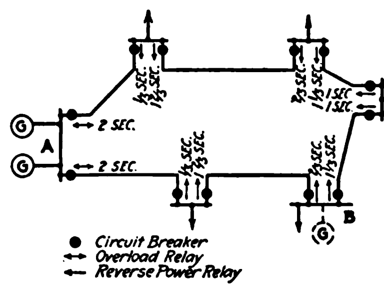


FIG. 5

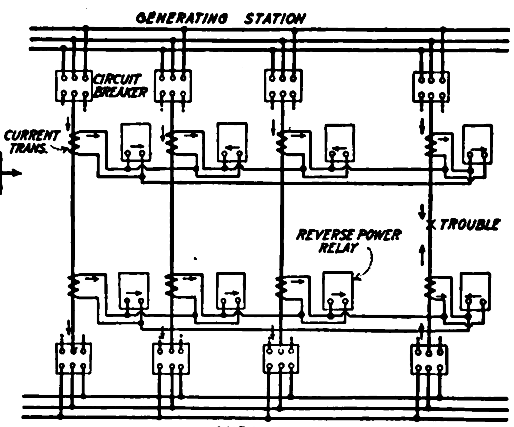


FIG. 6

A radial system, an example of which is shown in Figure 8, consists of one or more feeders leaving the generator bus bars—each of which may or may not be, in turn, subdivided into a number of smaller feeders. Protective relays are to be applied to this system in such a way that when trouble occurs on any feeder it is automatically cut off from the remainder of the system, leaving the others in service. This is accomplished by giving the relays a selective action, that is, giving them such current and time settings that due to their operating characteristics they will always disconnect the feeder at the proper point before other relays on the unaffected sections can operate.

On a radial system, such as we are considering, only overload relays are used. They are placed at the out-going of each section, except possibly on the ones most remote from the generating station, which may be protected by instantaneous overload circuit breaker or by fuses.

From the full load current values current settings are made so that the relay will not operate under normal conditions. From the short circuit current values time settings are so chosen from the characteristic curve that each relay will operate in its order, that is, the ones at the greatest distance from the generating station will operate in the shortest time, that time element becoming larger as the generating station is approached. In Figure 8 time settings for our typical radial system are shown, a half-second interval between the time of operation of each relay being chosen to allow for the operation of the circuit breaker.

These overload relays should be connected to the line as shown in Figure 9. Two current transformers may be used on a system having an ungrounded neutral, but there are cases in which the relays will fail to operate, such as the occurrence of a ground on the unprotected phase and an accidental ground in the generator at the same time. Three current transformers will always give complete protection and the insurance is worth the cost of an additional current transformer.

In the parallel feeders system, an example of which is shown in Figure 10, feeders are run in parallel between generating station and substation or between substations. The best method of protecting such a system is to place an overload relay at the outgoing end and a reverse power relay at the incoming end of each feeder. Current settings are obtained in the same way as described for radial systems. The overload relays are given time settings with short intervals between, so as to secure selective action, while the reverse power relays are all given the same short time setting, usually about 1/10 second. In Figure 10, time settings for both overload and reverse power relays on our typical parallel feeder system are shown.

The operation in case of trouble can be seen from the following example: Suppose trouble occurs on line No. 4 at X. Power immediately begins to flow into the trouble from both ends of the line. It is evident that the overload relay on this line will operate before the overload relays on lines No. 5 and No. 6, because it gets approximately twice the current that flows in either No. 5 or No. 6. Also the reverse power relay, in line No. 4 only, will operate because the power flow in this line only is reversed. Whether the overload or reverse power relay on No. 4 operates first will depend upon the point at which the trouble occurs. Thus the defective line is effectually isolated and the others are left in service.

Reverse power relays are connected in the circuit as shown in Figure 11. The current transformers are connected in star and the voltage transformers, of which two are used, are connected in open delta.

It has been found that in order to secure best action with reverse power relays on low power factor, due to unbalanced short circuits, the voltage transformers should be so connected that, at unity factor, the current in the current coils of the relay will lead the voltage by 30 degrees. It has also been found that the most severe condition under which a relay must operate is when two conductors of a three-phase line are short circuited. Numerous lists have shown that, when connected with current 30 degrees in advance of the voltage, reverse power relays operate satisfactorily under this extreme condition. In order to obtain satisfactory results with this connection, however, it is necessary to take into account the direction of phase rotation as shown in Figure 11.

The main difference in the case of the ring system and in the case of two feeders supplying a substation, is that each feeder is made to loop through a substation. Figure 12 shows an example of the ring system and gives time settings for the relays. The operation of the relays is similar to that of straight parallel feeders and when trouble occurs and the defective section is cut out, the system becomes radial until this feeder is put into service again.

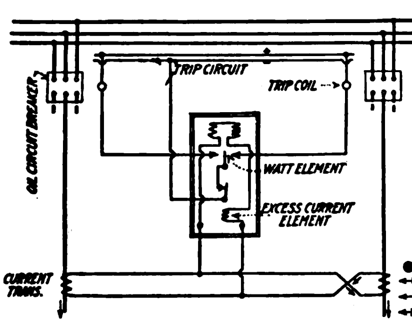


FIG. 7

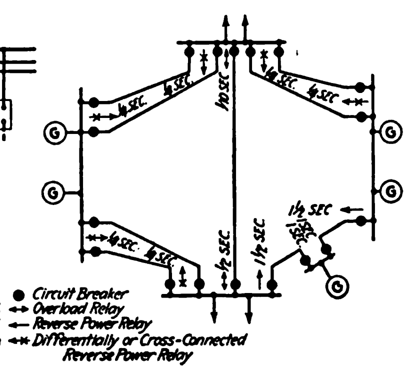


FIG. 8

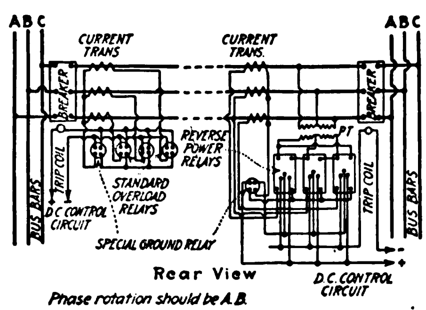


FIG. 9

Systems with More Than One Source

Lines operating in parallel where power is likely to flow in either direction can best be protected by using reverse power relays differentially connected as shown in Figure 13. When the load is balanced it is evident that no current flows through any of the relays. However, when a short circuit occurs, say at X, the relays at both ends of the defective line operate to clear the line, both because the flow of the excess current and because the flow of power is away from the bus bars. This can be seen by referring to the diagram in which the arrows show the direction of flow of the current and power. It will be observed that in every case the flow is in the direction to operate the proper relay. When using this scheme it is necessary to have auxiliary switches on the circuit breaker to short circuit the current transformer on the defective line when it goes out of service. When two lines only are operated in parallel a reverse power relay having double contacts on the voltage element may be used. These contacts operate in such a way that they always open the breaker on the defective line only and leave the other with straight overload protection. This scheme is shown in Figure 14. For simplicity both Figure 13 and Figure 14 are shown for one phase only and in Figure 13 voltage and tripping connections are omitted.

In both these schemes the time and current settings may be made very small but it is usually best to make the current setting somewhat higher than is theoretically necessary in order to take care of any operating difficulties that are liable to occur. No advantage can be gained by setting the relays to operate on smaller currents than those normally obtained during times of short circuit.

The Ring Systems.—If in Figure 12 another generating stations be placed at point B, difficulties would be encountered when it became necessary for this station to carry the entire load. Entire readjustment of the relay would be necessary but with modern induction type relays this can be done in a short time with no great inconvenience.

A great many modern powers are so connected that they form a more or less complicated network. Some sections of these networks can be most satisfactorily protected by the methods described above for parallel feeders having more than one source of power. Other sections to which these cannot be applied must be protected by some other method, using either reverse power or overload relays or a combination of both. No example can be given which will cover all the problems encountered in actual practice. Each case must be studied and the method applied which is best suited to it.

An example of a network is shown in Figure 15 in which reverse power relays are shown connected differentially for protecting some of the sections. For other sections where this cannot be used, reverse power and overload relays are applied as best suits each particular case. Time settings are shown which will give the best selective action. There will be cases in which the circuit breaker on a feeder which is not affected will be opened and in most cases this does not be interrupted. It sometimes happens that, by having other circuit breakers than those on the line actually affected open, the problem of sectionalizing may be somewhat simplified. This is, however, a question which must be decided for each individual application. It is possible, by carefully studying and analyzing the conditions, to secure automatic sectionalizing on any network regardless of its complications.

Protection against high resistance grounds.—It sometimes happens that a system has its neutral grounded through a comparatively high resistance and when a ground occurs conditions may be such that the trouble current is actually less than the full load current. Such a ground cannot be cleared by reverse power and overload relays connected to protect the system against short circuits.

This difficulty may be overcome by using an overload relay, constructed to operate on low currents, connected in the neutral lead of the current transformers as shown in Figure 16. Then under normal conditions no current flows through the neutral lead of the current transformer bank. But as soon as the ground occurs the unbalanced current flows through this lead and the ground relay and the circuit breaker is opened.

When used with overload relays the ground relay contacts so that its operation opens the circuit breaker directly. When used with reverse power relays, however, the ground relay contacts are used to short circuit the contacts of the overload element of the reverse power relays, thus leaving the watt elements to discriminate as to the direction of power flow This is clearly shown in Figure 16.

It should be borne in mind that this scheme can be used only on balanced systems. For unbalanced systems other schemes are used utilizing special relays but since these do not come under the subject of this discussion they will not be mentioned.

Foreign Markets for Electrical Goods

The annual report of the chief of the Bureau of Foreign and Domestic Commerce to the Secretary of Commerce is of particular importance at this time when our foreign trade is growing so rapidly and holds such vast peculiarities for the future. The report contains nearly one hundred pages, and details the activities of consuls and special agents in extending the market for American products. Much of the work has been along the lines covered by this magazine.

R. A. Lundquist has completed his investigation of markets for electrical goods in Australia, New Zealand, China, Chosen and Japan. The elimination of German competition in all these countries has naturally resulted in stimulating imports of American goods, and Mr. Lundquist has pointed out in his reports and by personal interviews with manufacturers the means by which this trade may be retained and extended. Of particular interest is the remarkable development of the Japanese electrical industies during the last four years. Japanese competition with American electrical goods, however, will probably be limited to the cheaper lines. During the year the following monographs by Mr. Lundquist were published: Special Agents Series No. 147, "Electrical Goods in New Zealand" and No. 155, "Electrical Goods in Australia."

The investigation of markets for electrical goods in South America, conducted by Special Agent Philip S. Smith, is nearing completion. The influence of the German electrical industry on South American demands has been very great, owing partly to the fact that in many cases specifications for electrical installations are based on German practice. The supplies of German goods have long been exhausted, however, and it has been very difficult to obtain any samples whatever of such articles. With the restricted imports of other foreign electrical goods and the almost complete lack of local manufactures, the United States manufacturers have had an unusual opportunity to establish themselves in the market. The following monographs by Mr. Smith appeared during the year: Special Agents Series No. 154, "Markets for Electrical Goods in Ecuador and Peru," and No. 167, "Electrical Goods in Bolivia and Chile."

Mr. Rhea's investigation of markets for railway equipment in Australasia, China and Japan was completed during the winter, and his voluminous report on conditions in Japan, China and Chosen will shortly be issued. While primarily a survey of the opportunities for extending the sale of American railway appliances abroad, Mr. Rhea's work in the Far East has been particularly timely and valuable from other points of view. For instance, the high efficiency of the Government-controlled railways of Japan is very instructive in connection with recent developments in this country. The intricate system of railway and other public-utilities concessions in China was necessarily studied in some detail in connection with Mr. Rhea's investigation of possible markets for American manufactures. The general railway situation in China and the general financial and economic conditions in that country are of particular interest at present, in view of the renewed interest in the subject of Chinese loans and the possibility of China's greater participation in the war.

The Year's Electrical Development

THE tremendous demands of war have permitted only the essentials to be supplied, leaving time only for such developments as were deemed necessary to help win the war. The great part that electricity and modern power machinery has played in this world holocaust is well emphasized in the following review of developments, based largely on the experiences of the Westinghouse Company. During the past year every effort has been made to utilize existing standards in order to meet the urgent demands of the war for unusual quantities of apparatus on short periods of shipment. As a result, there has been a marked tendency to concentrate on the perfection of details of existing apparatus instead of bringing out new lines. All manufacturers have endeavored to increase their productive capacities in so far as practicable by elimination of special manufacture. However, the government has had important problems to solve, and very gratifying results have been accomplished in conducting the required research and providing special machinery for their purposes.

High reliability and efficiency are essentials to the submarine. While the propulsion of submarines by electric motors is not at all new, the results heretofore accomplished have not been as desired. Distinct contributions have been made to this particular application during the past year in the instance of both motors and control. Motors have been developed, each consisting of two armatures mounted on a single shaft, two fields, and but a single frame. Improved insulation is an important feature. Equipment for controlling these main motors has been developed, this being of the pneumatic type.

Much has been accomplished in a comparatively short length of time in the development of generators and dynamotors for use with wireless telephone systems. The generators have been used on airplanes on the western front. They are of the wind-driven type, and have exceptionally small dimensions and weight. Dynamotors were developed both for the army and for the navy, and several thousand have been supplied. Noise due to vibration is minimized by mounting these machines in flexible cradles. Undamped sending and receiving sets for radio telegraphy were developed for the U. S. Signal Corps, and were used for instructional purposes at the various training camps throughout the country.

The application of electric motors for driving auxiliary apparatus aboard the merchant ships prior to two years ago was very limited. The tendency to electrically drive such machines has rightfully increased during the past year. Special equipment for this exacting service is now being regularly supplied.

The war programme in the steel mills has called for a decided change in the mill schedules, method of rolling and rate of rolling, due to the special variety of steel rolled. One of the advantages of motor drive is latitude permitted in operating conditions by virtue of speed adjustment, through a wide range, adjustment of control to utilize flywheel effect to the best advantage for various load conditions, and ability of the driving units to produce excessive torque to meet the demands of large mills, some of which are operated without the use of the flywheel. It is the development of these detail characteristics of the motor and control equipment to best suit the particular mill that has been a factor in meeting the requirements in such a satisfactory manner with increased tonnage in many cases. A recent report of a reversing type 30-inch Universal Plate Mill—Mark Manufacturing Company—equipped with Westinghouse motor drive, gives a monthly output of 17,393 tons of plate, averaging in thickness less than ⅜-inch. This is a remarkable record and emphasizes the possibilities offered with electric drive.

The question of electric power supply for large motor drives has received broader consideration during the last few years. Many plants have found it an advantage to analyze their requirements and future improvements from a complete plant standpoint, and thus give each individual mill proposition the benefit of its real relation to the plant proper and thus properly distribute general charges and enables the advantages of the motor drive to be capitalized as a part of the general scheme of improvement. Remarkable possibilities have been shown on this basis, but when the individual mills are analyzed as segregated propositions the summary of the advantages of motor drive do not establish the true over-all plant efficiency.

One of the noteworthy features of recent practice is the selection of large-size turbine units and a more liberal policy to provide for general plant electrification. This tends to improve the efficiency of power production as the water rate of the large-size turbines is materially better than for the size of units formerly selected for mill use. During the past year turbines ranging from 15,000 to 20,000 kw. have been selected for steel mills, as compared with the 5,000 kw. turbine, which is about the average of the units formerly installed.

The Duquesne Works of the Carnegie Steel Company installed a 15,000 kw. Westinghouse turbine this year, and the Mark Manufacturing Company has recently placed a 12,000 kw. Westinghouse turbine unit in operation.

The chemical industry has had a very noteworthy development during the past year, including many large plants for the manufacture of explosives, chlorine gas, and a general line of chemicals, the majority of which were previously imported. The electrification of these plants has been universal, and with but few exceptions central station power has been used, which not only facilitates the building of the plants, but also simplifies the readjustment of industrial matters when the demand for the products of these special plants is greatly reduced.

Some of the more important improvements are as follows: The Hopewell (Va.) plant of the DuPont De Nemours Powder Company, capacity of 1,000,000 pounds smokeless powder per day, and the latest plant which they have installed, located at Nashville, Tenn., and known as the Old Hickory plant, which is of equal capacity, each plant contains about 15,000 h. p. in Westinghouse motors. Nitrate Plant No. 2, Muscle Shoals, Ala., which contains a 60,000 kw. turbine, the largest power unit ever installed by an industrial plant, has already been mentioned.

There has been much activity regarding electrification in the textile industry during the past year, and the prospects for future improvements are very favorable. This, however, will depend largely on the ability of the central stations to furnish power. During the past few years they have been confronted with unusual problems that have limited their extensions and necessitated the postponing of much of their planned developments. With the resumption of normal business conditions, the textile industry will be able to secure additional desired power and thereby improve their plant operations. There has been a decided increase during the past year or so in the use of individual motor drive in this industry, including, particularly, looms and spinning machines.

Previous to 1918 there was a total of 25,000,000 tons capacity of by-product coke ovens, and during 1918 10,000,000 tons of oven capacity, including 2,380 ovens which were placed in operation. Practically all of the plants are entirely electrified, and while there have not been any particularly new lines of apparatus developed, modifications of existing standards have been made by including such features as special impregnation, totally enclosing the frame, and in some cases providing them with special box covers, adding conduit fittings and similar detailed improvements. One of the principal points has been a decided increase in the electrification of gas boosters. This particular requirement calls for an adjustable speed motor, and in the past it has been considered rather dangerous to use direct current apparatus on account of the possibility of sparks igniting the gas that might be in the room. With the rearrangements of the pumps, putting the motors in separate compartments, the electrification becomes a more practical proposition.

It is of interest to note that there have been 1,200 ovens with a capacity of 8,000,000 tons of coke contracted for installation in 1919, and of this number the Westinghouse Company secured the apparatus for 741 ovens, which is approximately 62 per cent. of the total.

During the past year the activity in metal working plants, especially in the manufacture of munitions, guns and shipbuilding, has been very large. Considerable progress has been made, as is shown by the fact that practically all the new plants constructed were erected in the most up-to-date manner. Individual motor drive on the machine tools was used almost exclusively, as also were up-to-date safety-first controllers, the majority being of the magnetic contactor type. Practically all large planers installed were operated by reversing motor drive with automatic control.

In the plant of the New York Shipbuilding Co., South Camden, N. J., there was installed approximately 800 d. c. type SK motors with type C control. In the new 12-inch howitzer plant of the Midvale Steel and Ordnance Co., Philadelphia, Pa., there were furnished approximately 250 d. c. of the same type motors and control. One significant feature of the year's work in regard to motor drive is shown in the fact that when these war plants were being built, none other than motor drive was considered, showing that steam and gas engine drive for such plants are things of the past.

A number of new railroad shops were built, and these were all equipped with modern motor drive, using automatic control both on the machine tools and on the cranes. The same remarks in regard to electric drive in metal working plants apply in these railroad shops. Two of such large shops, practically all the electrical equipment being Westinghouse, are the B. & O. shops at Cumberland, Md., and Glenwood, Penn.

Greater progress was made in the advance of the electric arc welding during the past year than any other time. It had previously been quite generally used in the railroad shops of this country, but during the past year it was used more in manufacturing establishments using iron and steel, and in shipbuilding.

The Welding Committee of the Emergency Fleet Corporation has been doing a large amount of work in promoting electric welding as applied to ships, and although no rivetless ships were built in this country a large one was completed during the past year in England, which was entirely electrically welded, and there is now building a 250-ton ship in which riveting is being replaced by electric welding. Electric welding also made a large advance in the field where formerly gas welding was used, due to the fact that electric welding is cheaper, does the work faster, and is very much less dangerous than gas welding.

Electric drive has made considerable progress in this industry, due to the fact that it is very much cheaper to make ice in electrically driven plants than in steam plants, as plants now equipped with electric motors are making ice for 42 kw.-hr. per ton, and are using Central Station power, on which they obtain very good rates. This does away, of course, with considerable labor, such as firemen, enginemen, etc. Synchronous motors have also been applied during the past year to ammonia compressors very successfully, and it is felt that there will be even more progress made in this industry during the coming year. Future ice plants will be electrically driven rather than by steam.

Activity in the small motor industry has progressed as formerly, with certain restrictions in the commercial field, and has been particularly active in the furnishing of apparatus direct to the government. For domestic service, such as small motor driven washing machines, house pumps, vacuum cleaners and sewing machines, the government has recognized that these are essentials and their manufacture has not been greatly restricted. No manufacturers for any of this class of apparatus, which is distinctly in the labor-saving class, have found any difficulty in selling all they could manufacture, with limited supply of labor and material. Higher wages to skilled and common labor has increased buying power, and therefore the use of these labor-saving devices by persons who, prior to the war, were unable to purchase them. Activities on the part of the manufacturers in view of war conditions have resulted in a considerable simplification of the sizes and types manufactured, and thus a relative decrease in cost of manufacture.

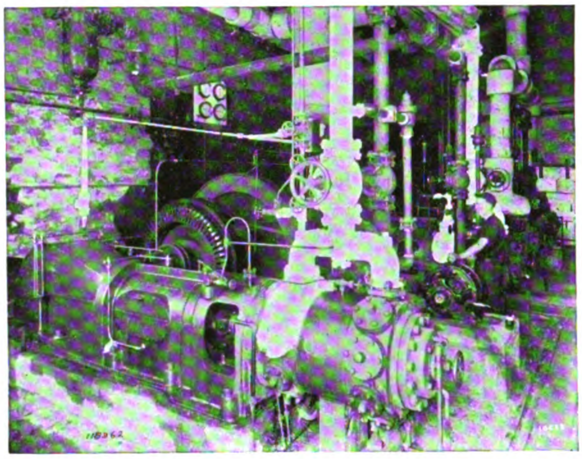
Contrasted with the domestic applications referred to are such applications as motor-driven refrigerators, talking and music machines, pianos, dish washers, etc. These cannot be classed as highly essential, and the domestic refrigerator in particular is a large user of central station current, for it has a high load factor. Consequently, the use of machines in this general class has been very largely eliminated, and many manufacturers have discontinued building them entirely.

In the field of office equipment, there has been a large demand for general use of adding, calculating, blueprinting, duplicating and such machines. Advertising display devices have been largely discontinued and the sale of ventilating equipments reduced.

As would be expected, there has been a good deal of activity in motor-driven apparatus for use in the medical field, such as X-ray and massaging machines, orthopedic devices, vibrators, etc., as well as dental equipment.

Perhaps the greatest activity has been in the use of small motors in machine shops, fabricating plants, shipbuilding plants, etc., with the use of electric drills and grinders. The demand has been enormous, and the use of this apparatus has largely hastened manufacturing processes which have been essential in war work. Electric drills and reamers have been used to a very large extent in shipbuilding plants. Small pedestal grinders employing motors of ½ to 1 h. p. have been used to a very large extent in machine shops.

Obviously, during the past year, there have been few new devices of novel nature employing small motors, developed. All efforts have been toward simplifying and increasing production. In many cases the lack of materials have necessitated substitutions. Some of these may result in permanently altering the class of apparatus manufactured. For instance, manufacturers of sewing machines, as well as decreasing the number of types built, discontinued the use of the cast-iron frame and legs for the sewing machine body. Manufacturers of portable vacuum cleaners agreed to discontinue the sale of hose and special set of tools. The manufacturers of washing machines greatly reduced the number and sizes of types built. It should be noted that there is a continuously increasing demand for small motor-driven machines equipped with low voltage motors (30 volts), for use in connection with farm lighting plants. These are all direct current and have somewhat altered the situation which



Compressor in Brooklyn Ice Plant
Driven by a 350 h.p. direct connect Westinghouse synchronous motor supplied by the central station current

has existed for a number of years of the relative increase in the use of alternating current motors.

A large demand has existed for farm lighting plants and the low voltage storage battery plant appears to be the most popular. One kw. size is largely used, and of course the direct connected plant has now come to stay. The manufacturers of these plants have been considerably limited during the past year in obtaining labor and material, except in so far as these units were supplied for battery charging. With the increasing wealth of the average farmer, the potential demand is increasing, although much educational work is required, as is the case of selling anything to the farming trade.

Early in the year the War Industries Board put a ban on the sale of surface condensers for land use on account of the shortage of non-ferrous tubes. The surface condenser business has, therefore, been practically at a standstill. Orders placed before the restriction went into effect were completed.

Notwithstanding this, there was made during the year another application of 100,000 square feet of condensing surface to a single generating unit similar to the New York Interboro unit. This is for the J. G. White Engineering Corporation, to go in the nitrate plant at Muscle Shoals, Ala. This surface is divided into four 25,000 square feet shells, one to go under each exhaust nozzle of the two-cylinder double flow low pressure elements.

In the jet condenser field there was placed in operation the world's largest jet condenser at Providence, R. I., in the plant of the Narragansett Electric Company. This condenser is of the twin jet type. Also, the world's largest single jet condenser is under construction for the Alabama Power Company. This condenser is capable of handling 13,000,000 pounds of water per hour.

The year has been a notable one in the small turbine field. This has been due to the large amount of standard apparatus which has been manufactured, principally for Government use on land and sea. Because of this demand, there naturally was not very much development along the lines of new devices and products. As an illustration, there were built several hundred small direct connected turbine generator units, of 10 and 15 kw. capacity, for lighting the new merchant marine; a large number of geared turbine units for lighting destroyers, several hundred turbines for driving centrifugal pumps on the merchant marine, and the usual quantity of generating units and auxiliaries for central stations and manufacturing plants working on war material.

The tendency for the past two or three years, and this tendency is growing very rapidly, is to make use of geared turbines for driving small and moderate capacity generators, pumps and blowers. There are many advantages in doing this, and the user has been quick to see the results obtanied. The question of economy is ever important, and in making use of the moderately high speed turbine with a reduction gear for driving relatively slow speed apparatus very much better steam performances may be obtained from the turbine, than where the two pieces of apparatus are direct connected. Generating units of 25 kw. and upwards are of this type, and it is safe to say that during the year 1919 the bulk of small turbines will be of the geared type for all purposes.

Several particularly interesting large turbine installations were made during the year. A 60,000 kw. cross-compound unit is now being installed at Muscle Shoals, Ala., for the Air Nitrates Corporation, which is going to produce nitrates for the War Department. This unit consists of three elements, one high-pressure, non-condensing, exhausting into two low-pressure units. Arrangements are made whereby any element may be run independently of the other two, but this is for use only in the case of an emergency.

There was furnished the Commonwealth Edison Company of Chicago two 30,000 kw. tandem compound turbines. These units consist of two elements coupled in tandem and driving a single generator.

The installation of the Holter plant of the Montana Power Company is one of the largest hydro-electric developments of the West. This plant includes four 12,000-kva. vertical water-wheel type generators, making a total plant capacity of 48,000 kva. The voltage is stepped up through Westinghouse transformers to 100,000-volt transmission lines, and the output distributed among the mining and metallurgical companies in Montana, and the Rocky Mountain electrified division of the Chicago, Milwaukee & St. Paul Railway.

The Eastern Michigan Power Company has placed in operation this year the largest hydro-electric development in Michigan. It is located at Wellston, is called the Junction Development, and the power plant houses three 6,250-kva., vertical, 30-cycle Westinghouse generators. The voltage is stepped up to that of the transmission line, 140,000 volts, which is the highest voltage used in this country with the exception of the one or two systems in Southern California. The largest capacity water-wheel unit yet to be purchased, the 32,500 kva. machine for Niagara Falls, was sold during the year.

The year has been one of output in the case of large transformers. All energies have been devoted to supplying transformers to central stations and industries to enable them to do their share of winning the war. One thing that has contributed to the war programme and that has also been a decided advance in the standardization work on transformers was put through by the National Electric Light Association and the Electric Power Club. Both of these bodies have adopted and published Standardization Rules on Transformers.

Though the principal work of the year has been devoted to output and there have not been built any larger or higher voltage transformers, a number of interesting designs have been completed and the transformers built. There was built for the Alabama Power Company at one time a number of transformers totaling 127,000 kva., which is probably the greatest kva. capacity ever contracted for and built on one contract. These are used in connection with supplying power to the nitrate plants.

There have been in the past year extensive developments in the electro-metallurgical and electro-chemical field. Included in the transformers manufactured is a 7,500-kva., three-phase, water-cooled transformer for supplying two 3,750-kva., 250-volt synchronous converters.

New developments in substation apparatus and equipment have been curtailed to the extent that only those necessary for carrying on war work have been consummated. The greatest difficulty encountered in supplying direct current power for railway purposes has always been in the commutation of the converting apparatus when short circuits, inherent to this class of service, occur. As a result of experience during the last few years, various improvements in the design and application of converting apparatus, together with minor protective features in switching equipment, have overcome many difficulties in 600-volt work. The use of higher voltages, 1,200 to 3,000 volts d. c., for heavier work naturally present conditions more adverse to the successful operation of converting apparatus.

In experimental work that has been in progress for many years with a view towards reducing commutator and collector ring wear there has been a tendency this year towards the adoption of brushes, especially for collector ring use, of a composition of graphite and metal combined, with a larger percentage of graphite than brushes formerly used. These brushes are showing marked improvement in operating results.

The automatic substation switching equipment, while by no means a new development, has undergone many improvements during the last year and has increased in precision and reliability. The indications are that a development of the automatic substation switching has come at a time when it may be an absolute necessity from a labor, if not from an economic, standpoint.

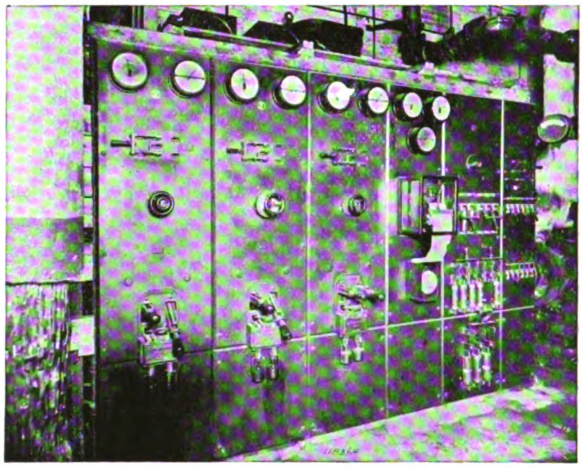
Typical of some of the demands made on account of war work is the case of the switch gear furnished for the nitrate plant at Muscle Shoals, Ala. This included not only the switch gear for the main power house, in which will be installed a 70,000-kva., 12,000-volt turbine and a 40,000-kw. incoming feeder from the Alabama Power Company's 80-mile 110,000-volt transmission line from the Warrior River plant, but also switch gear for the utilization of this power in the manufacture of nitrate. This equipment involves a total of about 210 switchboard panels and 148 oil circuit breakers of various types. A great number of large high conductivity copper fittings were furnished for use with electric furnaces in this plant. Copper required for these fittings totaled something over 100 tons.

Of course, the year has seen a complete utilization of some developments of the last year, including G-2 oil circuit breakers having a rupturing capacity of 1,000,000 arc kva. at 140,000 volts; type CO-2 oil breakers giving extremely high rupturing capacity with minimum space requirements, resulting in marked saving in cost of buildings, circuit-breaker structures, etc., have been developed. Also such minor details as improved oil circuit-breaker controllers, key type meter switches, etc. A constantly increasing number of installations has been made of automatic control for synchronous converters for substations, and this development gives more promise of successful and economical operation.

New switchboard type watthour meters, radio dynamometer type ammeters, motor-operated graphic instruments, transfer, reverse phase and temperature relays, and outdoor voltage transformers represent items that were developed and placed on the market this year.

The motor-operated type of switchboard graphic instruments supersedes the former solenoid operated type. They are furnished with universal motor operation, which feature tends to simplify them, making them more compact and of smaller size. They are more universal on account of being interchangeable on various voltages, and are more satisfactory also for 25 or 60 cycles or direct current, by slight adjustment of the resistor provided with the instrument.

The increasing tendency toward outdoor operation, particularly for the higher voltage service, has influenced the development of outdoor voltage transformers for 20,000 volts and above. This development has been continued so that outdoor voltage transformers can be supplied for a lower voltage.



SWITCHBOARD FOR ICE PLANT

It consists of three panels for synchronous-motor-driven compressors, a totalizing panel, and two panels for lights and small motors

In connection with the 3,000-volt d. c. motor generator sets in the substations of the C. M. & St. P. Railway, a flash suppressor has been developed to prevent flashing across the commutator upon the occasion of a short circuit on the d. c. line. A very high speed is necessary in killing or preventing the flash. This is obtained by automatically short circuiting the three collector rings on the d. c. generator of the motor-generator set, upon the occasion of an extreme overload occurring on the d. c. line and thus killing the d. c. voltage and preventing any flashing on the commutator. The three rings are connected to the internal winding of the d. c. generator in a three-phase relation. A quick acting overload on the d. c. side releases a trigger and allows the short circuit contacts to be closed by the pull of a very strong spring. The "short" on the a. c. side automatically operates to open the a. c. breaker through its overload coils. The d. c. breaker also opens from the over-load on its coils. Another circuit operated by the flash suppressor mechanism opens the electrically operated field discharge switch.

The chief progress in the art of street lighting during the past year is to be found in the replacing of a large number of arc lamps throughout the country by Mazda units of various kinds. The high candlepower series Mazda lamp is rapidly taking the place of the arc lamp in street lighting, because of its high efficiency, the superior quality of its light and the absence of flickering and instability. The Luzsolite pendant containing an auto-transformer has made it possible to use the high efficiency 15-and 20-ampere Mazda lamps on the 6.6-ampere distribution circuits regularly used for series street lighting.

The most recent development in the manufacture of pendant units used for this purpose is the substitution of cast iron for copper in the case. The earlier pendant units, and practically all arc lamps, were made with copper cases in the belief that copper was the only metal which would properly withstand the elements. It has been demonstrated that cast iron is better suited for this purpose, being even more durable than copper, and cast iron fixtures have been found to undergo the most severe service without the usual evidences of deterioration.

The high-speed turbine with the floating frame reduction gear, invented by Admiral G. W. Melville and Mr. John H. Macalpine, has proved its reliability not only for use on land but marine service as well. The records of the Westinghouse Electric & Manufacturing Co. show that between November, 1915, and September, 1918, thirty-one ships using this equipment had been put into service, and of these twenty-three have had no trouble with the propulsion machinery; four experienced some trouble due to improper lubrication, two to defective material and one to errors in assembling the apparatus. None of these troubles was vital and all were of a kind that might happen to any machine.

As large turbines are now being built which can deliver to the shaft about 80 per cent. of the energy theoretically available in the steam applied to them, it is evident that further improvements in the turbine itself will not materially raise this efficiency. Hence, in order to improve the performance of the ship's power plant, a matter of great importance in view of the rising cost of fuel, more attention must be paid to the auxiliaries, and the practice of the central station engineer studied more carefully.

Commercial Use of Electricity in Arizona

Preliminary figures from the forthcoming quinquennial report on the central electric light and power stations of the state of Arizona have been given out by Director Sam L. Rogers, of the Bureau of the Census, Department of Commerce. They were prepared under the supervision of Eugene F. Hartley, Chief Statistician for Manufactures.

The statistics relate to the years ending December 31, 1917, 1912 and 1907, and cover both commercial and municipal plants. They do not, however, cover electric plants operated by factories, hotels, etc., which consume the current generated; those operated by the Federal Government and state institutions; nor plants that were idle or in course of construction.

The commercial use of electricity in Arizona shows a remarkable increase at each census for which statistics are presented. There was an increase of 13 in the number of establishments from 1912 to 1917, four of which were municipal, this class of stations being shown for Arizona for the first time at the census of 1917. From 1912 to 1917 the total income increased $968,447, or 82.5 per cent., and the output of stations, 32,771,669 kilowatt hours, or 99.4 per cent. Although the actual increases from 1907 to 1912 were less—$603,336 and 23,567,782 kilowatt hours, respectively—the proportional increases—105.9 per cent. and 250.9 per cent., respectively—were greater.

Electric Power in Rhode Island

There have been substantial gains in the use of electric power in Rhode Island during the past decade, according to the figures given out by the Bureau of the Census, Department of Commerce. The figures for practically all items show substantial gains from census to census. A marked decrease appears in the number of steam engines reported for 1912 as compared with 1907, but this decrease merely shows the use of engines of larger horsepower capacity, since the total horsepower of steam engines was much greater in 1912 than at the preceding census. The decrease in the number of arc street lamps is due to the displacement of such lamps by those classed as "incandescent, etc." which shows an increase of over 50 per cent. for the period 1912 to 1917.

It is significant of the growth in the use of electricity that the actual and proportionate increases, with unimportant exceptions, are greater for the later than for the earlier five-year period. From 1912 to 1917 the gross income increased $2,409,675, or 104.5 per cent., and the output of stations, 99,749,642 kilowatt hours, or 160.6 per cent., as compared with $580,517, or 33.7 per cent. and 26,455,205 kilowatt hours, or 74.2 per cent., from 1907 to 1912.

ELECTRICAL ENGINEERING

With Which is Incorporated the

SOUTHERN ELECTRICIAN and the ELECTRICAL AGE

PUBLISHED ON THE FIFTH OF EVERY MONTH

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OWING to unprecedented price levels and wage standards during the progress of the war it has been necessary for a great majority of public utilities to place in effect higher rate schedules for service. It is only the merest justice to record that this was accomplished in a great majority of cities with the friendly co-operation of the public, which recognized the fact that in the past rates had been reduced when operating expenses were low. The effect of these rate increases enabled the companies to continue good service, maintain credit, perform necessary financing and make the extensions and additions necessary to war production and public welfare. No one doubts that when conditions return to the normal once more, the public utilities will recognize the fact and offer a readjustment of rates.

THE awful loss of life, the tremendous destruction of property, the disarrangement of industries and the interruption of production that follow a great war strike such a vital blow at every household that we are inclined to overlook the thousand and one other evils that follow in the train of a great world contest. Rights for the individual that have been secured by centuries of struggle and suffering may have to go by the board in order to secure the greater good, the safety of the community or the nation. As a temporary expedient, President Lincoln could suspend one of the inestimable benefits that came to us from Magna Charta, but it made us no less free. During the present war the Government has assumed various powers that were not contemplated in the building up of our nation. We have acquiesced in this without the slightest demur. But we do not expect that peace conditions will make necessary the continuance of war regulations. In this connection it is interesting to quote the following from a bulletin of the Public Ownership League of America: "The public ownership movement is not uniformly successful or satisfactory. Public ownership in and of itself is not necessarily a solution. We must have efficient management. We must have democratic control. There are also serious labor problems involved There are many 'failures' of municipal ownership."

A REPORT made to the Chamber of Commerce of the United States by its Committee on Statistics and Standards, headed by A. W. Douglas, of St. Louis, takes a very optimistic view of the general business situation of the country. The report points out that there is a widespread feeling that there must be such readjustments of prices as will bring them to a lower level, assuring stabilization of prices and purchasing and adds: "The general desire is not for radical reductions, but rather for such gradual declines as conditions may warrant. Commingled with this is the knowledge that wages and salaries have much to do with the cost of commodities today and nothing is further from the general thought than that there should be substantial reductions in the income and purchasing power of the many, but rather that a realignment of this nature should assume the form of readjustment in the line of such wages and salaries as are not warranted under the changed situation. There has been no sudden drastic economy, nor financial panic, nor in fact any of those untoward events which in the past we have reckoned as being the natural accompaniment of the end of a period of prosperity. In fact, there is a widespread feeling that the present situation is merely a readjustment and a realignment to something far better in the future when we have surmounted the difficulties that lie directly ahead of us, and thus found a firm foundation for greater business, both domestic and foreign, than we have ever known in the past."

IT IS pretty generally recognized that the one trait which serves best to distinguish the average Englishman from his fellows is conservatism. That any institution is and has been in existence for a generation or two, is a sufficient justification. The country and the people cling to forms, ceremonials, even grotesque and inconvenient state costumes, simply because they bear the indorsement of time and usage. For nearly five years past Great Britain has enlisted all of its wealth and power in the greatest and most momentous contest in its history. Hundreds of thousands of its young men, in all ranks of society, have given their lives that the Empire and all it stands for might endure. Millions of others, peers and costermongers, delicately reared scholars and brawny laborers, have been thrown together in the intimacy of camp and trench, and have learned to respect one another heartily, all heroes alike. It is a commonplace of criticism that the re-establishment of peace must bring about readjustments, social as well as business and political. The recent parliamentary elections are illuminating, in one way. In no country in the world does political feeling run higher than in Great Britain, and yet the voters have just shown that they can lay aside their political predilections for the time in order to give united and hearty support to those who have borne the burden of carrying on the war.

The country is now tackling the problems of reconstruction and readjustment, and these will be even greater in England than in America, because of the larger part the country took in the war, and the far greater toll taken from its young manhood. One special feature of the reconstruction work in Great Britain is of interest to this magazine—the housing problem. The ownership of the land rests in comparatively few hands. Unless there is a breaking up of the great estates there can never be an "own your own home" campaign in the United Kingdom. The housing of the people depends almost entirely upon the speculative builder. For a number of years past dating before the outbreak of the war, speculative building has been at low ebb, owing to financial conditions in general. The result is that there is now, at the most conservative estimate, a shortage of more than half a million houses. Building must be undertaken at once on the largest scale, and that with government aid in the matter of financing. Royal and local commissions are using every effort to speed up the work and much will have been accomplished before another year goes by.

In the discussion of the building programme in the general and the technical press there is one fact that is very striking. Almost without exception emphasis is laid upon the fact that the British householder, in whatever rank of life he may be, will no longer be content with the style of accommodation afforded him in the past. It is pointed out that even the women have had their awakening, that their work in the munition plants has familiarized them with electric labor-saving appliances, with steam heat, and the hundred and one conveniences that have long had a part in our daily life but are utterly unknown in the ordinary English household. Perhaps it is too much to expect that we of this generation shall see our English cousins discard their dearly cherished open fires, but it is certain that they will make a far more insistent demand than ever before for electric lights, telephones and gas and electric cooking and household appliances. A constantly growing market will surely be opened for our manufacturers in all of these various lines.

Wireless Communication with the President

President Wilson was in constant communication with the United States and France during his entire voyage from the United States to France through the U. S. S. Pennsylvania's powerful radio transmitting and receiving sets. The Annapolis high power transmitting station, transmitting on 16,900 meters, the high power transmitting set at New Brunswick, N. J., transmitting on 13,000 meters, the high power transmitting set at Tuckerton, N. J., on 9,200 meters and the high power transmitting radio station in Lyons, France, on 15,500 meters, were used for communications to and from the President.

The President, on board the U. S. S. George Washington, was convoyed by the U. S. S. Pennsylvania (which is the best equipped ship afloat for signalling purposes in regard to radio communications) and five torpedo boat destroyers. The Pennsylvania's radio equipment consisted of the following apparatus: One 30 kilowatt Federal Arc Transmitter which was used for transmitting messages to the United States and France on 3,600 meters, one 10 kilowatt Lowenstein Spark Transmitter, transmitting on 600 and 952 meters, which was used for intermediate communication with low power coastal stations, one short range radio telephone transmitter, transmitting on 297 meters and one vacuum tube short range transmitting set, transmitting on 450 meters which were used for intercommunication between the U. S. S. Pennsylvania and U. S. S. George Washington.

The Pennsylvania transmitted messages direct to the United States up to a distance of 2,500 miles. Communication with Lyons Station, France, was established long before the Pennsylvania was beyond communication range of the United States.

The Pennsylvania has six receiving booths which were able to receive on eight different tunes simultaneously as follows: One booth guarded Annapolis or New Brunswick tunes 16,900-13,000 meters, one booth guarded Lyons tunes 15,500 meters, one booth guarded Tuckerton's tune 9,200 meters, one booth guarded 4,000 meters (the Standard Arc Calling Tune), one booth guarded 450 meters for the U. S. S. George Washington vacuum tube transmitter tune and one booth guarded 297 meters (the radio telephone tune). One additional operator guarded 600 and 952.

The radio stations at Otter Cliffs, Maine, and Lyons, France, were used to receive messages from the President, transmitted by the U. S. S. Pennsylvania's arc.

The George Washington's radio equipment consisted of the following: one low power spark transmitting set, one 16,900 long wave receiving set, one short wave 600 meter spark receiving set, one short range radio telephone transmitting and receiving set, one vacuum tube 450 meter transmitting and receiving set. The U. S. S. George Washington was able to intercept messages transmitted by the Annapolis or New Brunswick stations and guard 600 meter (commercial calling and emergency tune and the radio telephone and vacuum tunes) simultaneously. Messages for the President transmitted from the United States by the Annapolis, New Brunswick, Tuckerton and the Lyons Station were received by the U. S. S. Pennsylvania and relayed to the George Washington by means of radio telephone and vacuum tubes transmitting sets simultaneously.

Automatic Electric Elevator Control

By T. Schutter

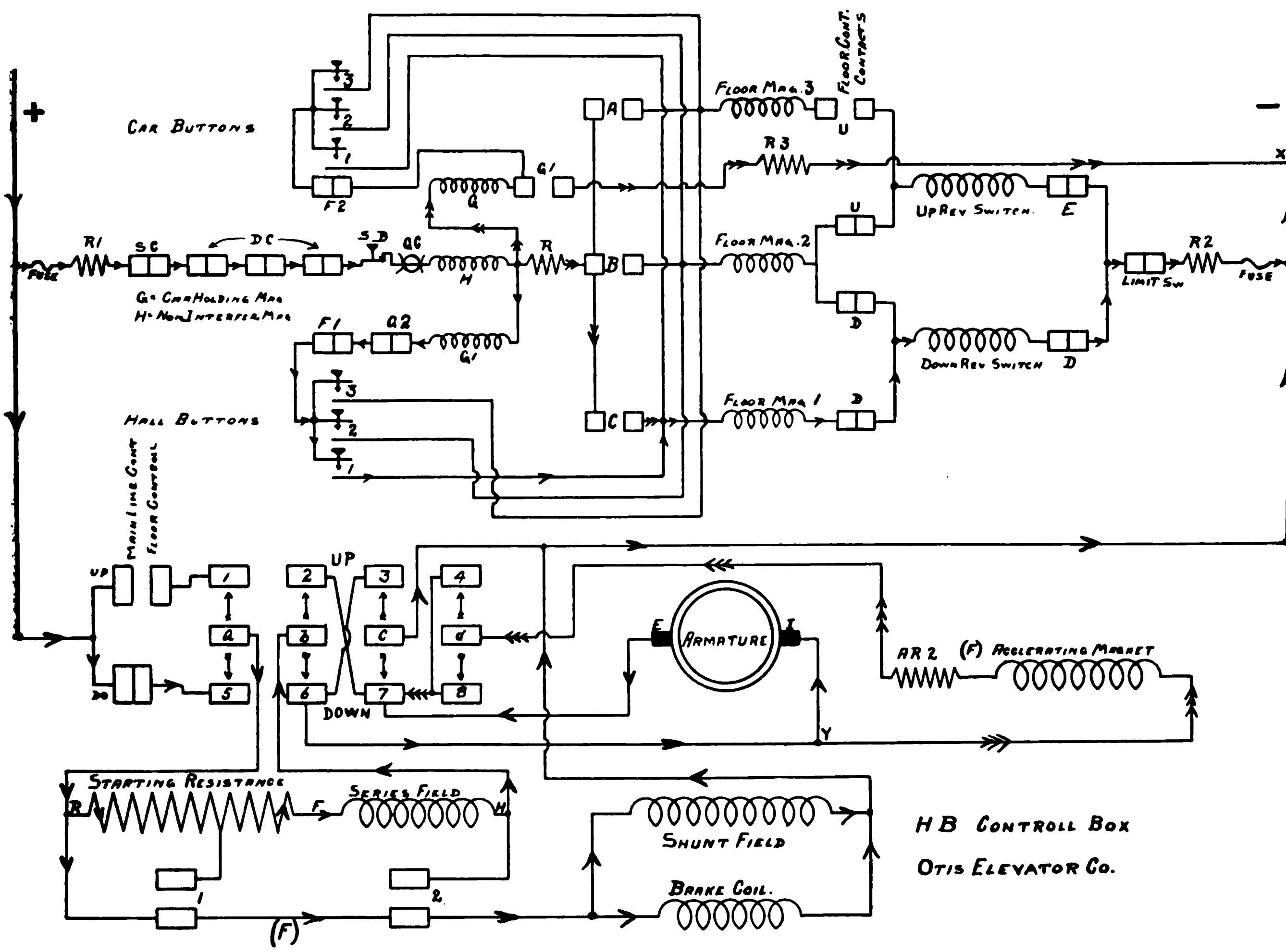
SOME electric elevators as used in clubs, hotels and private residences are automatic in their control and require no operator. A number of push buttons are arranged in the car by which the person riding can send the car up or down at will, and a push button is on each landing so that the person desiring to ride may bring the car to the landing from any part of the shaft, providing, however, no one else is using it at the time.

Each landing is protected by a special lock which cannot be opened from the outside (only from inside the car) and is also provided with an electrical contact so that in case the lock should stick and not properly lock the door, it will be impossible to start the car. There is also an electrical contact on the gate of the car which, if not pulled closed, makes it impossible to start the car. When the car reaches the desired landing, a cam which is attached to the car releases the door lock and the door may be opened at will. This also prevents the door from locking so that it can be opened again from the outside as long as the car remains at the landing. A person leaving the car must see that the car gate and the landing door are closed so that a person at another landing may call the car for his use. When the car is being used it is free from interference, that is, no one else can call it until the first party has left the car and properly closed all doors. This is done by means of a magnet known as the non-interference magnet; when this magnet is set it cuts all other circuits, except the one operating the car at that time.

When the car has been started and the person riding therein wishes to stop or go to some other floor other than the one first indicated, a separate push button is provided in the car, which, when pressed, stops the car; then by pressing the button for the floor now desired the car can be started either up or down again. The switches which control the starting, stopping and floor controls are all of the electro-magnetic type. The motor used in this type of machine starts as a compound, and when at full speed as a shunt motor.

In Fig. 1 is shown the complete wiring diagram with the car stopped at the landing. Before going into the detail of how the current flows through the different circuits a few words as to how and what the different switches control.

The up and down reversing magnets control the contacts a, b, c and d. When the up switch magnet is energized, contacts a, b, c and d make with contacts 1, 2, 3 and 4; and when the down switch magnet is energized contacts a, b, c and d make with contacts 5, 6, 7 and 8. Contacts a, b, c and d are movable and the others are stationary.



The floor control contacts U-U-D-D are automatically operated by cams, and as shown in Fig. 1, contact U on the upper is opened, showing that the car is at that point. If the car was stopped at the second floor contacts U and D would be open and the upper U and the lower D closed.

Contacts A, B and C are operated by their respective floor magnets, and cannot be closed unless the floor control contacts are set properly; that is, if contact U of the upper floor control was closed and some one should press button number 3 either in the hall or in the car, the car would start upward and jam into the overhead work or to the upper limit switch and then the circuit would be opened. That is the season why the floor control contacts of the floor at which the car is stopped must be opened by the automatic cams, and the U P and D O contact on floor control main line must open when the upper and lower floors are reached.

Contacts G^1, G^2, F^1 and F^2 are operated by the car holding magnet G and the non-interference magnet (H). When the car is in motion contact G^1 is closed and contacts G^2, F^1 and F^2 are open; this prevents the car from being interfered with once it has been started. When contact G^1 is closed and G^2, F^1 and F^2 are open, there is no current in the hall or car buttons.

The accelerating magnet is connected across the armature terminals, and as the voltage across the terminals increases contact 1 and 2 are closed in succession and in turn cut out the starting resistance and the series field windings. When this is done the motor is then operating at full speed as a shunt machine.

The brake magnet is connected directly across the line and is energized as soon as the reversing switch is closed in either direction. This magnet is used to hold the brake shoes off and as soon as the switch is opened the shoes are released and held on by means of heavy spiral springs.

As previously stated the car is now at the upper landing; a person at the first floor desires to use the car, so by pushing button 1 in the hall the following action takes place:

The current flows from the positive side of the line to the small safety fuse through a small resistance R^1, and the various safety devices, as slack cable switch, door or lock contacts, stop button in car and then through the non-interference magnet and the car holding magnet, to contacts G^2 and F^1 and on to hall button No. 1, then on through floor magnet 1 and floor control contact D to the down reversing switch magnet and on to the limit switches, another small resistance R^2 and out to the negative safety fuse.

With this circuit complete the various magnet switches and contact magnets act as follows:

The car holding magnet opens contact G^1 and closes contact G^2; now instead of the current flowing from the non-interference magnet to the car holding magnet, and contact G^2, it flows to G^1 and on through resistance R^3 to point X and out to the line. Floor magnet 1 has also closed contact C, and by following the circuit from resistance R it will be seen that the original circuit has been divided into two parts as shown by the double arrow heads.

When the down reversing switch magnet was energized contacts a, b, c and d are pulled over against 5, 6, 7 and 8, and then the motor and brake circuit are completed as follows:

From the positive line to the bridge of the main line contacts on floor control and then from D O to contact 5 to a to terminal R through the starting resistance to terminal F and through the series field windings to terminal H and on to contact b to 6 and on to terminal I through the armature to E and on to contact 7 and c and then back to the negative side of the line. The shunt field and brake are taped in at terminal R through contacts 1 and 2 at (F). With this circuit completed the motor now starts as a compound machine.

The acceleration magnet is taped in at point Y and as above explained is connected across the armature, as from Y, which is one side of the armature, to contact d, 7 and 8, which is the other side of the armature; now as the voltage across the armature is increased the strength of the acceleration magnet is also increased so that contact 1 (F) will be closed, which cuts out a large part of the starting resistance, thereby speeding up the motor by increasing the voltage across its terminals (I and E) still more and also strengthening the acceleration magnet so that contact 2 F will also close, cutting out the remainder of the starting resistance and all of the series field windings, and the machine now runs as a shunt motor full speed downward.

When the car reaches the level of the first floor, contact D on the floor control opens, thereby opening the circuit of the down reversing switch magnet and the machine comes to a full stop. All magnets and switches now come to their neutral position so that the car may be called from any other part of the building.

The various resistances marked R, R^1, R^2, R^3 and A R^2 are placed into these circuits so as to keep the current evenly balanced and as low as possible.

The most important point that all persons using this kind of an elevator must remember is that before the car will start one must see that all doors and car gates are closed so that one may be able to start the car, and on leaving to see that all doors and car gates are again properly closed so that the car can be called to another landing.

Cozy Glow Radiator

Among the many new electrical appliances which have been designed to satisfy the demand for heating which will conserve coal and likewise the energy which heating devices generally takes to operate them, the Westinghouse Cozy-Glow heater is sure to gain popularity. The Cozy-Glow heater is the answer to the recognized demand for a substantially built heating appliance that will throw heat in any direction. This heater throws the heat in a manner that is similar to the way a searchlight throws its rays of light in a desired direction. For use in the nursery and bath room on chilly mornings this heater is unexcelled, while it serves to a good advantage in ticket booths, train cabs, watchmen's booths, waiting rooms, etc. It may be used to keep frost from store windows. A heavy cast-iron base insures firmness, yet allowing the radiator to be easily moved from place to place. The heating unit, easily removable, is wound on a porcelain cylinder and is protected by a stout copper wire guard, which can be removed when cleaning the reflector. The reflector, which aids in the proper spread of the heat rays, is built of polished copper, neatly finished.

Anchor Ice and Turbines

To the Editor of Electrical Engineering:

I was very much interested in reading the article by Mr. J. M. O'Hara in your December issue, having fought a number of years ago along the same line. My first initiation was at Brunswick, Me. The plant for furnishing light and power to the city at that time was hydroelectric and on an island mostly of rock and reached only by a suspension foot bridge and an old scow. If I remember correctly our turbine was about 300 h.p. and the installation of the plant as a whole was about as poor as one could possibly imagine. And, as to cold weather, one who has had experience in the Northwest has had fair sample. I went there in the late fall, and it makes me shiver to think of the cold nights I was called to an almost hopeless job of keeping out anchor ice, but by hard work and plenty of help the plant operated most of the time.

The next jump I made was back in northwest Vermont, where I had charge of a small town plant consisting of one 150 h.p. turbine and two 50 kw. alternators. I was the whole thing and the "Little dog under the wagon," as they have it, staying here seven years. If the river froze over early in the winter and staid frozen I got along very well. The ice covering the water kept it warm and no anchor ice formed, but in open weather, thawing and freezing, night after night, it brought us almost to a standstill. So, after seven winters I was ready to turn it over to some one else.

My next experience was in northeastern York State, near Mechanicsville on the Hudson River, where we had seven 1,000 h.p. generators, each operated by its turbine or all in parallel as occasion might require, gates being controlled by "Lombard" oil pressure governors. I had three months' winter weather on this plant, about two weeks on governors and then as switchboard operator. A number of times during my short stay here we were compelled to drop our entire load on account of anchor ice, and so suddenly did it get us that we had no time to transfer our load to other plants we were tied in with, leaving our gates partly open. The only solution we had lay in being tied in with a 35,000 h.p. hydro plant about 30 miles north on the same stream. This plant, to my knowledge, was never bothered with ice. It had a large storage for water, a deep forebay with turbine intake low down, keeping the water warm and melting the ice before it could reach the wheels. So, if we got time to shift our load they were always in position to handle same. But three months was enough here, 14 hours and two men's work at $60 per month didn't look good to me.

My next and last experience was one winter on 3,000 h.p. plant in the same state and owned by the last named company, or under the name of the Hudson River Power Company. This was about five miles from Amsterdam on a small stream. I started in as general man but finally had charge of the governors. Water here was taken through an open canal about one mile long. As luck would have it, we had plenty of snow and cold weather, freezing over canal so ice gave us little trouble until early spring, when ice and high water made plenty of music. However, it was not so much of a problem to drop the load here, it being in proportion to water we had and we had ample time to shift it. But one winter was enough here. I always was mighty careful about getting too much of a good thing. Now I may feel a little puffed up but I think it would take a pretty good man to tell me anything about anchor ice.

As for a solution of the problem: Anchor ice forms on top of stream and to a certain depth at a certain temperature. If you have a shallow, open stream, the water is full of it. You might combat it to a certain extent by revolving wood screens or moving racks, but the chances are the water at this same temperature will freeze on gates and turbines after leaving screens. Anchor ice will commence to form almost by magic, and leaves the same way on a rise of temperature or on the sun coming up in the morning. To my mind the only real solution is a deep body of water or storage, with your turbine intake at right angles to the current flow and at a good depth below the surface or where the water is warm enough to melt the ice before it can reach the wheels. Satisfactory service may also be had even from shallow stream in steady cold weather where ice forms early and water stays covered for a mile or so from the turbine intake. If you can't meet these last two conditions and must have dependable service, better have steam to fall back on (of course I mean to run an engine with, not to heat the river). Now, I don't know as I have handed out anything new, but Mr. O'Hara has my sympathy and there's one who won't be snooping around after his job.

Kamms, Ohio, Box 55. G. STEVE PARTLOW.

Here and There in the Electrical Field

The Tioga, W. Va., Coal Company, J. N. Berthy, Jr., manager, will install a new electric mining equipment.

The Western Association of Electrical Inspectors will hold its annual meeting in Chicago January 28-30. W. S. Boyd, 175 West Jackson Boulevard, is secretary.

The Springfield, Ill., Gas and Electric Company has filed in the Illinois Supreme Court an appeal case from the Circuit Court of Sangamon County to enjoin the City of Springfield from operating its electric light plant without coming under the jurisdiction of the Illinois Public Utilities Commission. The Circuit Court refused to issue the injuncton.

Judge E. C. Gates has announced that the sale of the property of the Fort Scott, Kans., Gas & Electric Company would be held on January 18. The plant will probably be bought by the second-mortgage bondholders, including the Central National Bank of St. Louis, which holds about $100,000 in bonds, and several St. Louis business men, who have been chief stockholders.

The West Kootenay Power & Light Co., a subsidiary of the Consolidated Mining & Smelting Co., is building a new high-tension transmission system from its power station at Bonnington Falls to Northport and Princeton, B. C., by way of Trail, B. C. The new line is estimated to cost about $1,000,000, and will be used by the Northport Smelting & Refining Co. and the Canada Copper Corporation at each location, respectively. At Northport, the electric energy will be used for smelting operation, while at Princeton, with site known as Copper Mountain, the service will be for mining and concentrating work.

The New Mexico Electrical Association will hold its annual meeting at Albuquerque, N. M., on February 17-19.

How electricity is supplanting the housewife in the matter of bread baking is described in an article in the Minneapolis *Journal*. At least one Minneapolis bakery performs every operation in its bread baking, from mixing the ingredients to wrapping the bread in wax paper, by electricity. The loaves are even distributed to the dealers in electric automobiles.

Favorable water power conditions this year at the Skaguay, Colo., hydroelectric plant of the Arkansas Valley Railway Light & Power Company has enabled the plant to show an output 34½ per cent. in excess of the preceding year.

The farmers in the vicinity of Wegdahl, Minn., are petitioning the Northern States Power Company for electric service, expressing their desire to pay the cost of extensions necessary.

An interesting example of housewifely thrift came up in Denver recently. The Denver Gas & Electric Light Company is carrying on a washing machine campaign, and in the course of reports by representatives one of them spoke of having sold a 1900 Cataract several years ago. Recently he called at the house and found that the woman purchaser had made the machine pay for itself three times. This housewife has a very fine laundry in her basement which she rents out, together with the use of the machine, four days a week at $1.50 a day.

Fort Smith Light & Traction Company is negotiating contract for the electric power requirements of the Frisco shops, amounting to approximately 175 horsepower in motors to cover immediate needs. This will be increased by 125 horsepower in the near future.

The Navy Department has begun the construction of two one-story sub-charging stations at the New London, Conn., Naval Station.

The Seneca River Power Co., of Baldwinsville, N. Y., has filed application with the Public Service Commission, Second District, for permission to acquire the capital stock of the Oswego River Power Transmission Co., Syracuse, and to increase its capital stock to $200,000. The company recently increased its capital to $100,000. The two companies operate distributing systems at Baldwinsville, Phoenix, Van Buren, Lysander and other municipalities, and they declare that the business can be handled better and more economically by one than by two corporations.

The Public Service Commission, Second District, New York, has authorized the issuance of $2,000,000 mortgage bonds by the Niagara Falls Power Co. under a mortgage executed by the Hydraulic Power Co. to the Bankers Trust Co., Buffalo, as trustee. The proceeds of the bonds will be used for extensive additions and improvements.

Pompton Lakes, N. J., will build an addition to its lighting plant.

The War Department will abandon the project for a power plant at Milton, Pa., to cost $100,000.

The annual meeting of the American Institute of Consulting Engineers will be held in New York on January 13 .

The latest census of London, Ont., estimates the population at 67,243, and there is need for street railway extension. The company claims that it has been refused rate increases and that it is unable to finance any improvements.

It is said that negotiations are advancing with respect to a possible amalgamation of the power plants of the Montreal Tramways & Power Company with the Montreal Light, Heat & Power Consolidated, and that sufficient data is on hand to enable the directors to bring the matter to a definite head. The combined capital of these two organizations is in the neighborhood of $100,000,000.

Luchnow, Ont., will vote on a proposition to purchase the electric lighting plant of Walter Stewart & Son.

The Winnipeg Electric Railway Company are adding ten new steel cars to their rolling stock. They are being manufactured by the Ottawa Car Company and are at present in the last stages of construction. The Winnipeg company are also reconstructing their present rolling stock at the rate of ten cars per month, forty cars having already passed through their hands.

For two days Sherbrooke, P. Q., was without a tramway service, the Sherbrooke Railway Company discontinuing its service owing to the council refusing to meet the request of the company for increased fares. The result of the deadlock was a decision of the council to grant a temporary new contract for five months, under which the fares are 5 tickets for a quarter; 6 workmen's tickets for a quarter within restricted hours, and seven tickets for school children for the same amount. On this basis the service was resumed. A new permanent contract will be drawn up and submitted to the taxpayers. The company and the council have been negotiating for a long time as to extension and fares.

In the Miami (Okla.) mine field, the Ann Beaver mines are equipped with all the comforts of a city home. The change rooms, commonly called dog houses, are steam heated and lighted with electricity and modern in every way. A complete telephone system connects all of the offices and dwellings, even the offices 200 feet below the surface.

The West Kootenai Power & Light Company is preparing to construct a new electric transmission line from Grand Forks, B. C., to Princeton by way of Camp McKinney, at an estimated cost of $300,000, and has purchased the copper cable for this purpose.

The city officials of Weatherford, Tex., are planning for the rebuilding of the electric lighting plant recently damaged by fire.

The Magnolia Electric Light & Power Company, of Magnolia, Del., has incorporated with a capital of $10,000 to do a general electric light and power business. John B. Lindal, James Martin and George W. Collins, incorporators.

Work will soon begin on the installation of the new street-lighting system to be furnished Spokane by the Washington Water Power Company under contract. The new lamps, which are of the nitrogen-filled type, will replace the old carbon arcs which have been in use nearly twenty-five years. The new contract is for a period of ten years and calls for 1,410 lamps at $52,170 per year.

The Philadelphia Electric Company has made application to the Public Service Commission for permission to issue bonds for $1,500,000 for proposed extensions and improvements.

An agreement has been signed by the British Marconi Company and the Chinese Government for a loan of £600,000, for the construction of wireless plants. The material for these plants are to be furnished by the Marconi company and the price deducted from the loan.

Pipestone, Minn., has voted to issue $100,000 of bonds for the improvements of its city water system. Electric pumping apparatus will replace the steam equipment and energy for operation will be furnished by the Southwestern division of the Northern States Power Company. The city of Montevideo, Minn., is adding a 50 horsepower motor at the water works to supply increased demands. This station is operated electrically with power furnished by the Southwestern division of Northern States Power Company.

The next regular meeting of the Pennsylvania State Association of Electrical Contractors and Dealers will be held in Philadelphia on January 28, with headquarters at the Hotel Adelphia, where open and executive sessions will be held, followed by a dinner, to be addressed by prominent speakers. Representatives of all branches of the electrical industry are invited to attend.

Application will be made to the next session of the Quebec Legislature for the incorporation of the Levis Tramways Company, with power to acquire the property and franchise of the Levis County Railway.

As a means of smoothing out the load curve, staggered hours for closing seem to offer very great promise. A recent investigation made in Boston showed that at least 15,000 kw. in generating capacity would be saved on the system of the Edison Electrical Illuminating Company if 30 industrial establishments would change their working hours by thirty minutes. This statement was made at a recent meeting of the Boston section of the A. I. E. E., by Mr. L. L. Elden, electrical superintendent of the company.

Fifteen thousand kw. represents about one-sixth of the total estimated peak load of the Boston system for the coming winter, and the comparatively small change in closing hours required to realize such a large increase in available capacity is something of a surprise.

Authority has been given to an American company to gratuitously make studies for a new underground telephone system for the city of Montevideo, Uruguay. Under the same conditions authority will be granted to any other concern to make studies. The studies are to be presented within five months of December 10.

Personal Notes

F. L. Hinman has been appointed mechanical engineer of the Sheffield Company, of Sheffield, Ala. This company, which is under the management of the J. G. White Management Corporation, New York City, furnishes street railway transportation, electric light and power, and water service in Sheffield, Tuscumbia and Florence, Ala. For a number of years Mr. Hinman was master mechanic of the New York State Railways, Syracuse lines. He left the employ of that company in the early part of this year to become associated with the United States Ordnance Department, with headquarters at Watervliet arsenal, Watervliet, N. Y., in which service he was engaged up to the time of his present appointment.

J. F. Killeen has resigned his position as vice-president and sales manager of the Rathbone, Sard Electric Company, Albany, to become associated with the Edison Electric Appliance Company. Mr. Killeen was formerly associated with the General Electric Company, at Schenectady.

E. G. Miller, formerly traffic manager for the Walla Walla Valley Railway Company, Walla Walla, Wash., recently resigned to accept a position with the Pacific Power & Light Company, of Portland, Ore.

Union N. Bethell, vice-president of the American Telephone & Telegraph Company and president of the New York Telephone Company, has been made chairman of the board of operation of telephones and telegraphs now under the control of the Federal Government. Mr. Bethell has been identified with the telephone service since 1888, and is acknowledged to be one of the very foremost experts on telephone operation in the world. In recognition of this fact and particularly for his work in adapting the telephone to conditions in Japan, the Mikado, in 1909, conferred upon him the Order of the Rising Sun. Mr. Bethell has taken a leading part in civic and philanthropic activities, and is president of the Board of Education of Montclair, N. J., where he has made his home for a number of years.

Mortimer Elwyn Cooley, dean of the College of Engineering, University of Michigan, was elected president of the American Society of Mechanical Engineers at the annual meeting held in New York. Dean Cooley was born in Canandaigua, N. Y., on March 28, 1855, and graduated from the United States Naval Academy in 1878.

C. F. Sise, general manager of the Bell Telephone Company, of Canada, has been elected vice-president of the company, succeeding the late C. Cassils.

According to the Associated Press dispatches of December 11, Brigadier General George H. Harries, in civilian life a vice-president of H. M. Byllesby & Co., was the ranking member of three American officers first to reach Berlin since the signing of the armistice. General Harries and his aides arrived in Berlin December 10, as members of the American commission for the repatriation of war prisoners.

John R. Andrews, one of the honor roll employees of the Arkansas Valley Railway Light & Power Company, Pueblo, Colo., was one of 58 soldiers who volunteered their services as nurses and aids in the severe influenza epidemic which gripped Portland, Ore. Two of the number died as a result of their heroism and ten contracted the disease in its most violent form. Special medals were presented to the soldiers by the City of Portland, with impressive ceremonies, while 16,000 soldiers passed in honorary review before them.

Mr. O. A. Rofelty has been appointed manager of the Sioux Falls (S. D.) division of Northern States Power Company, succeeding Mr. N. C. Draper, who is retiring from active management on account of ill health. Mr. Rofelty was formerly manager of the credit department of the Minneapolis General Electric Company.

The following officers for 1919 were elected December 12 by the Electric Club of Chicago: President, H. A. Porter, district manager Century Electric Company; First Vice-President, W. H. Hodge; Second Vice-President, C. W. PenDell; Secretary-Treasurer, H. V. Coffy; Trustee, 3-year term, C. H. Roth.

B. Ross Jones has been appointed manager of the Doherty oil properties in Mexico, succeeding Fred V. Burns, resigned. Mr. Johnson's headquarters will be at Tampico. For the last three years he has been with the land and leasehold department of the Empire Gas & Fuel Company, covering Southern Texas.

George McDermand, formerly chief chemist of the Denver Gas & Electric Light Company and in charge of the laboratory of the Crown Tar Works, has been appointed manager of the tar department, succeeding the late Albert E. Reynolds. Mr. McDermand has been with the Denver company for the last eleven years, going to Denver from Detroit, where he was engaged in similar work. Mr. McDermand holds the degree of master of science and has had eighteen years experience in the gas and tar businesses.

Mr. Prescott C. Ritchie, Western Representative of the Westinghouse Automobile Equipment Department, moved his headquarters from Indianapolis to the Conway Building, Chicago, on December 1st. Mr. Ritchie has had extensive experience in the auto electric equipment here and had been with the Westinghouse Electric Company for several years.

Mr. H. D. Townsend has been appointed electrical superintendent of the Dominion Iron & Steel Company's works at Sydney, N. S., succeeding Mr. Collins, who has gone to the United States. Previous to going to Sydney Mr. Townsend was chief electrical superintendent for the United States Steel Company, Lorraine, Ohio.

Franklin L. Hall, formerly assistant secretary and auditor of the Narragansett Electric Lighting Company, Providence, R. I., was recently elected secretary and treasurer of the company to succeed the late William G. Nye.

Obituary Notes

Harvey Hinchman Green, connected with the Thomas A. Edison enterprises, West Orange, N. J., as paymaster for the past eighteen years, died recently at his home, West Orange, aged 64 years.

Ralph Carter, age forty-two, manager of the Smithville Telephone Exchange, near Bloomington, Ind., died recently at his home in Bloomington as a result of influenza and meningitis.

Jacob Bard, Chief Engineer of the Sangamo Electric Company and one of the leading electrical meter engineers of the country, died on December 13th at his home in Springfield, Ill., from pneumonia. Graduating from the University of Illinois in 1906 and after a few years' work divided between the Western Electric Company and the Peoria Gas & Electric Company, Mr. Bard entered the employ of the Sangamo Company in 1911, rapidly rising to have charge of all engineering matters, including development work, for that company. Mr. Bard was a member of the American Institute of Electrical Engineers. He leaves a widow and one son.

Commutation

THE term commutation and its meaning are something that many electricians know little or nothing about. When a motor is running with considerable sparking at its brushes, and the maintenance man comes along and shifts the brushes backward or forward and the sparking disappears, in many cases all he knows is that the brushes were out of neutral; as to what caused the sparking or what he did when shifting the brushes backward or forward he knows little or nothing.

When a brush bridges two or more commutator bars, the coils which are connected to them are short circuited,

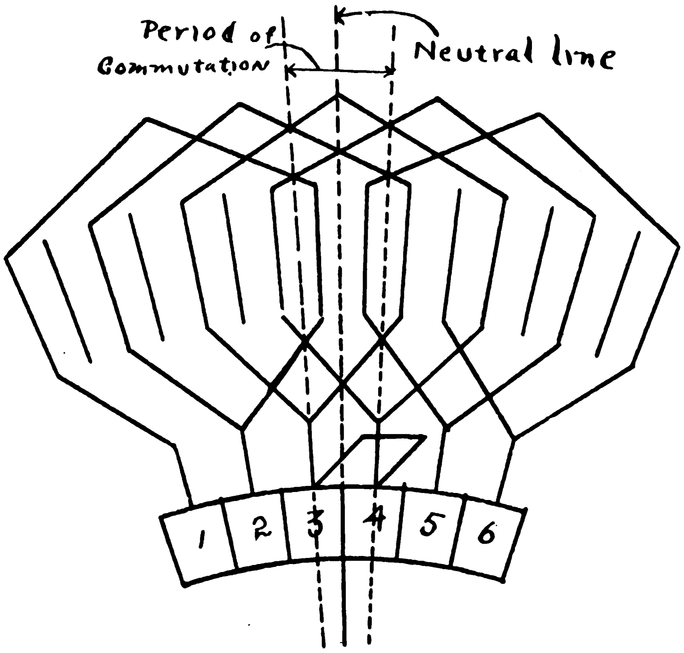


FIG. 1.

that is, from the time a commutator bar begins to pass under a brush until it leaves again the current in the coil connected to the bars has been gradually stopped and started again in the opposite direction against effects produced by self induction. The time it takes to commutate a coil depends entirely on the width of the brush and the speed at which the armature rotates. (See Fig. 1.)

The effects of self-induction are these: When the coil which would be connected to bars No. 3 and No. 4 in Fig. 1 is short circuited by the brush which is set in the neutral plain no voltage will be induced in it and the current, which was flowing through it has stopped; as the brush breaks contact with bar No. 3 the coil will become part of the opposite path of the winding, with the current now flowing in the opposite direction. When this coil became a part of the opposite path of the winding the length of the path was increased, and on account of the self induction in this coil, (self induction only takes place when the current varies in value, stops, starts or changes its direction) the current would jump the gap between bars No. 3 and No. 4 and sparking would result.

In order to obtain proper and sparkless commutation the brushes should be set a little behind the neutral plain, as shown in figures Nos. 2, 2a, 2b, 2c and 2d. In Fig. 2 commutation of the coil is about to begin, with the brush set a little behind the neutral plain. In figure No. 2a commutation of the coil has started, and the current from opposite sides of the winding are flowing toward the brush as shown by the arrows. The current at bar No. 2 divides, a part passing out through the brush and the other part passing through the coil to bar No. 3 and also out through the brush, although the coil is short circuited, and having passed the neutral plain, is cutting lines of force in the opposite direction and is beginning to produce an E. M. F. in opposition to the present direction. In Fig. No. 2b the flow of current through the coil has stopped entirely, as the E. M. F. in opposition to the original flow has equalled it and as shown by the arrows the coil is carrying no current in either direction. The coil is practically dead as it does not belong to either circuit of the armature. In Fig. 2c the coil is beginning to produce an E. M. F., flowing in the opposite direction but not up to its full strength as there is a divided circuit as shown by the arrows, a part passing from bar No. 3 out through the brush and a part through the coil and out through the brush at bar No. 2. In Fig. 2d the coil has been completely commutated, the brush is no longer in contact with bar 3 and the full current is now passing in the opposite direction through the coil as when it entered commutation in Fig. No. 2. This process of commutating coils will insure sparkless running.

If the brushes are set a little ahead of the neutral plain the machine will not run sparkless, as the coil will have passed completely through commutation before it reaches the opposite induction and in Figs. 3, 3a, 3b, 3c and 3d, the explanation of improper commutation will be given. In Fig. 3 commutation is about to begin, showing the brush

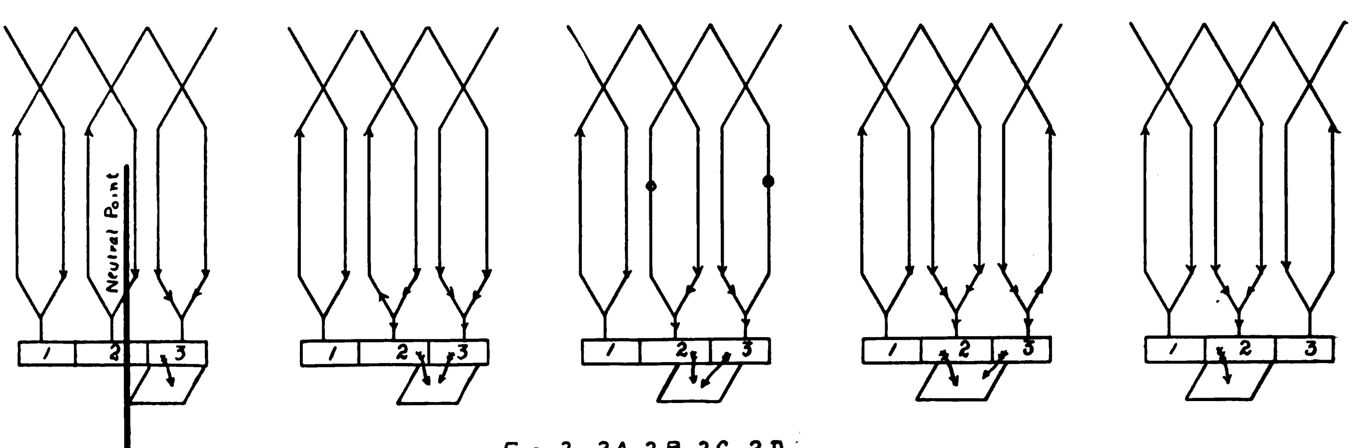


Fig 2, 2A, 2B, 2C, 2D.

set on commutator bar No. 3 and a little ahead of the neutral plane, and the current from both paths of the winding flowing to this brush as indicated by the arrows. In Fig. 3a the coil is short circuited by the brush although it is still carrying current due to the current dividing at bar No. 2, part passing out throught the brush at bar 2 and part passing through the coil to bar 3 and then out bar No. 3 as on bar No. 2 the current leaving bar 3 will be 30-I and from bar 2 10-I. In Fig. 4b commutation is half completed and the brush area on bars 2 and 3 is equal, therefore the current passing from each bar to the brush will be equal or 20-I from each. Fig. 4c shows the third quarter of commutation, in which the brush is set three-quarter on bar 2 and one-fourth on bar 3 and for this rea-

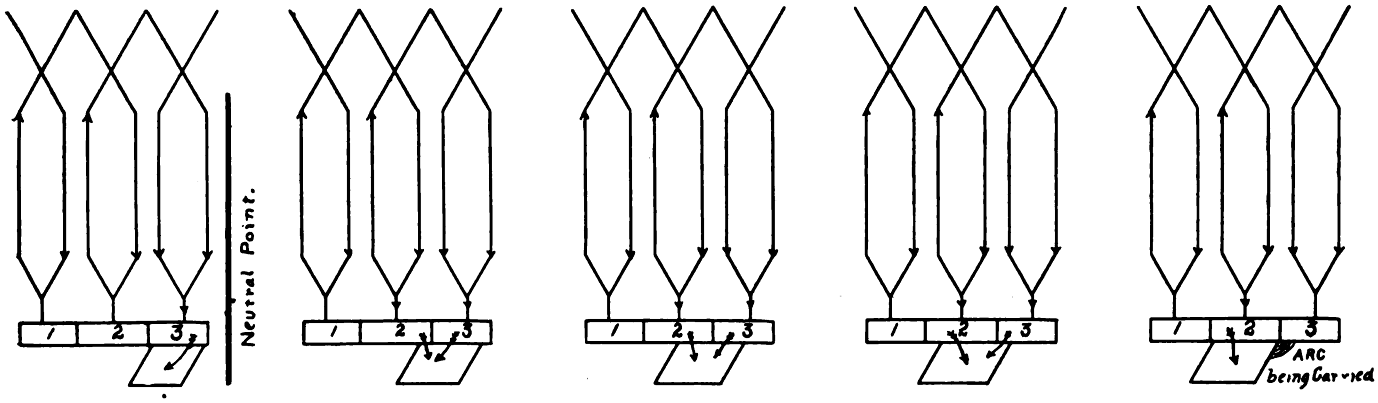


Fig 3, 3A, 3B, 3C, 3D.

through the brush, as shown by the arrows. In Figs. 3b and 3c the same condition exists as in Fig. 3a, although commutation has nearly been completed. It will be remembered that the coil has not passed the neutral plain as yet and therefore it is not cutting lines of force in the opposite direction so as to produce a flow in the opposite direction also. The direction of flow of current is shown son 30-I are leaving bar 2 and 10-I leaving bar 3 to the brush. In Fig. 4d commutation has been completed and the brush is in full contact with bar 2 from which the full current of 40-I is now passing. This same course of events takes place for each coil in the winding once in each revolution.

The reader may get a good idea of the time consumed

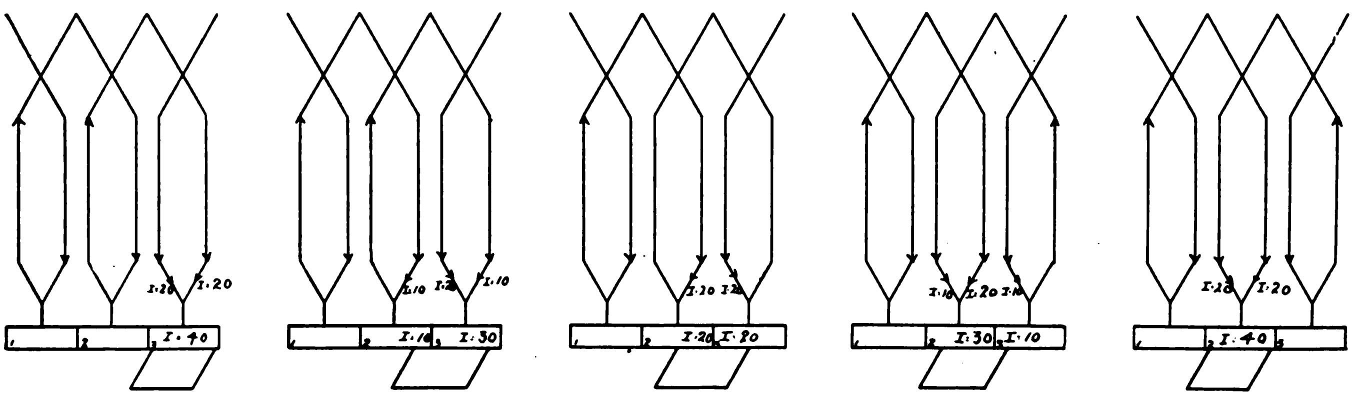


Fig 4, 4A, 4B, 4C, 4D

by the arrows. In Fig. 3d the commutation has been completed; the brush has broken contact with bar No. 3, but as the coil has not yet begun to cut the lines of force of the opposite polarity, the current will be still in the same direction, and as the brush is no longer in contact with bar 3 the current will jump across the insulation to bar 2 so as to reach the brush as shown by the arrows.

This proves that the brushes must be set a little behind the neutral plane to insure sparkless commutation as shown in Figs. 2 to 2d. The effect of resistance on commutation is shown and explained in Figs. 4, 4a, 4b, 4c and 4d. In Fig. 4, commutation is about to begin, the brush is set entirely on bar No. 1 and a current of 40 amp. is passing through this brush from this bar. In Fig. 4a, which is the first one-quarter of commutation, the brush is set one-quarter on bar No. 2 and three-quarter on bar No. 3. Since there is three times the brush area on for the commutation of a coil by assuming that the armature makes 600 r. p. m. or 10 r. p. m. per second; there are 60 coils on the entire winding. From this it can be seen that each coil will pass a given point in 1/600 part of a second, and the time consumed for the commutation of a coil will be the same in length.

Contracts for After-the-War Power

General Manager H. G. Bonner, of the Alliance Gas & Power Company, has finally received a form of contract from the procurement division of the War Department covering the installation of turbine and boilers, etc., and the furnishing of power to the Morgan Engineering Company. This contract is along the line of the procurement order issued to the Alliance Gas & Power Company in March.

The Morgan Engineering Company has been doubling the capacity of its plant, chiefly to provide facilities for the manufacture of gun carriages. It is believed that the equipment now being made for the American Army for service abroad will be diverted to coast defense use. The Morgan company has been advised of the probability that much other work will be given it to replace all war business as soon as the contracts expire. There is little likelihood of the Alliance Gas & Power Company having any surplus power in the near future.

Using Films to Show Industrial Progress

It is announced by Tampton Aubuchon, general manager of the Louisville Industrial Foundation, the so-termed Million Dollar Factory Fund of Louisville, that the organization's annual report to the stockholders will be partly rendered in motion pictures.

About twenty new industries have been located in the city of Louisville as the result of the Foundation's activities, and camera men are busily engaged in Louisville in photographing the salient features of the various new factories in order that an intimate review of the industries, their processes and products, may be presented to the stockholders and the citizens of Louisville. It is the idea of the Foundation directors that the stockholders and citizens should be afforded an opportunity to visit all of the new plants located in the city and the motion picture method was adopted as the most practicable.

The contract was made for the work with the Rothacker Film Manufacturing Company, Chicago, who will produce the films. After the cinematographic review is presented to the stockholders in January, it will then be exhibited at the various motion picture theatres in the city of Louisville. It is planned to have exhibitions later at business conventions held in Louisville and elsewhere.

The film will include views of the manufacture of automobile axles, overalls, clothing, tobacco, wood products, soap, oil, bed springs, heating apparatus, furniture, etc. It will be expressive in a measure of the character of industries located in Louisville as well as the type of skilled mechanics employed.

The idea of presenting an annual report in moving pictures is unique and it is believed to be orignal in its application in Louisville. The motion picture manufacturers of the country are keenly interested in the success of the idea, for it is hoped that through Louisville's experiment the cinematograph will ultimately be utilized as an assistive force in the development of communities and in the solution of civic and industrial problems. The use of the film in merchandising is quite popular now but its adoption as a means of presenting a clear and impressive record of the accomplishments of an industrial development organization is said to be without precedent.

One of the prominent features of the film will be to show that, although a large number of industries were located in Louisville during the period of the war, none of them are strictly war industries but, as the pictures will reveal, are engaged in the manufacture of peace products, a development along permanent, substantial lines.

A Westinghouse Department Moved to Newark

The Westinghouse plant at Newark, N. J., is now devoted to the making of electrical equipment for automobiles, this department of the company's works having been located previous to the war, at Shadyside, Pittsburgh. The increasing demand for automobiles has given an added impetus to the manufacture of equipment, so that the Newark works promises to become a real industrial growth for that city. Besides a number of accessories, they are manufacturing lighting apparatus, an ignition system, a self-starting device, and a generator and storage battery to supply power for these.

The core of the Westinghouse electrical system of automobile equipment is a small generator, which is attached to the automobile engine. The electric power generated is fed to the lighting, self-starting, or ignition systems either direct or through storage batteries. A unique cam-regulator so controls the voltage of the generator that when the car is running at full speed the lights cannot receive an excess, making it unnecessary to use the storage battery except when the car is standing still or running at low speed. The generator also supplies current to a small powerful motor attached to the engine, used as a self-starter. The ignition system utilizes the current from the generator, making magnetos unnecessary.

Trade Notes

The Bates Expanded Steel Truss Company, with office at 208 South La Salle Street, Chicago, and works at East Chicago, Ind., are the sole manufacturers of one-piece steel poles, designed as the logical substitute for fabricated steel poles, tubular steel and wood poles. Being of one piece, it has greater strength than any built-up pole, and it has all its surfaces easily accessible for painting. The fundamental theory of construction is based on the truss elements of a triangle, consisting of a series of triangles in alignment. The Bates poles are designed for telegraph, telephone, electric light, power transmission and electric railway service.

A. F. Daum, 1157 Hodgkiss Street, Pittsburgh, makes a refillable plug fuse that is meeting with great success, because of its simplicity and effectiveness. It is made entirely of porcelain and can be refilled in less than a minute without the use of tools. It is made in all sizes from 3 to 30 amperes, 125 volts, and the refill fuse strips are put up 100 to the box in any amperage.

The Youngstown Steel & Tube Company, of Youngstown, O., has issued one of the most striking calendars that the new year has brought. This is of large size, 19 by 25 inches, and is printed in two colors. What makes it of wonderful general interest are the large engravings, 15 by 7 inches, for each month, showing the great works of the company and the various processes of manufacture going on therein. Besides its industrial output, the company supplied the Government with much that was needed for the prosecution of the war. The photographs from which the engravings were made are among the most successful ever taken of a great manufacturing plant in operation.

The Kuhlman Electric Company, of Bay City, Mich., is the oldest independent company manufacturing transformers today, having been organized in 1894 and incorporated in 1897. The company specializes in this one branch of the electrical industry, and does nothing else. Every improvement that is incorporated in the Kuhlmann transformer has been very carefully considered and tried before being put on the market. Owing to the care in construction and the thorough testing of every piece of apparatus before it is shipped, the company is enabled to issue an individual certificate of guarantee, which is in effect an insurance policy against repair bills for a period of two years without conditions, injury by lightning not excepted. This will be automatically extended to five years for all customers who give all business in this line to the company. The Kuhlman company knows none but satisfied customers.

ELECTRICAL ENGINEERING

VOLUME LIII FEBRUARY, 1919 No. 2

Electricity in a Southern Textile Mill

NOT only are industrial municipalities awakening to meet new civic problems by making their cities desirable places to live in as well as to work in, but industrial plants themselves throughout the country are beginning to realize the economic value of housing their employees in comfortable and attractive homes. The question of labor turnover which is in some places as high as 60 per cent is largely due to an acquired spirit of restlessness among the men employed in communities with poor homes; where this side of a corporation's interests is men will come, but will also go. Where men cannot bring their families, and take root in new soil; where they say, "that the wages are good but the living is poor," the employer finds dissatisfaction and constant shifting.

The far-sighted company makes the place where the men work, and the place where they live, light, roomy, clean, orderly, and sightly. For instance when one sees a community taking pride in pointing out to the stranger "the attractive backyard," then one feels that that community is there to stay.

The Rex Spinning Company, at Ranlo, N. C., has built cozy homes for their present and prospective employees to live in, and a model plant for them to work in. It is an interesting example of a carefully designed and efficiently operated textile mill.

The village of Ranlo, which consists of the mill, the employees and their families, is situated 18 miles southwest of Charlotte, N. C., and may be reached by the Piedmont & Northern Electric Line. Freight is consigned over the Seaboard Air Line to Mount Holly and thence over the P. & N., or over the Southern to Gastonia and thence over the P. & N. to Ranlo. It has been the consistent aim of the management of this mill, to make it an ideal textile manufacturing community. This policy instituted by its president, Mr. Mayes, has been enthusiastically carried out by the other officers. To-day the mill, from the points of view of operatives' accommodation and uplife, perfection of mechanical equipment, and beauty of its property, make it a model institution.

Ranlo has a population of about 300 people and the mill has at present 120 employees. The mill, in conjunction with other mills in the vicinity and the county, is now erecting a graded school building of the finest and most modern type. It will compare well with modern high school buildings in any of the smaller cities. Until the present, a school has been maintained and operated for the benefit of the children of the operatives, entirely at the expense of the company. The neatly furnished houses, well kept and clean, and the pretty gardens bear testimony to the appreciation of the employees. The company owns twenty five-room and eleven six-room houses, which are rented at unusually reasonable rates. They are substantially built, being equipped with electric lights, bath and sewerage.

The Rex Spinning Company was organized in 1915, began operation on May 1, 1916, and is under the direction of President, J. H. Mayes, Charlotte, N. C.; Vice-President, John Rankin, Lowell, N. C., and Secretary, Wm. Bryce, Charlotte, N. C. The operation of the plant is under the direct supervision of Superintendent C. E. Bean, who makes his home on the property, and therefore possesses more than a passing interest in the community and its welfare.

The mill has 12,000 spindles which will shortly be increased to 20,000 and is engaged in producing yarn from raw cotton at the rate of about 8,000 pounds a week. The raw staple is secured mostly from Mississippi.

The main building is 125 x 400 in area, of an unusually well ventilated and light type of construction, which adds to the comfort of the employees, as well as forming an important factor in production. The building is well supplied with humidifiers and fire extinguishers. The cleanliness, the safety devices for protection of employees and the general spirit of the company seems to have been to make the men and women that work for it contented and happy in their work. But this is not all; the equipment in the mill is of the finest in the market. The shafting in this mill is virtually eliminated, being used only for driving cards and warpers. The drive employed is a two- and four-frame with individual drive on winders, spoolers, and pickers. Westinghouse 25 H. P. motors are used to drive four spinning frames, or twisters, a 10 H. P. Westinghouse motor drives the drawing frames. To drive each two of the speeders 5 H. P. Westinghouse motors are used. All motors except the individual motors are of the ceiling mounted type. Other motors are used to furnish power for the opener and fire pump, and a well equipped machine shop.

Electric power is supplied from the high tension lines of the Southern Power Company, the distributor of electric energy in this district. This eliminates the trouble and additional expense of maintaining a power plant, and enables the operators to devote their time and energy to the production of yarn. The high tension current is stepped down to 550 volts by a bank of transformers located just outside the main building. Water is supplied for the factory and for the town from a deep well by an electric motor-driven pump, the excess going to a reservoir tank from which it flows by gravity into the mains.

Removable Truck Safety First Switchboard Units for Power Plants

For use in electric power plants, the removable truck type safety first switchboard units are eminently fitted. They can be obtained for the control of generator, motor and feeder circuits, and are particularly adapted to plants where electrical distribution to various buildings is made from economically located distribution centers. The construction is such that extensions can be readily made or the units moved to other locations to meet changed or new conditions.

All live parts are enclosed, and the opportunity for an operator to come in contact with the circuit is practically eliminated. A spare removable unit can be used to reduce the time of shut down for inspection or repair. Busbars need not be killed, disconnecting switches need not be opened, leads and small wiring are not disturbed. The design of the units is in accord with the best engineering practice. The oil switches, busses and all live parts are in compartments. This tends to reduce fire hazards and limits disturbances to a single point.

The stationary member of the removable truck switchboard carries current and potential busses with their disconnecting switch studs and barriers between the current studs to prevent accidental contact by any one who enters the compartment. The rear end of the current disconnecting switch studs runs to busses and incoming or outgoing leads; the potential buswires to small contact studs near the top of the compartment. The side walls are provided with hand holes, so that the busbars and buswires can be continued from unit to unit. On the exposed walls of the end units these openings can be closed by removable covers. Access to the rear of a compartment can be had by means of hinged sheet steel doors provided with means for padlocking in closed position.

The removable truck is mounted on wheels. The fore part carries a sheet steel panel on which are mounted the instruments, meters, oil switches or other appliances usually mounted on the ordinary slate switchboard panel. The current transformers are mounted on steel brackets back of the instrument panel. The rear of the truck carries the movable parts of the disconnecting switches, the potential transformers and small wire accessories. To center the truck and to assist in placing it in or removing it from a compartment, rails fastened to the sides of the compartments are furnished. The oil switches, instruments, meters, transformers, and all adjunct parts are removed entirely from the installation by wheeling out the truck.

To remove or replace a switch unit, the oil switch must be open and therefore the load disconnected. This is provided for by an interlock attached to the oil switch operating toggle, which engages cast lugs on the walls of the stationary unit. With the oil switch closed it is impossible to remove or insert the truck. The value of this feature needs no discussion.

The panels are being regularly manufactured in a variety of styles and capacities. These vary in capacity from the smallest up to and including 1,200 amperes—and to operate at voltages up to 15,000. In the larger sizes the housings are usually of re-inforced concrete—and all capacities are designed for use with either solenoid or manually operated oil circuit breakers. These units are made by the General Electric Company.

Electric Equipment for an Italian Plant

Consul B. Harvey Carroll, of Naples, makes an interesting report on one of the largest manufactories of macaroni in his district. This has wholesale offices in Naples and factories at Foggia and Castellamare di Stabia. The plant at Castellamare covers a surface area of 10,000 meters, of which 5,000 meters are occupied by two large 4-story brick buildings, connected at the rear by a covered drying shed. The company is incorporated for 3,000,000 lire (at normal exchange the Italian lira is worth $0.193 U. S. gold) and the plant cost to build about 2,000,000 lire. The company had just had installed new, expensive oil-burning power machinery when the war began. To duplicate the plant would to-day cost at least 5,000,000 lire. This new oil-burning machinery is, however, to be speedily replaced with electric-motor machinery already purchased although not yet installed. Electric power will run the plant at a cost about one-fifth that now paid for oil, but at a price slightly higher than was paid for oil before the war. All new mills of the company will probably use electric engines and motor power.

The Question of Hydro-Electric Development

By D. H. COLCORD

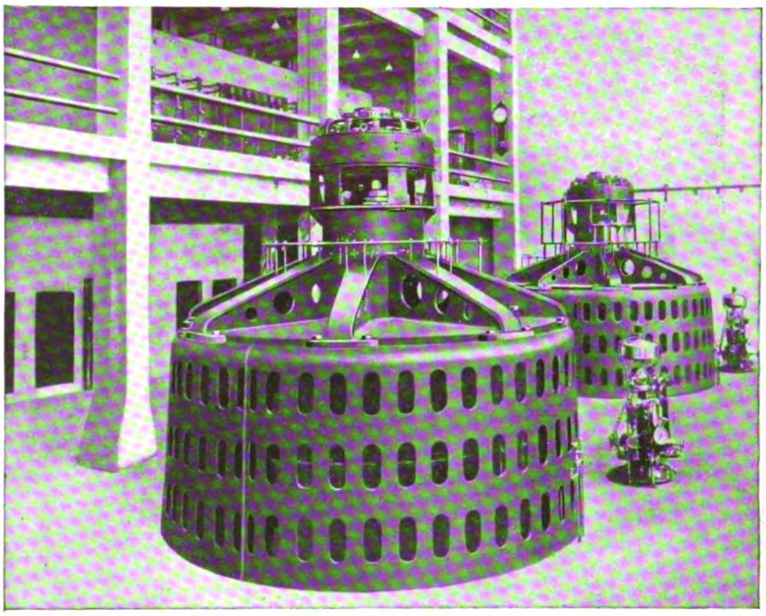
NOW that the Great War is over, the question of developing our Eastern water resources, converting them into electric power for use in our industrial centers is no longer so urgent as the tremendous burden that has been loading the long suffering shoulders of the railroads and coal mines will gradually be lightened until they are able to function normally and as in pre-war times. However, in a normal economic order the value of water power for generating electricity is far from being a dead issue. Even in an industrial section where coal is the natural source of power, water power that is contingent to extensive markets, can and will be developed to supplement steam. And it can be made to reduce the operating cost of central stations enough to make it pay. Again there are a number of instances where our Eastern rivers afford excellent head-sites within easy transmission distance of manufacturing centers, that if developed on a large scale would be practical from a business standpoint to say nothing of their tremendous benefit to the public by affording cheaper light and power.

In the United States to-day there are approximately four or five times as much steam as water horsepower in use. The aggregate water horsepower developed is around 60,000,000. The Secretary of Agriculture estimates the water power development in 1916 to be 6,500,000. This means that there is still undeveloped water power in this country equal to twice the present steam capacity in service. Approximately 40,000,000 of the undeveloped water power is in thirteen of the Western States, leaving about 13,500,000 in the East.

It is with the possibilities of developing these 13,500,000 horsepower in Eastern United States that this discussion deals. As 32,500,000 horsepower is generated by steam and as this steam is generally created from coal—a fuel which is sometime going to be exhausted—and as the greater proportion of steam power is used in the East, where there is always a market for power, the question of numerous small developments here, although less romantic than harnessing the tremendous water power potentialities in the Rockies, has certain concrete financial possibilities.

Certain economic and legislative factors have taught the uninitiated investor in hydro-electrics several costly lessons in recent years, and it seems worth while to review these considerations before pointing out water power advantages.

1. Load factors have been overestimated.
2. Drought in summer and ice in winter have prevented the constant source of power counted on to supply the consumer. The initial cost for building impounding dams to overcome this difficulty was so great that although companies might have succeeded in the long run, they could not compete with steam power companies, during their infancy.



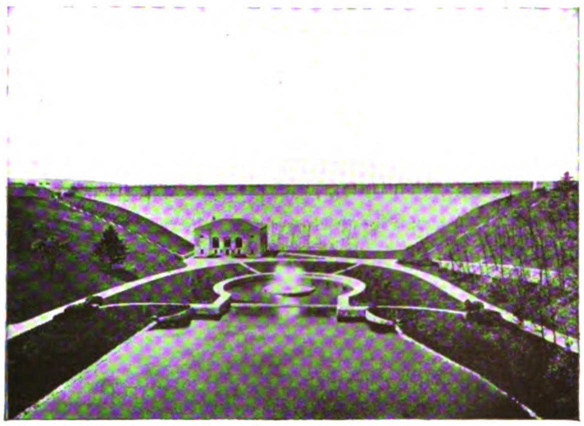
POWER PLANT AT ROCHESTER, N. Y.
Two 12500 Kva, 11,000 volt Westinghouse Waterwheel Generators Furnishing Power for Manufacturing Plants

3. The high cost of transmission systems in a mountainous country has been prohibitive in some degree.
4. The cost of installation is high. In 1914, the total cost of installing hydro-electric plants was estimated at $27,000,000, including distribution systems and auxiliary equipment. This gives an average cost per horsepower of $158. A general estimate of the cost complete as given by a prominent engineering company, not including distribution or step-down transformers, has ranged from $75 to $150 per kilowatt installed. If the price of coal increases, in time it will compare favorably. At least the marginal difference in cost will demand increased efficiency in the operation of hydro-electric plants which might make up for this difference. The best steam practice secures at the electric generator less than 20 per cent of the energy stored in coal,

while the efficiency of the water wheel frequently exceeds 90 per cent, which is worth considering.

5. The rapid development of the steam turbine with its increased efficiency has discouraged water power.

6. The distance because of the mountainous nature of the East, from the market, has been a factor.



Dam and Power House at Clinton, Mass.
Public water supply being used to develop electrical energy for commercial purposes

7. The high value of land in industrial districts has restricted development.

8. Railroads have followed the streams and in many instances would have to be rebuilt.

9. Many of the streams are of an interstate character involving legislative difficulties.

10. The fact that several projects have been started and abandoned has had a bad moral influence.

11. Long term franchises held by municipal heating and lighting companies made competition impossible.

12. The forestry laws contain inadequate provisions for the leasing of land.

13. There is a scarcity of real good head sites.

14. There is not enough data available on the geological features of stream beds.

15. The recent scarcity and high cost of labor and building material has prevented, since the war, even the completion of development already started.

The report of the Pennsylvania Water Commission of 1916, contains data on hydro-electric projects that have been started and dropped for various reasons and although for one of the Eastern States.

1. These projects were begun at a time when there was a marked scarcity of capital in this country.

2. The companies failed to realize the necessity for a complete engineering survey and improper sites were chosen and then abandoned.

3. Hydrographic conditions were overestimated and in some cases there was not as much water available as counted on.

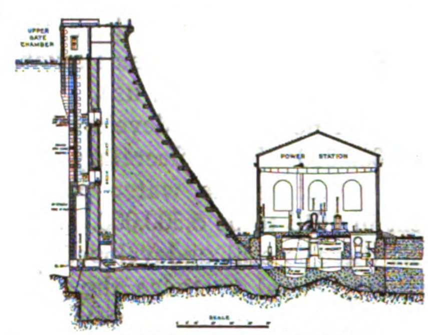
4. Commercial surveys were not thorough in all cases and companies in some cases overestimated their markets for power.

5. In three instances uncertainity in regard to the legal rights possessed by the companies, and subsequent legislation blocked their progress.

6. In several projects, the blame for failure can be laid at the door of financial misfortune.

To attempt to present in so limited a space even a general summary of what has already been accomplished in developing water power facilities in the East would be a task of doubtful value. The wide difference in the capacity of completed plants, some producing as small an amount as 8 horsepower, would indicate little but a brief account of the completed developments in Pennsylvania are indicative of conditions in general.

The grand total of all hydro-electric plants, 61 in number, in Pennsylvania in 1916, including auxiliary powder units, was 172,872 horsepower. These plants vary from 8 horsepower to the capacity of the largest central station at Holtwood. The Holtwood plant is located on the Susquehanna River and is laid out for ten vertical units. Eight units have been installed. Units six, seven and eight are of Westinghouse manufacture of the vertical type and have a normal capacity of 12,000 Kva.



Cross-Section of Power House at Clinton, Mass.

each. The dam is half a mile in length and is built of solid concrete with an average height of 55 feet. The power generated at 11,000 volts is stepped up to 70,000 volts through three-phase transformers and is transmitted about 40 miles to the city of Baltimore over aluminum cables suspended from steel towers. The development is owned by the Pennsylvania Water and Power Company. Nineteen of the 61 power plants in Pennsylvania are equipped with Westinghouse generators, the largest number for any single company.

The following table is taken from a report of the New Jersey Water Commission for 1918 and compares the utilization of water power along the Musconetcong River between Hackettstown and

Riegelsville for 1894 and 1918. Excepting the Passaic River, the Musconetcong has the greatest hydro-electric facilities in the state.

Kind of Mill	1894 H. P.	1894 No. of Mills	1918 H. P.	1918 No. of Mills
Paper mills	955	3	1610	3
Grist mills	579	10	368	6
Graphite grinding mills	80	1	290	2
Worsted yarn mills ...	—	1	110	1
Machine knives mills .	75	1	100	1
Saw mills	—	—	40	1
Snuff mills	35	1	——	—
Total	1724	16	2518	14
Total head in feet.....	179		176	

The table shows an increase of 46 per cent in total horsepower in 24 years, although the number of mills decreased by two. It proves that hydro-electric power is successful even within easy hauling distance of the coal mines, and means that a singular outlay on other developed streams would not be a mere venture.

The general advantages desired from a greater development are:

1. The highest use of coal is to create heat to preserve man's life and the term of man's existence may depend on the care of the supply. Fuel is not essentially reproductive. Water power for industry can save the nation millions of tons of coal a year.

2. The East is first and foremost an industrial section and depends primarily on fuel and any effort to conserve it will lengthen out productive life.

3. The electrification of all railroads in the United States is inevitable and provision must be made to supply the electric power. As railroads follow the streams the natural source of power is that which is the most available—the stream itself.

4. Water power makes electric lighting possible wherever it is needed.

5. Where steam power is already used it can well be supplemented by water power.

6. Storage reservoirs used with hydro-electric plants are a protection against floods.

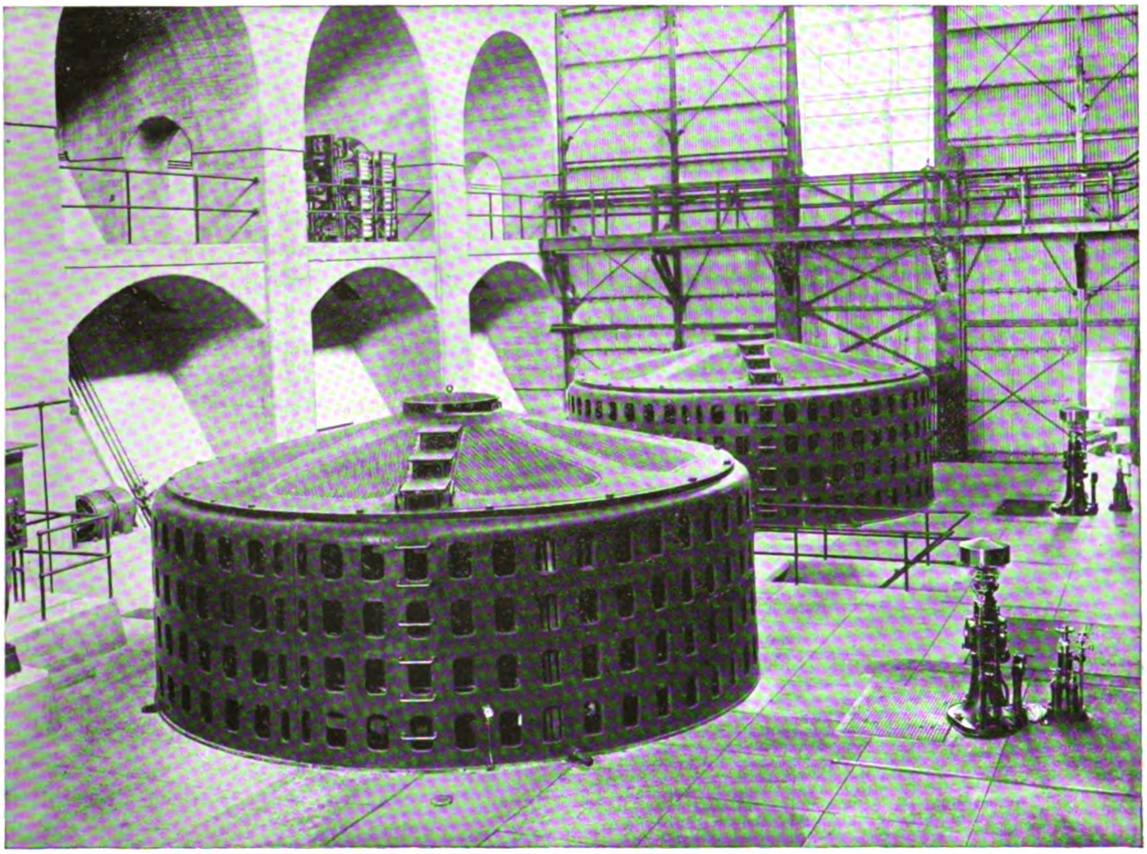
7. During the droughts in summer, the expulsion of water from impounding dams improves sanitary conditions along the stream below.

8. Impounding dams on rivers often improve navigation.

9. The thickly settled districts afford a large market for electric power with reasonable transmission distances.

10. The prevalence of old canals and dam sites make it possible to install a plant at a small cost.

11. There are many limestone streams in the mountainous districts that have a high rate of flow during the dry seasons.



Power Plant at Holtwood, Pa.

Interior of generator station, showing two Westinghouse 12,000 kva., 25 cycle, 11,000-volt vertical water-wheel units

12. Labor that is released with the close of the war, can be used to build the plants.

13. Increased industrial efficiency is effected due to labor saving and waste prevention in distributing power.

From a conservative and absolutely safe standpoint, considering immediate returns on the investment, the correct policy here in the East is to use but water power only to supplement steam and where coal is available at a fair price. But this policy is somewhat pinched and near-sighted from a national, industrial and economic standpoint, because the time is coming when the available coal will be gone. At least a nation like ours can afford to dream of the time when every river that runs from the summits of the Appalachian Mountains to the sea will halt from time to time in its wanton course and convert its energy into power that will electrify the Atlantic Seaboard. There may come a time when the coal that is left will be required for purposes that a central station cannot serve, such as driving the engines on our ocean liners or as fuel for keeping us warm.

Eons ago a shaggy haired fisherman paused in his day's occupation. No fish were caught for several hours. The fisherman's unusually uneventful life had been interrupted with the birth of an idea. For days the idea had been struggling in his thick head and now he was compelled to recognize it. So he paused and thus he reasoned: "If I could cast my lines a few times more each day, in a week I could accumulate a surplus of fish that would allow me a day holiday. I can take this day to build a net which, when ready to use, will catch enough fish in an hour to feed my tribe for a week. The trouble is, I already have a good set of lines and hooks that have cost me time and labor. Must I throw these away, and find new material for a net? Yes, because what little I lose will be made up a hundred fold by my net. It will require sacrifice, labor and new material to create this net; but the net will be capital that will perform my work with increasing returns."

Of course the idea materialized as it has always done. It won because, as Mr. Balfour said, its cubical congealed concrete essence was universal. The idea is simple, it is old, the story is worn threadbare, but like most of the great truths, it is so near that it cannot be seen. For a nation that can raise over $6,000,000,000 in one Liberty Loan Campaign for the prosecution of a just war; for us to cling to an old industrial method because of a lack of capital is absurd.

Right now in Eastern United States, hydro-electric possibilities represents another big idea, still vague, indefinite, but so tremendous, so colossal that it is food, fit only for the brain of some Titan of Industry like George Westinghouse or Thomas Edison. Horsepower that runs into millions is being wasted every year as our rivers run wantonly to the sea.

Why isn't it possible for the Geneso, the Delaware, Susquehanna, the Juniata, Allegheny, Monongahela, Ohio, the Passaic or the Musconetcong Rivers to be harnessed as completely as has the Huron, the Kalamazoo or the Grand Rivers of Michigan? For example, imagine central stations at Lock Haven, Williamsport, Harrisburg, Sunbury, each the size of the complete hydro-electric plant at Manistee, Michigan. They would furnish power for twenty cities and towns, turning the wheels for great silk and paper mills and make it possible to electrify the whole Buffalo-Washington Division of the Pennsylvania Railroad. Multiply in your imagination, this river by hundreds of other streams, and these cities by thousands of other cities, and the vision appears of a vast network of transmission systems extending from Maine to Florida, furnishing every unit of power required from that of preparing the toast for breakfast to that of driving giant locomotives over the Allegheny Mountains. The vision contracts considerably, when you consider that Pittsburgh in 1914 had only 2,320 horsepower derived from water turbines in the Ohio basin.

In Great Britain proposals have been set forth for vast central station power plants, and stock is being taken of all of the water powers of the British Isles. Since the outbreak of the war the Italian government has proceeded with an active water power policy. In 1917 and 1918 there have been concessions granted for 1,024,000 horsepower. Norway has developed 1,120,000 turbine horsepower, and plans to export hydro-electric power to Denmark. Barcelona, in Spain, is replacing steam power by hydro-electricity. In Switzerland 25 per cent of its 2,000,000 available horsepower had been developed. A Canadian company has completed a large portion of an extensive system of reservoir and hydro-electric stations on the Nogurea, Pallaresa and Segre rivers. All of these are indicative of the fact that other people are laying a lasting foundation for power for years to come and it is with them that we must compete for the world's trade.

Applications of Electroplating

Electroplating is an art which has been developed during the last 50 years with only occasional applications of scientific principles. Formerly the industry was much shrouded in mystery, each plater guarding jealously the formulas and methods employed by him. Of recent years, however, there has been a considerable demand from electroplaters and manufacturers for more exact data relating to this industry.

This need and demand for information has been emphasized during the war by the numerous problems that have arisen in connection with the plating of military supplies of the most varied description. Thus, zinc plating has furnished an excellent and, in many cases, the best protection against the corrosion of steel parts, such as airplane and seaplane fittings, fuse parts, hardware on ammunition boxes, etc. Black nickel plating was very extensively used for producing the so-called "government bronze" finish upon brass, hardware and saddlery equipment. Lead plating proved valuable in the lining of gas shells and for bringing up to standard weight shells which were underweight. In connection with these problems a number of investigations were conducted at the Bureau of Standards, whose experts made frequent visits to munitions plants to advise upon the best methods of securing the desired results.

Appropriations have been requested by the Department of Commerce to permit more exhaustive study by the Bureau of Standards of plating problems and their application to various manufacturing industries. Electroplating forms an excellent illustration of a "key industry," *i.e.*, an industry which, while it is not itself of great magnitude, is often of fundamental importance to larger industries. Thus, electroplating is essential to the manufacture of tools, builders' and saddlery hardware, plumbers' supplies, gas and electrical appliances, automobiles, silverware, jewelry, stoves, household utensils, mechanical devices, such as phonographs, cash registers, sewing machines, adding machines, typewriters, cameras, and other optical and scientific instruments, and, in fact, almost every industry in which finished metal articles of any description are produced. Progress in the art of electroplating will bring about corresponding improvements in all such industries.

Pending the appropriation of funds adequate to conduct extended or exhaustive investigations on electroplating, arrangements have been made by the Bureau of Standards to secure, by inquiries addressed to platers, reliable information regarding the kinds and methods of plating now in commercial use. From such a preliminary survey it is hoped to secure much information which can be made immediately available and at the same time to define more clearly the problems most in need of investigation.

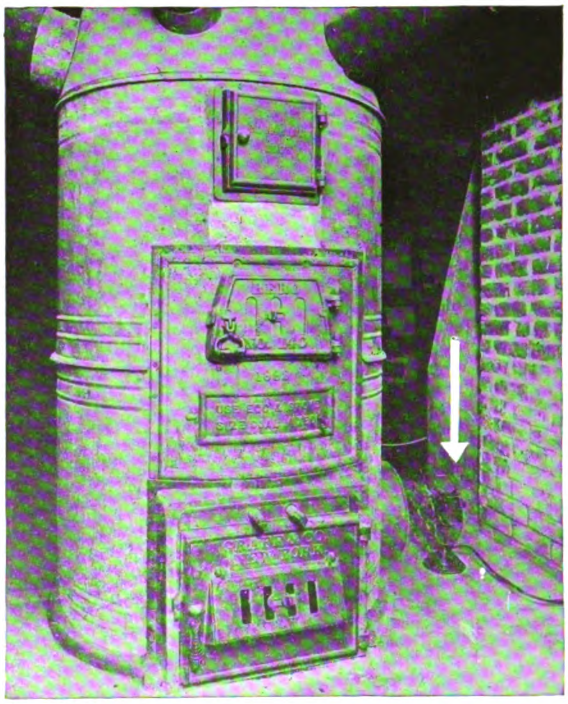
Electric Fans as Heating Aids

THE scarcity and high price of coal makes it imperative that every householder should be as economical of fuel as possible. The fullest service that can be obtainable must be gotten from every heating appliance. The suggestion is made that an electric fan in this connection actually saves money for the user, as it helps to do the job of heating the house, by distributing more of the heat through the house and allowing less of it to slip away up the chimney.

Every householder, whether he is using a hot water, steam, or hot-air system, can save money and coal. In our consideration let us suppose that a closed room is to be heated with a single radiator which receives its heat supply from a hot-water furnace. The effectiveness of that coil depends on two things only: First, the rapidity with which heat is supplied to the coils in the furnace; and second, the speed with which the heat is carried away into the room. Naturally the first object is to get the water as hot as possible in the furnace, and send it back from the radiators to the furnace as quickly and as cool as possible. If it could be sent back at room temperature the system would be working at top efficiency.

Now consider the things that happen while the room is heating. First, the air directly around the coils is heated; second the heater air rises to the ceiling; third, a layer of hot air spreads over the room; fourth, it gives up its heat to ceilings, walls and surrounding air; fifth, it drops to the floor; and sixth, it flows back to the base of the radiator to begin the cycle all over again.

There are only two ways by which the efficiency of a connection system of this sort can be improved. One is by adding more coils to the radiators, and the other is by forcing a current of air past the coils to carry off the heat more rapidly. The first way involves more expense, the latter involves only a small invest-



"FEEDING" A HOT AIR FURNACE
Westinghouse electric fan used to supply air to risers that were formerly cold

ment in a fan, which can be used summer and winter for many years.

The principle used in the house heating system is much the same as that of a steam-engine boiler. In the engine the capacity of the boiler depends on the freedom with which the hot gases sweep over the coils and the ability of the boiler to turn the heat into steam. In the heating system the capacity depends on the speed with which the heat can be removed from the coils and circulated in the room.

In the case of a steam heated house, the heating of a room is indicated both by the movement of air and by room temperature taken at the point farthest removed from the radiator. When forced circulation is introduced, the change made in the normal conditions is really surprising.

Some advocates of the electric fan method of distribution claim that the fan should be placed on the floor so that the natural direction of air circulation will be retained, but the movement accelerated. It is also believed that better results can be secured by forcing a downward current to carry the hot air along the floor, and thus use the heat to a better advantage by spreading it across the floor surface than by allowing it to give off the heat near the ceiling.

An electric fan also increased the efficiency of a hot-air furnace. A furnace used to heat a seven-room house had four risers to carry hot air to the various parts of the house. Cold air was taken from the basement. Normally this furnace could not keep more than three risers hot at a time and it seemed that no amount of changing drafts could set things right. A good deal of coal was wasted in trying to keep the house warm until the owner hit on the place of blowing the cold air into the heating jacket with a Westinghouse eight-inch fan. There has not been the slightest difficulty since the new plan was adopted. There is no doubt that the fan system, used with either steam, hot water, or hot-air furnaces, has great possibilities in the way of saving coal.

Licensing of Engineers

Members of the Ohio Engineering Society on the first day of its annual convention in Columbus, voted unanimously in favor of the principle of licensing engineers. It is expected that a bill will be presented to the state legislature at its present session. The action of the Ohio Engineering Society followed an address on "Licensing," by C. E. Drayer, Secretary of the American Association of Engineers.

President Clyde T. Morris of the Association of Ohio Technical Societies announced a plan for the study of the subject of licensing by all engineering organizations of Ohio in order that a generally acceptable bill may be drafted. He has called upon the societies composing the Ohio Association of Technical Societies to name committees on licensing. A conference will be called at Columbus in the near future for discussion and the drafting of the bill.

Mr. Drayer emphasized the necessity of such a law to provide for the safety of our citizens and pointed out that efficiency would be increased, resulting in a very great saving to the public. Licensing would help to dignify the profession by tending to elevate it. Licensing would promote unity of the profession by putting the control of it by law into the hands of engineers.

License laws now in effect in the several states, as well as bills proposed that failed of passage, and bills pending or to be introduced, were reviewed and a comparative statement of them prepared by the Committee on Legislation of the American Association of Engineers was exhibited. In this chart the model law proposed by the American Association of Engineers in 1915 was used as a basis. It was announced that the Legislative Committee of the American Association of Engineers would present a new proposed law in about one month.

The need was recognized of a "grandfathers clause" in any bill in order to avoid an *ex post facto* law and in order not to work hardship upon anyone now in the practice of the profession.

Regarding the question as to licensing, for instance, only civil engineers and surveyors, or all engineers, Mr. Drayer said, "Another moot point is whether all branches of engineering should be included—civil, mechanical, electrical, mining and the score or more of other varieties—or only the civil. It must be borne in mind that the line dividing them in many phases of public work is rather imaginary—for instance, in the construction of municipal waterworks and lighting plant. The tendency is to increase public utilities so that it is fair to assume that more and more of the engineer's work in the future will be in public service.

It might be held in some quarters that the mining engineer need not be licensed if the principle underlying the proposed legislation is to protect the public. The safety of many lives depends on the mining engineer, and likewise the safety of millions of dollars. It has been said by an experienced mining engineer that four out of five mining ventures, in all of which the public invests its good money, would not have been undertaken had they been reported upon by a competent mining engineer.

Higher Rates in Denver Upheld

The Supreme Court of the State of Colorado has declined, by a vote of 5 to 2, to grant the application of the Denver City Attorney, James A. Marsh, for a writ of prohibition to prevent the Denver Gas and Electric Light Company from collecting the higher rates recently authorized by the State Utilities Commission. This decision is not a ruling upon the question of the Utilities Commission's jurisdiction over public utilities in home rule cities. It does, however, allow the Denver Gas and Electric Light Company to maintain the present rates pending final decision.

Electric Heating of Houses

THE Hydro Electric Power Commission of Ontario has just issued an interesting report comparing the heating of houses by coal and electricity. The commission says that during the past few years, and perhaps more particularly since the fuel problem has become acute in Canada, an idea appears to have been gaining ground that the immense water powers of that great country (which by many people are vaguely considered as being illimitable) will amply suffice to meet all heating requirements; and that, in the Provinces of Ontario and Quebec especially, where water powers are so abundant, the fact that little or no coal is ever likely to be found is of no consequence. It is to dissipate the idea that electric heating of houses in the Dominion is possible under existing conditions that the present report is put forth. The commission says:

Undoubtedly electric heating approaches more nearly to the ideal than that obtained by any other means. Electric heaters can be designed for operating at any desired temperatur, i. e., they may be arranged to work at a high temperature and give off radiant heat like a fire, or they may be designed for operation at a low temperature like a hot water or steam radiator, and give up their heat by convection, that is, the heat is convected (or conveyed), by setting the particles of air in motion, to various parts of a room. There is no dust, smoke, smell or noxious gas from an electric heater, no soot, ashes, or dirt of any kind, and it does not vitiate the atmosphere by using up the oxygen; the heating can be under complete and ready control by the turning of a switch, thus decreasing or increasing the number of heating elements in service or shutting off the current entirely; automatic control by means of thermostats is, of course, possible. Electric heaters can be obtained in portable form, and there is less risk of fire from electric heating than from any other method.

No other system of heating can claim all these advantages. What, then, are the difficulties in the way of utilizing electric energy for this purpose on a large scale?

The difficulties are two, viz.:

(a) The enormous amount of energy that would be required and which could be more efficiently applied to other purposes.

(b) The high cost of electric energy for heating as compared with other sources of heat energy.

The commission then goes into detail as to the heating of a typical house on the basis of horse power, so that it may be possible to compare the relative cost of coal and electric energy. It is assumed that an eight-room house uses nine tons of anthracite coal per season of seven months at a cost of $10 per ton. There is no need to give all of the calculation, but this figures out to about 16 horse power, approximately. The report goes on:

On converting electricity into heat there is nc loss such as takes place with coal, and the efficiency is said therefore to be practically 100 per cent. It follows then that if a house be heated by electricity we shall only require to meet the net maximum demand of 16 h. p., as there is no lost power to be supplied. This sounds encouraging, but disappointment is in store.

For example, there are about 80,000 homes in the city of Toronto; if each of these is to be heated and a demand of, say, only 12 h.p. per home must be met (probably a very conservative figure as an average for large and small homes) no less than 960,000 h. p. must be supplied for homes alone—no factories, no offices, no works, no street cars, no houses even, will get any lighting or power from this, it is all required on the coldest days for heating homes alone, and more will be needed in proportion, as the population increases. The great Chippewa scheme at Niagara Falls only contemplates developing 300,000 h. p. for the present and the total generated at Niagara 780,000 h. p. and the entire maximum demand of all Toronto at present, including all power, lighting and traction purposes is only in the neighborhood of 125,000 h. p.

It may be added that the 6,000,000 h. p. which represents the estimated total possible development of Ontario water powers is not sufficient to supply merely the existing *homes* of Ontario with electric energy for heating alone, exclusive of all other domestic, commercial and industrial requirements.

A still further difficulty in supplying electric energy for heating on an extensive scale lies in the fact that all the heating is required in the winter only, and assuming that a maximum demand of 1,000,000 h. p. had to be met for supplying a city like Toronto, the load on the plant required for this purpose, throughout the summer months, would be practically nothing. In other words, for five months every year this enormous plant would be idle. Suggestions have been made that use might be made of it to supply certain industries which could be operated mainly during the summer months, but here there are two difficulties: (1) What are the industries on a large enough scale to be of any use? (2) How could such enormous undertakings afford to lie idle during the winter months when power was unavailable? The situation in this case would be just about as bad for the industries in the winter as for the electric stations, without the industries, in the summer.

Figures and statements such as the foregoing, which are based on incontrovertible facts, should once and for all answer the question in the negative as to whether the great water powers of Canada will ever entirely solve the fuel problem in a climate such as that of Ontario and Quebec.

Turning to our second difficulty, it was found above that power at an average rate of 10.5 h. p. would be required throughout the entire season—this means that the horse-power hours (h. p. hrs.) needed are $10.5 \times 7 \times 30 \times 24 = 52{,}920$ (h.p. hrs.). Electricity is sold by the kilowatt hour (kw. hr.) and a kilowatt equals 1.34 h. p.; therefore, if the price per kilowatt hour be, say, 1 cent, the price per h. p. hr. would be practically 0.75 cent, so that the season's bill on this basis, if electricity were used, would be $52{,}920 \times 0.75 = \$397.00$; the net amount would be 10 per cent. less, viz.: $357.00. People would not care to pay so large a bill for heating an 8-roomed house for a single season if they could do it for $9 \times \$10 = \$90$ by means of anthracite, even if they had the satisfaction of eliminating dust, dirt, ashes, labor, etc. The price per kilowatt hour (1 cent) assumed above is the lowest domestic rate of the Hydro-Electric Power Commission of Ontario at present available in Toronto; were it reduced to ½ cent, heating by coal would still be very much cheaper.

It has been assumed in the foregoing that the service charge for the house, at the standard Hydro-Electric Power Commission's rate of 3 cents per 100 square feet of floor area has been already paid for by the person living in it for his lighting service and is not therefore charged against his heating account; but undoubtedly it would cost more to supply him with a maximum demand of 15 h. p. instead of, say, 1 to 5 h. p. for lighting, cooking, etc., and therefore an increased service charge would be essential; this, however, has not been reckoned in. This is very evident when it is considered that, to supply such an extra load for a large community, much larger meters, heavier overhead wires, stronger construction, bigger substations, more powerful generating stations and increased size of equipment in every way would be required.

The commission considers that with a demand of such magnitude the supply authorities might be prepared to give service on a power shedule. They figure out the cost on such a basis as this, with all of the possible discounts and allowances, as $140.02 total net bill for the season.

It will be seen that, while, reckoned on this basis and at the lowest existing power rates, the bill is considerably less than calculated above on the ordinary lighting rate, yet the cost of heating by electricity is, even so, more than one and one-half times that of heating with anthracite.

The capital cost of furnishing a million horse-power to the city of Toronto, including hydro-electric development at Niagara Falls and all the switching and transforming equipment together wtih transmission and distribution lines, etc., etc., would probably be somewhere between $200 and $250 per h. p. to deliver electricity to the 'consumers houses—this means a capital investment of from 200 to 250 million dollars. This enormous sum, owing to the fact that the plant would be idle for nearly six months out of every twelve, as already pointed out, would, during half of its existence, be earning nothing, and the services of a large number of men would, of necessity, have to be retained throughout the summer months during the non-earning period in order that they might be available when required in the winter.

Thus the capital charges and running costs of such a plant, compared with its earning capacity would be very heavy. Annual charges on such a plant, covering interest, sinking fund, depreciation, maintenance and operation, would amount to from $22.00 to $27.00 per h. p. year. This plant would only be used for heating during a period of six or seven months, and the consumers would have to pay the charges for the whole year during this period.

Further, there would be no "diversity" factor enabling the supply authority to make any reduction on this cost, as is possible with ordinary, existing electricity supply, since the power would be required practically continuously throughout the cold season.

By the word "diversity" is meant that condition of electricity supply whereby, owing to the diverse character of the loads and the times at which they come on and go off, the maximum load on a generating station in a given period, say, one day, is not the sum of the various maximum loads on the station during the day, e. g., the maximum load due to factories does not necessarily occur at the same time as the maximum load due to street car traffic, nor does the latter necessarily occur at times of maximum load due to lighting. Owing to this state of affairs, supply authorities are enabled to make their charges appreciably lower than they would be able to in the case of a winter heating load, in which the power, as already stated, would be required all the time, and when one person needed extra power all the others would need it at the same time, for the same reason, viz.: that the outside temperature had dropped.

Public Utility Securities

According to a circular sent out by Stone & Webster, Boston, public utility securities have been affected during the past four and one-half years of war by two outstanding factors—the lack of demand for investments other than Government bonds, and the securities of industries which have greatly benefited under war conditions; and the decrease in net earnings of public utilities as a whole brought about by the abnormal costs of labor and materials. The prices of all bonds of companies under Stone & Webster management have reflected general market conditions during the war by a decrease in average price from 96.70 August 1, 1914, to 86.90 December 1, 1918; the price of all preferred stocks from 88.60 August 1, 1914, to 66.20 December 1, 1918. The earnings of all public utility securities under Stone & Webster management have shown an increase of 19.45 per cent in gross earnings for ten months of 1918 as compared with 1917, and an increase of 7.63 per cent in net earnings.

Fuel Saving on Steamships

The high cost of fuel is one of the facts that the ship owner will have to face for some time to come. Of course present abnormal prices will not hold very much longer, but it is doubtful whether fuel will ever again be as cheap as it was before the war, and consequently more thought than ever must be bestowed on fuel conservation. What can be done in this direction? In what ways, not already recognized as good marine practice, can fuel be saved?

As pointed out by Francis Hodgkinson, Chief Engineer of the Westinghouse Electric & Manufacturing Company, in a recent address before the Society of Naval Architects and Marine Engineers, the properly designed steam turbine can now deliver to the shaft up to and over 80 per cent. (depending on the size of the turbine) of the theoretical energy available in the steam expanding between the specified limits. Hence there can be little material improvement in the economy of the prime mover itself and greater consideration than ever must be given to the auxiliaries.

It is not unreasonable for the marine engineer to look to the central station engineer for information concerning fuel economy. The latter is subject to keen competition, and his main problem is to produce reliable energy for the least cost and he has had considerable success in solving this problem. Of course, conditions on land are different from those at sea, and the marine engineer would not for a moment consider installing some of the elaborate equipment that provides the central station engineer with many of his best results, but nevertheless certain features of advanced central station practice can be adopted for marine purposes with a saving of fuel on one hand and without producing unacceptable complication on the other.

Take the matter of feed-water heating systems for example. It is most desirable, from a point of view of fuel economy to have a system that will automatically maintain a predetermined temperature in the feed-water heater at all times, drawing steam from the main turbine for this purpose when necessary and permitting any surplus uncondensed steam from the auxiliary machinery to return to the turbine and develop useful work in the low pressure elements. Heat balance systems of this kind are already available for land purposes, and should find a place in both war and merchant vessels.

High steam pressures are also engaging the attention of central station engineers. Since steam at 600 pounds expanded to 29 inches of vacuum, is theoretically capable of giving 13 per cent. more energy than steam at 200 pounds expanded to the same vacuum, there is, here evidently, an excellent opportunity to economize. Economizers are usually found in good central station plants, but they do not appear to have ever been used at sea. Yet it would seem that their cost would be well warranted in the case of express steamers because on such vessels they can readily produce a net saving of 10 per cent. in the work of the boilers.

Though superheat of as high a degree as is desirable in central stations may not be practical at sea, nevertheless a superheat of 100 degrees F. should present no difficulties with well designed high-speed turbines and its use would save some 4 or 5 per cent. of fuel.

The use of higher vacua will also materially effect fuel economy. The steam consumption of a properly designed turbine is 7 per cent. better with 29 inches vacuum than it is with 28 inches. This higher vacuum is therefore well worth securing, tlthough this can only be done by the use of excellent air removing apparatus and a constant vigilance in the elimination of air leaks.

To sum up, fuel economy will be a matter of price importance in the future and the most efficient steam power plant is one consisting of a high-speed geared turbine supplied with high pressure or superheated steam and using a heat-balance feed-water system, fuel economizers and high vacua.

Hydro-Electric Power in Greece

The Bureau of Industry of the Greek Ministry of National Economy has prepared a report on the post-war needs of Greece in machines and equipment. The Government has created a special department in the Ministry of Communication for the utilization of water powers, but this cannot be furthered, the report says, unless a sufficient number of turbines are imported for the purpose.

According to the latest industrial census, hydraulic horsepower developed thus far amounts to 6,272 horsepower. Flour mills use 1,662 horsepower, oil factories 202 horsepower, chemical producers 1,095 horsepower, cotton, woolen, and thread mills 3,288 horsepower, tanneries 10 horsepower, sawmills 15 horsepower. The whole amount is but one-tenth of the potential hydraulic power of the country. Indeed, it is officially stated that steps are soon to be taken to make Greece's lakes and rivers yield 66,000 horsepower, apportioned as follows:

Lake Ostrovo, the Voda River, with three dams at Vladovo, Vodena and the Divies River	34,000
Axios River	40,000
Aliakmon River	3,000
Moussa Falls	4,000
Verria Falls	2,000
Gorgopotamos River	2,000
Reneos River	3,500
Strymon River (probably)	3,500
Other falls and rivers (to be used by small business in all parts of the country)	10,000

The larger sources of power are to be worked either by the State itself or by companies to which grants are to be made for one of three different periods of time.

The power obtained is to be used chiefly in the production of high-tension electric current for the manufacture of nitrogen fertilizers (calcium cyanamid) and also for supplying light to certain cities. To carry out these plans it will be necessary to import large quanities of dynamos, transformers, transmission systems, and in general, all accessory equipment.

Economy in Electric Cooking

The leading electric journal of Great Britain puts the case for electric cooking in a very convincing way. The *Electric Review*, of London, says: "Statements issued by Messrs. Belling & Co. show that to cook one hundred pounds of meat in a coal range requires one hundred pounds of coal; in a gas range, thirty pounds of coal (in the gas works); and in an electric range, twenty-five pounds of coal (in the electricity works). If only half the total amount of roasting and baking done each day were done by electricity, the daily saving would approximate ten thousands tons of coal. With regard to meat saving, they say that every one hundred pounds of raw meat cooked in a coal range weighs eighty-six pounds when done. The same amount cooked by gas weighs seventy pounds, and by electricity ninety pounds when finished. If only half the total weight of meat consumed eacch day were cooked by electricity, the daily saving would be approximately 350 tons of meat.

"The pity of it is that very few people seem to be aware of these astonishing figures, and the vast saving which can actually be effected. Those in the electrical industry do not push electrical cooking forward as they should do, and those outside the industry seem to try to retard it. Why is there not some co-operative movement amongst manufacturers to drive these points home, when it is so obvious to all who are willing to see it that electric cooking effects an enormous saving in coal, labor and many other ways? While the conditions may not be favorable at the moment for such a movement, at any rate preparations should be made to set it going at the earliest opportunity.

"Any device that will add to the safety of the house is commendable. The use of electricity for heating displaces matches and open fires; there is no gas to explode and no flame or flare-up to start fires or to burn the operator. No business man would think for one moment of going back to the old office methods and discarding the use of modern labor-saving devices, such as typewriters, billing machines and adding machines. These devices are considered necessary to the proper and efficient management of one's business. Electricity in domestic service is simply a modern labor-saving device—saving also money, time and worry—and, therefore, should be considered as part of the modern housekeeper's equipment."

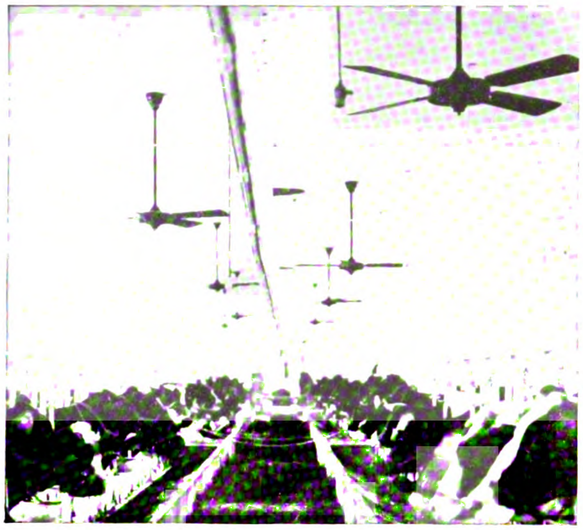
Electricity on the Farm

A FEW years ago economists were greatly alarmed at the shifting of population from the country to the towns and cities. It was easy to understand the reason for the movement but difficult to find a remedy. The prime objections to life on the farm were loneliness, lack of amusement and hard work. One could scarcely blame the young man and woman if the gayety of urban life held attractions for them. That this general movement city-ward has been checked in large measure, few can doubt. It is true that the lure of high wages has drawn many to the factories and munition plants, and that many country boys drafted into the army will seek to establish themselves in the centers of population when they are mustered out. But those who have given study to the subject believe that thousands of the anaemic city-bred, made lusty and vigorous by military training and enamoured of their life in the open air, will scorn desk and counting room, and turn with eager longing to the fields and woods.

Do we ever stop to consider that the greatest single factor in re-establishing country life in favor has been electricity? The tremendous growth of rural telephone service has done much to banish loneliness, especially for the women of the household, who were the greatest sufferers. The telephone has been aided by rural free delivery, which brings the daily or weekly paper to the door, so that the farmer no longer feels that he is out of touch with the world. Moving-pictures have made possible a most attractive form of entertainment even in little hamlets which heretofore could provide very few amusements. Motor cars make these accessible for the farmer and his family, and also give as much social intercourse as may be desired. Electric light, provided either from a central station or by an individual plant of moderate cost, make the home more cheerful, a great asset in itself. Every day electric power is performing more and more tasks on the farm, and lightening the labor of man and beast alike.

In few rural communities has electricity been put to more novel uses than at Briarcliff Dairy Farm, near Atlanta, Ga., owned by Mr. Asa D. Candler, Jr.

Briarcliff Dairy Farm was originally a chicken



A Model Dairy Barn

Double row of Holstein cattle and Westinghouse electric fans

ranch which has been remodeled for dairy purposes. The barn is provided with concrete floors, wooden blocks, electric lights and fans, steel frame stalls, novel drinking fountains, milking machines, concrete feed troughs, electric equipment for the silo and bottling milk. The farm has a colony of 180 full-blooded registered Holstein cattle. They are a fine family and universally conceded to be the best stock for level pasture. Their value is based on their direct proportional response in milk to scientific feeding and careful housing.

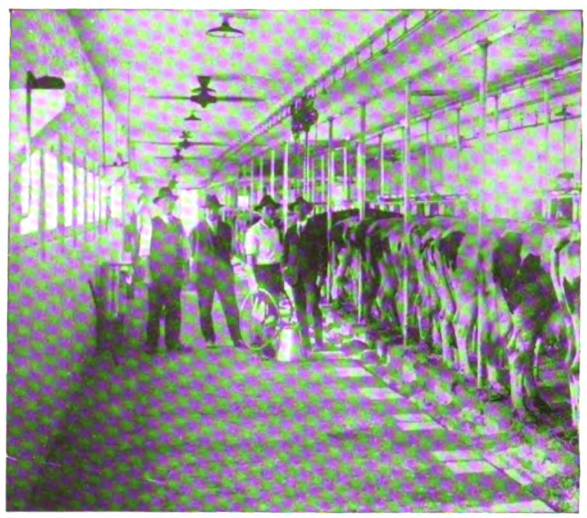
The interior of the barn is absolutely clean and looks it. Some dairy barns are of the bungalow type furnishing numerous catch-alls for everything that's loose. This reminds one of a hospital ward. Fresh air and sunlight are supplied in abundance by the numerous windows on each side equipped for easy adjustment. The floors, walls, and ceiling are concrete and also spell cleanliness. Westinghouse ceiling fans cool the atmosphere in summer and ventilate it in winter. There are also electric lights.

The green corn for ensilage is cut with the aid of a type C. S. 15-H. P. motor, and is blown through a conveyor into the top of a forty-foot silo. Mr. Candler considers green corn ensilage as the next best thing to green grass as a milk producing food.

Each Holstein cow gets its share of sunlight, the windows being so arranged that the sun shines near the cow in the morning and on her just before sunset. Mr. Candler uses the Vacuum Milking Machine. All of the milking is done with these machines, thus preventing any dirt from getting into the milk. The milk flows into an air-tight bucket, is emptied into a larger can and carried to the milk house. Just as soon as the milk arrives at the milk house, it is strained and passed over a cooler until it reaches the proper temperature. From here it passes to a bottle filling machine, where the bottle is automatically filled and sealed. Briarcliff Farm pure cream, pure milk, pure buttermilk and pasteurized milk are served in various hotels in Atlanta and sold to discriminating customers.

Cable Concessions in Uruguay

Consul William Dawson writes from Montevideo that a resolution of September 24, 1918, contained important provisions with referenece to cable concessions in Uruguay. Article 1 of the resolution refuses to grant the petition of the Western Telegraph Company for the extension for thirty years of its concession which expired on July 15, 1917. Article 2 provides for the presentation to the Chambers of a bill regulating cable concessions. Article 3 authorizes precariously (con carácter precario) the Central and South American Telegraph Company to extend its telegraph and telephone lines from Buenos Aires to Montevideo.



Briarcliff Dairy Farm

A view in the great cattle barn showing milking machine and fans

A statement published in connection with this resolution shows that the Western Telegraph Company has enjoyed an exclusive concession for telegraphic communication with Brazil, Europe, North America, the West Indies, the Guayanas, Venezuela, Colombia, Central America and Africa. In applying for an extension of this concession, the company offered the Government 1 per cent. of the charge per word on all messages to and from Uruguay as well as transit messages, the company to enjoy complete exemption from taxation on its equipment and properties.

The statement further reveals that the Compañía Telegráfica Alemana Sudamericana (a German concern) applied several years ago for the permission to extend its lines from Pernambuco to Montevideo and that this permission was refused because the Western concession was still in force. It appears that the local representatives of the German company has been active in opposing the extension of the Western concession.

With the expiration of the Western concession the Uruguayan Government proposes to establish competition among cable companies and exclusive concessions will not be granted, privileges and monopolies being reserved to the State. It appears that the bill to be presented to the Chambers will provide for the granting of concessions for not over thirty years, the concessionaires to enjoy no privileges or exemptions of any kind. On the other hand, the Government will not subvention companies nor otherwise give preference to one company as compared to another.

It may be recalled, in this connection, that while the Western has enjoyed an exclusive concession as respects the countries and continents noted above, cable communication with Buenos Aires has thus far been maintained by two local lines. These lines belong, respectively, to the Compañía Telegráfica del Rio de la Plata, which is controlled by the Western, and the Compañía Telegráfico-Telefónica del Plata, a subsidiary of the Deutsch-Sudamerikanische Telegraphengeseilschaft, the German company (also known as the Compañía Telegráfica Alemana Sudamericana) which has already applied for permission to extend its lines from Pernambuco to Montevideo. The Central and South American Telegraph Company used up to April, 1918, the lines of this German-owned concern for its traffic between Montevideo and Buenos Aires. Since last April, by special agreement, the Compañía Telegráfica del Rio de la Plata (Western subsidiary) has been dispatching and receiving the Montevideo business of the American company, thus eliminating the German lines.

Italy Utilizes Volcanic Power

The present enormous price of coal in Italy, according to the Italian Bureau of Public Information, has resulted in the realization of an idea which at first thought seemed but a dream, but which instead has been developed in a marvelous manner and is assuming quite considerable importance; this is the industrial exploitation of one of the features of vulcanism and that is the natural heat omitted from the soil in those regions more or less volcanic in character.

The first experiments along this line were made some years before the war by Prince Ginori-Conti in Tuscany at Lardorello, near the salt-mines of Voltorra, a region extensively covered with volcanic formations, the most wonderful being the so-called "soffioni," which are certain volcanic vents emitting powerful jets of very hot steam containing boric salts and various gases used in the extraction of boracic acid. Instead of limiting the use of these steam-jets, as in the past, to extracting the salts contained in the exalations of these natural vapor-vents, the ejection of the steam is stimulated by boring holes. In this way it is possible to obtain powerful jets at a pressure of two to three atmospheres, according to the locality, and in some exceptional instances as high as five atmospheres, the temperatures varying from 150 to 165 degrees Centigrade. These jets maintain their force and temperature unchanged for many years, and they are not affected even when other openings, not too near each other, are bored in the ground, proving that they do not influence each other reciprocally, so great is the underlying thermic energy below. In 1905, Prince Ginori-Conti applied this natural steam to a 40 H. P. engine, using only a small section of the Nenella fissure, which is the most powerful "soffioni," the steam ejected having a pressure of five atmospheres.

The results obtained during several years of experimentation were satisfactory, so that he continued to make larger and deeper borings, measuring the force of the steam ejected; combined, this force could operate engines of many thousand horsepower.

In 1912 an experiment was made, very wisely on a more modest scale but sufficient to obtain conclusive results, for which a 300 H. P. turbine-alternater was used. Later, because of the enormous increase in the price of coal, the Prince decided to exploit the thermic energy of these soffioni on a much larger scale, but as other substances are omitted with the steam, among them sulphuric acid which corrodes metals, particularly iron and therefore the pipes in which the steam was to be collected, he attempted to use this steam only for heating. Three turbine-alternaters of 3,000 kilowatts each were installed, fed by boilers at low pressure not heated by coal or other combustible fuel, but by the natural steam, superheated to 165 degrees C., issuing from these soffioni and piped and carried to the boilers.

To-day the works at Larderello have a central plant of 16,000 H. P. operating without interruption and distributing current to Florence, Livorno and Grosseto; its capacity is soon to be increased. Here we have a new and original utilization of Italy's natural wealth; current is generated not by the use of "white coal" (water power), but by means of heat energy of volcanic origin. As the natural steam available at Larderello and the surrounding country is, one might say, unlimited and depends upon the number of boreholes made in the boraciferous soil, the great possibilities for further development are readily seen.

Electricity's Part in "Welcome Home"

THE action of Fuel Administrator Garfield, in removing the embargo on the use of electricity for the purposes of street illumination and advertising assures a more striking welcome to our returning soldier boys. Of course there will be no more gratitude and affection than if our streets were dark, but there will be the keen satisfaction of expressing our feelings by a blaze of light and color and in flashing welcoming messages so that all eyes can read them. Electricity has come to be the generally accepted and employed medium for expressing the sentiments that are in our heart to utter publicly.

Incidentally, too, the flooding of streets and shop windows with light without stint is having a salutory effect upon the spirits of all. Light begets optimism, which in turn is needed to inspire confidence in the unbounded future of our country, as well as to restore men's minds to the normal channels of thought which fathered the past, and will continue the future development of business and industry.

Reports that has been received indicate that the welcome-home spirit is being manifested electrically everywhere, and that many of the signs and devices which are being employed are of a character to insure their permanency for a long time to come. On the front of the Rivoli Theatre in New York City, for instance, there is a cluster of myriad lamps so grouped as to flash out the Allied emblems in all their glorious color, 'atop of which is the American Eagle guarding a shield. On the Union League Club there is a great electric sign which blazes forth this message: "Welcome Home to the Boys from Over There." In fact, look where you will, electricity is on the job of welcoming the boys back to "God's Country."

Some idea of the magnitude to which the plan of welcoming the boys home electrically is being carried can be had from these facts regarding the equipment that is being installed for the New York Times Building, and which consists of over 5,000 10-watt lamps distributed as follows: The entire building will be outlined with 300 two-foot stars, each star containing eleven lamps, alternating red, white and blue on a flasher. On the Forty-third Street side, facing Times Square, will be a cluster of Allied flags, surmounted by a spread eagle holding the American shield. This display utilizes 1,000 lamps and will measure forty feet wide by twenty-four feet high. The flags will have a waving effect, and over this will be an electric sign reading "VICTORY" in six-foot letters. At each of the four entrances of the building will be a pair of crossed American flags waving, these will contain 250 lights each. And on the roof will be four flashlights illuminating the American flag flying from the flag staff.

However, expression of the welcome-home spirit is not restricted to those only who can go in for large and elaborate displays. Individual dealers, many of whom have neither the facilities nor the means to make a big display, have utilized their windows as the basis for their share in the generally expressed welcome. In some of the windows, army and navy signal flags are grouped to spell out appropriate messages of welcome, the whole being lighted by flashers or flood lights. In others, small lamps, operated by flashers, are grouped to spell out such messagess as "Welcome Home," "And You Did Come Back and With Victory," "Welcome to the Victors," "Welcome Home Boys." In others, flags and painted messages are rendered attractive by the judicious use of light.

Participation in the movement is in every sense general; trade and civic organizations, church bodies, societies, patriotic associations, all are doing their "bit." In New Jersey the Governor called a conference of Mayors of the cities in that state to consider plans for celebrations, memorials and rehabilitation, stating in his address that he wished to have devised "a plan for uniform public celebrations in honor of the home-coming soldier and sailor heroes." He further added that it was his idea that every community would want its own local celebration and that the initiative should spring from the individual municipalities, with the State Government co-operating both morally and financially, and that he would recommend to the State Legislature an appropriation for this purpose. The Mayor of Newark emphasized the fact that it was very important to acknowledge in an appropriate way the great service rendered by Uncle Sam's fighting men.

Other states and cities, too, have taken up the question and are formulating definite plans for welcoming their returning citizen-soldiers. In Chicago, for instance, the Commonwealth Edison Company has taken an active part in the movement to arouse and direct the enthusiasm of business interests, as well as to secure the co-operation of clubs, churches, civic and other bodies. Recommendations to cheer up, paint up, brighten up and light up were scattered broadcast. A series of newspaper advertisements were run in the six leading Chicago papers, being continued over a period of six weeks. "Let us," said a newspaper editorial, "show our boys that Chicago welcomes them back home just as heartily as it enthused when they marched away. The Chicago slogan is 'I will'—well, let's put the I WILL spirit back of our welcome." Chicago is doing just that.

The Society for Electrical Development held a meeting of a Special Committee, to formulate ways and means to enable the Electrical Industry to do its share towards making the boys realize that America honored them for their patriotism and was not forgetful of their many sacrifices. Copies of the advertisements used by the Commonwealth Edison Company of Chicago have been sent to all the central stations in the country, together with a letter outlining how they can best get behind the welcome-home movement. Dealers, contractors and manufacturers, too, have been advised of the parts they can best take in making the movement successful. And all business interests that can contribute to the brighten-up phases of the movement have been, or are being, notified of the responsibility resting upon them to participate.

Light-Up Nights Replace Lightless Nights

Signs of the Times for January, 1919, devotes a great deal of attention to electric signs, and includes short article by H. E. Young, sales manager of the Minneapolis General Electric Company, and W. H. Hodge, publicity manager of H. M. Byllesby & Co. In connection with Mr. Young's article the publication reproduces newspaper advertisement entitled "A Timely Opportunity for Minneapolis Merchants," and circular letter addressed to all electric sign customers and prospects concerning the desirability of getting their electric signs into action again. The following paragraphs are quoted from Mr. Young's article:

"The turning on of all signs was especially noticeable after the long period of darkness, and the comment was universal as to the feelings of relief and optimism which this caused after such a long period of dismal and depressing darkness.

"We feel that the stimulating effect of the appearance of signs after this period of darkness has convinced the public in general more than ever of the value of this advertising. The public in general and the advertisers in particular had gotten so used to seeing electric display advertising that they failed to fully appreciate its wonderful value until they were deprived of it and until they were impressed with its advantages by seeing it again in operation."

The following paragraph is quoted from Mr. Hodge's article:

"The above evidence of the commercial and psychological value of electrical advertising and outdoor electric lighting is extremely significant. After nearly two years of retrenchment the demand for greater use of electricity for these purposes is bound to be much greater than anything before known. It is going to take some time to dispel the gloom and sorrow caused by the war in this country, and electricity will be one of the mediums employed for accomplishing this object quickly. I am confident that our business men will realize the manifold value of the liberal electric lighting displays and that the increased use of electric advertising has already begun."

Correct Lighting of School Buildings

THE importance of the proper lighting of school buildings will be understood when it is stated that there are in the United States 20,000,000 school children working at their desks several hours a day. According to statistics, about 10 per cent. of these have defective vision.

In order to improve school lighting as far as possible, the Illuminating Engineering Society has formulated a code of lighting for school buildings, making available the best information extant with regard to this subject.

One of the conditions most productive of eyestrain is the glare of an unshaded lamp. The glare from a bright, reflecting surface will also produce this condition in a greater or lesser degree, depending upon the degree of reflection. To remedy this, all lamps should also be suitably shaded. They should also be so arranged as to secure a good distribution of light on the work, avoiding objectionable shadows and sharp contrasts.

Walls should have a moderate reflection factor; the preferred colors are light gray, light buff, dark cream and light olive green. Ceilings and friezes should have a high reflection factor; the preferred colors are white and light cream. Walls, desk-tops and other woodwork should have a dull finish.

Basements, stairways, store rooms and other parts of the building where required should have switches or controlling apparatus at point of entrance.

Emergency lighting should be provided at main stairways and exits to insure reliable operation when, through accident or other causes, the regular lighting is extinguished.

All parts of the lighting system should be properly maintained to prevent deterioration due to dirt accumulation, burned-out lamps and other causes. To insure proper maintenance, frequent inspection should be made at regular intervals.

A direct lighting system is known as one in which most of the light reaches the work plane directly from the lighting unit, including the accessory, which may be an opaque or glass reflector or a totally enclosing transparent or translucent envelope. Direct lighting systems may be further classified as localized and general or distributing. In the former the units are so placed as to light local work spaces, and in the latter they are well distributed so as to light the whole area more or less uniformly.

A semi-indirect system is known as one in which a portion of the light reaches the work plane directly from the unit and a relatively large portion reaches the work plane indirectly, by reflection from the ceiling and walls. The accessory is usually an inverted diffusing bowl or glass reflector. When this glass has a high transmission factor the lighting effect approaches that of ordinary direct lighting, and when of low transmission the effect approaches that of indirect lighting.

An indirect system is known as one in which all or practically all the light reaches the work plane indirectly after reflection from the ceiling and walls. The accessory is usually an opaque or slightly translucent inverted bowl or shade containing a reflecting medium.

All three of these systems of lighting are in successful use in schools. There has been a growing preference for semi-indirect and indirect lighting, especially since the introduction of modern lamps of great brilliancy. Local lighting by lamps placed close to the work is unsatisfactory except for special cases such as the lighting of blackboards, maps, charts, etc.

Except in very rare instances bare light sources should not be exposed to view. They should always be adequately shaded. Even when shaded by translucent media, such as dense glassware, the lighting units should be placed well out of the ordinary range of vision; in other words, it is recommended that lighting units be of low brightness, even if they are located high in the field of view.

Glossy surfaces of paper, woodwork, desk tops, walls and blackboards are likely to cause eyestrain because of specular or mirror-like reflection of images of light sources, especially when artificial light is used. Matte or dull-finished surfaces are recommended. It is to be noted that a high reflection factor does not necessarily imply a polished or glazed surface.

The chief factors which must be considered in arriving at the size and number of lamps to be used in a given room are: (1) the floor area, (2) the total luminous flux emitted per lamp, and (3) coefficient of utilization of the particular system considered. The first should be measured in square feet. The second may be obtained from a data book supplied by the manufacturers of lamps. The third involves many factors such as the relative dimensions of the room, the reflection factor of the surroundings, the number of light units and their mounting height, and the system of lighting. By coefficient of utilization is meant the proportion of the total light flux emitted by the lamps which is effective on the work plane.

Suitable switching and controlling arrangements should be made to permit of lighting one or more lamps independently as conditions may require.

The teacher's desk may be illuminated by one of the overhead lighting units, or if necessary by a desk lamp.

With the usual lighting equipments the distance between the units should not exceed one and one-half times the height of the apparent source of illumination above the working level.

Blackboards should be of minimum size practicable and should not be placed between windows. Their position should be carefully determined so as to eliminate the glare due to specular reflection of images of either artificial or natural light sources directly into the eyes of occupants of the room.

Glare due to specular reflection from blackboards may be reduced or eliminated by lighting them by means of properly placed and well-shaded local artificial light sources.

Electrifying Italy's Railways

Great savings in the use of coal, according to the Italian Bureau of Public Information, have been effected in Italy in the past few years through the electrization of railroads and harnessing the water power of the country to generate electricity. The percentage of railroads electrified in Italy from 1900-1915 is greater than in any other European country, and the economies resulting have been gratifying.

Electric traction of railroads began in Italy in 1900 with installations on the Varesina Line, which runs through Milan, Gallarate, Varese and Ponteceresio, and on the Valtellinese Line which runs from Lecco to Chiavenna. Railways which runs on mountainous routes and carry heavy trains have been installed with different systems. The principal mountain routes electrified are the Moncenisio Line, the Ceva-Port Savona Line, the old line of Giovi and the new supplementary Giovi line. These cover some of the most difficult territories traversed by any of the railroads in Europe.

The Moncenisio Line is the longest of the mountain railways. It is 8.5 miles long, travels at an altitude of more than 1,000 yards above sea level and is continuously on the ascent. It has a nominal carrying capacity of 640,000,000 tons per mile, and actually carries 240,000,000 tons. The Ceva-Port Savona Line is a series of steep inclines and declines. The Giovi Line has the most rapid descent of any railroad in Europe and the supplementary Giovi Line carries the heaviest traffic in Italy.

The perfect systems installed on these mountain routes has made possible the increase in the carrying capacity and the speed of the railways. There is at present under consideration the electrification of 1,250 miles more of railways.

Haiti and Dominican Telephone Connection

The telephone systems of Haiti and the Dominican Republic have recently been connected, writes Consul Arthur McLean, from Puerto Plata, Dominican Republic. It is now possible to communicate between the principal towns of the two Republics. Telephone messages are written out in this country the same as telegrams in the United States. They are then transmitted by the telephone operator. There is no exchange telephone service between the various towns of this Republic. The rates to Haiti are 20 cents a word from the southern section, and 25 cents from the northern provinces of the Dominican Republic. The address and signature are charged for additional.

Growth of Electric Service in Various States

PRELIMINARY figures of the report on the central electric light and power stations of a number of the states have been given out by Director Sam. L. Rogers, of the Bureau of the Census, Department of Commerce. They were prepared under the supervision of Eugene F. Hartley, Chief Statistician for Manufacturers.

The statistics relate to the years ending December 31, 1917, 1912, and 1907, and cover both commercial and municipal plants. They do not, however, cover electric plants operated by factories, hotels, etc., which generate current for their own consumption; those operated by the Federal Government and state institutions; and those that were idle or in course of construction.

The number of establishments in Delaware, District of Columbia and Maryland, reporting increased from 56 in 1912 to 63 in 1917, a gain of seven, four of which were commercial and three municipal. During the same five-year period the income increased $3,803,905, or 70.6 per cent, as compared with an increase of $2,040,675, or 61 per cent, from 1907 to 1912. Steam power in 1917 formed 97.9 per cent of the total for all classes of power, and a noticeable feature of these statistics is the steady increase in the capacity of the steam engines and turbines used. The average horsepower per unit increased from 565 in 1907 to 997 in 1912 and to 2,702 in 1917. The increase in the output of stations from 1912 to 1917, amounting to 208,404,896 kilowatt hours, is significant of the growth in the business of the electric stations.

The figures for New Hampshire show substantial gains for each of the two five-year periods for which statistics are presented, although the increases are somewhat greater for the 1907-1912 period. From 1912 to 1917 there was an increase of $941,666, or 40.4 per cent, in the total income, compared with a gain of $905,918, or 63.7 per cent, from 1907 to 1912. The total horsepower, which increased 80 per cent from 1907 to 1912, shows a gain of only 10.8 per cent from 1912 to 1917. The kilowatt capacity of the dynamos shows corresponding increases, 81 per cent and 13.5 per cent, respectively. From 1912 to 1917 the output of stations increased 33,862,253 kilowatt hours, or 26.7 per cent compared with a gain of 71,335,049 kilowatt hours, or 129.1 per cent, from 1907 to 1912. There was a great decrease in the use of arc lamps for street lighting, together with a decided increase in the incandescents, etc.

Substantial increases in Virginia are shown from census to census in all details except the number of arc street lamps. This decrease in arc street lamps, however, is in harmony with the general practice in street lighting, and in Virginia the loss is more than made up by the large increase in incandescents, etc. From 1912 to 1917 the income increased $1,612,064, or 200.2 per cent as compared with an increase of $414,394 or 106.1 per cent from 1907 to 1912. The expenses show similar increases, that for the five-year period 1912 to 1917 being 267.4 per cent and that from 1907 to 1912, 116.8 per cent. A similar proportionate increase appears for the output of stations; from 1912 to 1917 this increase amounted to 78,856,074 kilowatt hours, or 274.5 per cent compared with an increase of 18,516,324 kilowatt hours, or 181.4 per cent from 1907 to 1912.

The figures for Nevada show general increases at each succeeding census. As a rule, however, the gains are greater for the later five-year period. From 1907 to 1912 the number of establishments decreased from 9 to 8, but from 1912 to 1917 it increased to 14. The income and expenses increased during both five-year periods, and it is noticeable that the percentage of increase in expenses was greater than that for income; from 1912 to 1917 the income increased $319,987, or 51.7 per cent and the expenses $234,104, or 54.7 per cent; from 1907 to 1912 the increase in income amounted to $246,834, or 66.3 per cent and in expenses to $182,964, or 74.6 per cent. From 1907 to 1912 there was an increase in each of the three classes of power shown, but from 1912 to 1917 the horsepower of steam units and of internal-combustion engines decreased, while that of water wheels increased 2,575 horsepower, or 20.5 per cent. From 1912 to 1917 the output of stations increased 8,876,406 kilowatt hours, or 19.7 per cent, compared with an increase of 15,348,042 kilowatt hours, or 51.8 per cent from 1907 to 1912. In common with other states, Nevada shows decreased use of arc lamps for street-lighting purposes.

The figures presented for Utah show a remarkable growth in the central electric light and power stations, more pronounced during the later five-year period, from 1912 to 1917. The total number of companies reporting increased fourteen from 1907 to 1912, and only two from 1912 to 1917. The number of stations, however, has but little significance because of the tendency to combine in a single system two or more plants that previously reported as independent stations. From 1912 to 1917 the income increased $3,895,542, or 251.4 per cent., compared with an increase of $844,024, or 132.9 per cent., from 1907 to 1912. The expenses increased correspondingly, 233 per cent. and 161.4 per cent., respectively. From 1912 to 1917 the output of stations shows a gain of 380,360,478 kilowatt hours, or 439 per cent., compared with an increase of 24,961,997 kilowatt hours, or 40.5 per cent., from 1907 to 1912. The total horsepower increased 274 per cent. and 68.5 per cent. during the respective five-year periods. Unlike most of the states for which such figures are presented, Utah shows a large increase from 1912 to 1917 in the number of arc street lamps, the gain in incandescents being comparatively insignificant.

The figures presented for New Mexico show substantial gains for each five-year period. From 1912 to 1917 the income increased $396,312, or 79.6 per cent., compared with a gain of $205,213, or 70.1 per cent., from 1907 to 1912. From 1912 to 1917 also the actual increase in expenses, $395,059, or 87.9 per cent., was greater than from 1907 to 1912, when the gain was $222,579, or 98.1 per cent. From 1912 to 1917 the output of stations increased 8,216,944 kilowatt hours, or 91 per cent., compared with a gain of 4,413,475 kilowatt hours, or 95.6 per cent., from 1907 to 1912. The actual increase in dynamo capacity was greater from 1912 to 1917 than for the prior five-year period, but the percentage of increase was less for the later than for the earlier period. In harmony with the showing for street lamps in most of the states, the use of arc lamps for street lighting shows a decided decrease from 1912 to 1917.

The total number of establishments reported from Mississippi increased at a nearly uniform rate between 1907 and 1917, from 68 in the earlier year to 97 in the later. The figures for most of the remaining items show greater increases, both actually and proportionally, from 1907 to 1912 than for the following five-year period. For example, the increase in the total income from 1912 to 1917 amounted to $134,610, or 11.5 per cent., as against $481,087, or 70.1 per cent., for the preceding five years; the increase in the total expenses during the later period was $169,291, or 19.3 per cent., as against $358,510, or 69 per cent., for the earlier; the increase in the total horsepower between 1912 and 1917 was only 2,791, or 9.2 per cent., as compared with 14,975, or 96.5 per cent., between 1907 and 1912; and the increase in the output of stations from 1912 to 1917 amounted to only 2,573,918 kilowatt hours, or 9.2 per cent., whereas during the earlier period it was 12,219,559 kilowatt hours, or 77.8 per cent. As in the cases of most other states, the number of arc lamps used for street lighting decreased materially from 1912 to 1917, the rate of decline being 53.2 per cent.

Electrical Combinations in Connecticut

There were fewer commercial and municipal electric light and power stations in the state of Connecticut in 1917 than in 1912, according to figures just given out by the Bureau of the Census, Department of Commerce. As a matter of fact, however, seven plants were added during the five-year period and none reported for 1912 were omitted for 1917. The decrease is due to combinations that have taken place whereby a number of separate plants reported for 1912 have been included under a single ownership for 1917. The actual increases are generally greater for the later five-year period, while the relative increases, as a rule, favor the period from 1907 to 1912. The income from 1912 to 1917 increased $5,373,712, or 100.5 per cent, and the output of stations, 214,890,942 kilowatt hours, or 164.5 per cent. From 1907 to 1912 the corresponding increases were $2,878,009, or 116.5 per cent., and 63,265,969 kilowatt hours, or 93.9 per cent.

To Build Electric Locomotives at Essington

Discussing the prospects for the year 1919 at the Essington, or South Philadelphia, Works of the Westinghouse Electric & Manufacturing Company, Mr. R. B. Mildon, assistant to the vice-president, made the following statement: "We share the general opinion in the industrial field that business will slow down somewhat owing to the readjustment of the industries from a war to a peace basis; but by spring this phase should be over and then for the next few years we should have a period of prosperity.

"As far as the Westinghouse Works at Essington is concerned, we have enough orders on hand to keep us busy for the next year without considering new business which is now beginning to develop.

"We are at present making nothing here but ship propulsion machinery, but our plans contemplate bringing here all of our turbine and electric generator construction work that is now being handled at East Pittsburg. Before we can accommodate this additional business, however, we shall have to build several new buildings, including an office building, a shop for making turbine blades, and an electric generator shop. Unless we are mistaken in our expectations, however, this new construction work should begin this spring.

"Looking a little further ahead into the future, it is probable that we shall in time erect a building for the construction of electric locomotives. The electric railroad situation is unquestionably very favorable and a large amount of electrification will be undertaken in the next ten years. We co-operate with the Baldwin Locomotive Works in the manufacture of electric locomotives and our location here, so close to the Baldwin plant, makes this the proper place to do our part of the work.

"In other words, we plan to build at Essington all of our large and important apparatus, and as the demand for this class of apparatus is certain to increase rapidly from year to year, we expect to see our plant expand in the near future to many times its present size."

Medical Service in Public Utility Company

The Division of Industrial Hygiene and Medicine of the Department of Labor gives the following report of the service that has been established in a public utility company in Illinois: "Periodical inspections, which include all employes of the company with the exception of laborers and temporary help, are conducted by the company physician. * * * A visiting nurse service is also maintained to insure proper care and medical attention of sick employes. The nurse is sent to the home of any absent employe on the request of the head of department in which he works to give such help or suggestions as the case may warrant. The physical inspection and medical examination of employes, the visiting nurse service and the company's welfare work in general are conducted under the supervision of the employment bureau. The care exercised in safeguarding the health of employes since this system was established several years ago has been productive of excellent results and has materially increased the efficiency of the working force."

Cumberland Has Right to Raise Fares

Under the laws of Maryland the Cumberland & Westernport Electric Railway Company filed a new tariff of rates which were 2⅓ cents a mile. The franchise agreement provided a rate of 1⅔ cents a mile, and taking this as a basis two individuals filed protests against the Commission approving these rates. The matter was referred to W. Cabell Bruce, general counsel, who, in a recent opinion, holds that the Cumberland & Westernport Electric Railway Company had the legal power to take the action it did.

The opinion is as follows: "I have received your communication of the 20th instant asking me whether the Cumberland & Westernport Electric Railway Company has the legal power to file tariff schedules with commission fixing rates in excess of those prescribed by the franchise agreement entered into between itself or some of its corporate predecessors, and the County Commissioners of Allegheny County, all of these agreements having been executed prior to the Public Service Commission law on April 5, 1910. In my judgment the Cumberland & Westernport Electric Railway Company has the legal power to do so. Contracts, even as individuals, when entered into are necessarily subject to the control of the police power of the state whenever a contract relates to matters which are, or may be, subject to the exercise of such power."

This particular point has been raised in many instances in which traction companies or other public utilities sought increases in rates, and this decision is of particular interest in consequence. Also because the opinion holds that a state commission can raise as well as lower rates.

Minnesota's Telephone Systems

Minnesota has 250,610 miles of telephone wires, according to James W. Howatt, supervisor of telephones, in his annual report to the Minnesota Railroad and Warehouse Commission. There are 1,719 known telephone companies in the state, ranging from the Arthur Freese Telephone Company, of Lyon county, with one subscriber and three-fourths of a mile of wire strung on fence posts, up to a $24,000,000 corporation. The total investment in telephone properties reaches the huge sum of $15,671,957.

The total number of telephones in use is 395,789, which on the population basis of 2,132,000 gives one telephone for every six inhabitants. There are 99,439 telephones on rural or farm lines. The number of farms is given as 156,137, and hence 64 per cent. of the farms in Minnesota are supplied with telephone service, or, in other words, 64 out of every 100 farms are connected with the extensive telephone web of Minnesota.

Lead and Zinc in 1918

The domestic mine output of lead and zinc decreased in 1918, according to C. E. Siebenthal in a statement just issued by the U. S. Geological Survey, Department of the Interior. The lead and the recoverable zinc of ores mined was approximately 563,000 tons and 627,000 tons, as compared with 651,156 tons and 711,192 tons in 1917. The refined lead output of smelters and refineries was 615,000 tons, against 612,214 tons in 1917, and the antimonial lead output was 22,000 tons, as against 18,647 tons. The lead available in the United States is 540,000 tons, against 515,258 tons in 1917. The output of spelter from domestic and foreign ore was 525,600 tons, compared with 669,573 tons in 1917. Spelter from foreign ore decreased to 23,300 from 84,976 tons in 1917. The apparent domestic consumption of spelter was 440,000 tons, compared with 413,984 tons in 1917. The consumption figures of both lead and zinc include the metal shipped abroad for use of the American Expeditionary Forces. The average price of lead at New York was 7.6 cents a pound and of spelter at St. Louis 8 cents a pound.

England Needs Half a Million Houses

The providing of housing for the thousands who are arriving in London daily is a problem which is causing much anxiety to the authorities. One of the daily papers discusses conditions in the city under the heading "One Million Persons Too Many in London." The creation of Government departments and bureaus for war work has brought thousands of people into London. There are approximately 130,000 people employed in clerical work relating to the war, and 900 buildings have been taken over by the Government in which to house them. These buildings, in the main, have been large hotels, which has caused added congestion to the hotels not affected. In a good many instances these war workers have brought their families with them, causing quite a demand for small flats and houses and resulting in congestion and insanitation.

The housing of the transient or floating population, made up of soldiers and sailors on leave, is one of the chief factors which is causing concern. Transportation facilities are inadequate, especially in the tubes and busses. This has been due to the shortage of rolling stock and labor, but the situation is being relieved as rapidly as possible and new trains are being added. The gasoline restrictions heretofore in effect have caused the bus companies to curtail their service, but no wthat this restriction has been relaxed a better schedule is being maintained.

It is estimated that 100,000 new houses are needed in London alone. During the war 1,500 houses have been condemned as insanitary and should not have been used, but under the circumstances they had to be occupied. The London County Council has 105 acres on which houses are to be built at once, which can accommodate 17,000 persons. It is proposed to spend £3,500,000 ($17,032,750) on this program. Other councils in Greater London have made application to erect houses on 60,000 acres. The Local Government Board has a scheme for erecting 300,000 houses, but the procuring of the material required is a great problem. Six thousand million bricks, 94,000,000 cubic feet of timber, 2,500,000 windows, and 3,000,000 doors are needed for these houses. British industries at present can not furnish all these materials, and the Government will have to import considerable quantities.

Apart from present overcrowding, if London's population continues to grow at the rate it did before the war, 145,000 houses to accommodate 720,000 persons must be built by 1928, in addition to those for people to be rehoused from cleared slums and those now living in overcrowded houses. At least 500,000 houses are needed in this country, involving the expenditure of some £200,000,000 (roughly $1,000,000,000).

Governor Coolidge Urges Building at Once

Governor Calvin Coolidge, of Massachusetts, has issued an inspiring message to the people of his state, arguing that the return to normal business life will not be accomplished by worrying over what may happen, but can only be accomplished by doing the tasks at hand. He says:

"Instead of being the sport of chance, Massachusetts ought to be the master of destiny. Instead of waiting, we should act. Government has released raw materials, labor and transportation. There is plenty of money, which makes a demand for merchandise. There ought to be no lack of a disposition to act, no lack of enterprise.

"The question is where to begin. A committee working with our board of labor and industries suggests the revival of building. This industry has been at a standstill for the past two years. It is in its nature basic. A contract for any kind of building at once makes the opportunity for other contracts for steel, cement, bricks, lumber, plumbing, steam heating, electrical equipment, and all other materials required in construction. This would mean the employment of large numbers of people in various factories manufacturing these materials.

"In this the various agencies of government ought to take the lead. It is therefore urged that all the departments in the commonwealth, counties, cities and towns should start the foundations, at least, for school houses, hospitals, libraries, police and fire department headquarters, bridges and other public buildings. There are many of these operations partially completed, and many others for which plans have been drawn and money appropriated. If public construction begins, private construction will soon follow as the increase in population requires more housing facilities. There is also much construction work on the railroads of New England, which the roads themselves and the national government should be urged to begin at once.

"The material resources of the community must be used for the benefit of the people of the community. Such use is the only thing that gives them value, and the only warrant for their existence. Unless this is done by private enterprise, it will have to be done through the taxing power and otherwise, for the purpose of relieving the suffering caused by unemployment. Every facility is at hand for an era of great prosperity. What is needed is the courage to act. In the exhibition of that courage the government agencies must take the lead."

Cities Service Company Buys Colorado Plant

The Cities Service Company has purchased control of the Western Light and Power Company of northern Colorado from Westinghouse, Church, Kerr & Co. Directors of Cities Service Company have ratified the negotiations and new directors have already taken charge of the company.

The power plant of the Western Light and Power Co. is located at a coal mine near Lafayette, and is equipped with automatic stokers and other machinery to save labor in handling its coal supply. The company furnishes light and power current for Boulder, Longmont, Loveland, Greeley, Fort Collins, Milliken, Fort Lupton, Brighton and other northern Colorado towns. The main offices are at Boulder.

Equipment improvements to cost $1,250,000 are being planned by the Doherty interests and a reorganization of the Colorado Company is probable.

Wireless Station in South Pacific

A wireless station has been established at Avarua, the principal town and port of Rarotonga, that now practically connects up a chain of wireless stations between the Fiji Islands, Tahiti, and Rarotonga with New Zealand, writes Consul General Alfred A. Winslow from Auckland. This was made possible by the fruit export trade of Rarotonga agreeing to pay a duty of 2 cents a case on fruit exported from that island of the Cook Group, this tax amounting to about $3,407 a year. This is quite an important matter for the South Pacific Islands, and will bring this part of the world in much closer touch with the outside, and should be of interest and value to the shipping interests at home.

ELECTRICAL ENGINEERING

With Which is Incorporated the

SOUTHERN ELECTRICIAN and the ELECTRICAL AGE

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VOL. LIII FEBRUARY, 1919 No. 2

The following appeared recently in a Minot, North Dakota, publicataion: "Some time ago the city of Drake bought the local electric light plant and ran it as a municipal proposition. This proving unsatisfactory, the original owner was induced to buy back the plant and give the city the old-time good service." As we showed in the review of the recent volume by Prof. Edmond Earle Lincoln, of Harvard University, the experience of Massachusetts in the municipal operation of the electric light and power plants has not been very satisfactory. Mr. Lincoln's conclusions are: "Whatever the sequel may be, this modest study, as well as most careful and unbiased investigations, points to the conclusion that as a rule only the simplest and the 'well-seasoned' enterprises are at all suitable for public operation; and even these are in grave danger of becoming less efficient than they would be in private hands. Though political expediency or social necessity may sometimes momentarily outweigh all economic considerations, it still seems inherent in the nature of things that private industry must continue to show the way."

ITALY, whose population as a whole was without coal for heating and in large part without gas for cooking, for many months of the war period, was the worst sufferer from fuel shortage among the allied nations, according to the report of the commission sent to Europe by United States Fuel Administrator H. A. Garfield. Representatives of the Italian government, the commission reports, urge an annual national supply of 12,000,000 tons to meet actual requirements, drawing attention to the fact that "while the people may suffer privation without protest in war time," with the coming of peace a refusal to supply fuel "may give rise to serious disturbances." The whole of this quantity would of necessity be imported since Italy's only domestic fuel is a very poor grade of lignite. Before the war Great Britain shipped annually to Italy some 8,000,000 tons a year, but under present conditions it is doubted whether it can approximate to anything like these figures. The exports from the United States dwindled from nearly two million tons in 1915 to but 9,700 tons for the first nine months of 1918, due to prohibitive freight rates and shortage of ships. A month or two ago we printed a map in these columns showing the elaborate system of central stations and electric trunk lines in Northern Italy. In view of the very unpromising condition of the fuel situation, the country must make the most determined effort to develop its hydro-electric resources.

THE cessation of the war naturally left the United States Government in possession of a vast amount of supplies of various kinds for which it has no use. The disposition of these without a disastrous effect upon the general market is a problem that needs careful attention. Meetings of the director of sales and the representatives of the various industries affected have been held in order to decide upon some method of disposition that would not seriously disarrange the industries affected. It was agreed that the Government, in the case of machine tools, for instance, the manufacturers of these tools will be given an opportunity to purchase them at a price and on terms of settlement which will be satisfactory to all parties concerned. In case it is impossible for the manufacturers to purchase his product outright, an effort will be made to arrange for the marketing of the product by the manufacturers in an equitable manner, securing for the Government and the manufacturer alike the best possible terms. In case both these methods of disposition fail, the material will be offered for sale to the general public in a manner prescribed by law. The Government also has on hand a great amount of building material, and this will be disposed of in such a manner as to produce the least possible disturbance to the general market.

THE American Association of Engineers is giving its attention to a discussion of the question of licensing engineers, believing that it is important that an early solution of this most vital problem should be secured. The committee on legislation, of which Mr. L. K. Sherman, of Washington, D. C., is chairman, has just submitted a preliminary report on licensing. This discusses at length the existing license laws, and statutes that have been proposed in various states. As to the scope of license laws, the report says: "No existing license law includes all of the branches of engineering. Some states include surveying, others civil engineering. Illinois includes structural engineering. Other states license the practice of hydraulic and irrigation work and mining engineering. Electrical and mechanical engineering are not licensed to our knowledge, but almost invariably the operator of a steam or electric plant requires a license. The fact that steam boilers, elevators and electric wiring are subject to either state or municipal inspection probably accounts for this. Inasmuch as there is no apparent demand for license by the mechanical engineers, and as the works of the mechanical and electrical engineers can be readily proven by actual tests, which is not the case in general, in the works of the civil engineer, it is here suggested that the committee consider only a license law as applying to civil engineering or specific branches thereof." The matter of licensing engineers will be brought up for discussion in the various chapters of the association not later than the first of next month.

THERE are few people in this country who believe that our public utilities can be managed better by the Government than by private initiative. The demand for Government control is largely a matter of politics, purely and simply. Unfortunately politics has great weight here, and we do not always stop to consider questions of public polity on the basis of the truest interests of the greatest number. In this connection we are glad to quote a paragraph from one of the leading weekly journals of England, the London *Architect*. In a review of the "Lessons of the Year," the leading article has the following paragraph: "We hope that we have learned our lesson, and we also trust that a nation which has built up its power by the enterprise of its people, working without the help and sometimes in the teeth of the opposition and indifference of governments, will not become in the future an official-ridden and overtaxed community. The war has resulted, it is said, in converting every fifth man in the community into an official; it should be our first effort to get rid of this incubus and drag upon our strength. We have no evidence that the official can build better and more securely than the private pioneers of industry and commerce who have created the power and wealth of the nation which has after all stood the stress of the greatest of the world's wars, while we have constantly recurring proof of the expense and failures incidental to the system." Have we learned the lesson, or are we ready to turn over many of our great and vital industries to Government control, so that they may become the football of politics?

THERE is no question that the war taught us certain weaknesses in our social and economic fabric that we should scarcely have learned in fifty years of peaceful progress. It was inevitable that this should be so. Demands were made upon us that we could not possibly foresee and that could not have arisen under any other conditions. It is not enough that we, and all of the allied countries, met the exigencies of the hour in a creditable manner. In the great work of reconstruction and readjustment, in many ways as trying and vital as the war stress itself, we must study what were the demonstrated causes of weakness and apply the remedy unshrinkingly. The National Government is helping us through investigations in various lines by trained experts. The United States Department of Labor, Training and Dilution Service, C. T. Clayton, director, has presented a bulletin on "British Methods of Training Workers in War Industries." The mistakes of our English cousins were much the same as our own, and we are not above profiting by their experiences. A note on training prepared by an official of the ministry of munitions, intelligence and record section, has the following paragraph: "Bad works management, in the hands of men to whom the production idea was totally unfamiliar, has been another more serious difficulty. Such officials have merely seen in it a convenient method for tinkering with wages, and have been blind to its real possibilities. Recalcitrant education authorities have caused obstructions and delays. But the production idea has gained acceptance, and progress has been and is continuous." In another bulletin put forth by the same bureau, the result of careful and extensive investigation is summarized as follows: "One of the principal factors in labor turn-over is the failure of manufacturers to obtain from their workers a full measure of efficiency. That this failure is chiefly ascribable to employers themselves is rather eloquently indicated by the results of a recent analysis of various causes of discharge in one of our big establishments. Only ten per cent. of the dismissals, this study showed, were upon grounds of slacking. The other ninety per cent. of the discharges, it was disclosed, were attributable to shortcomings of one sort or another in the management. The same kind and degrees of failure were responsible for ninety per cent. of the quittances among employes, it was revealed by another survey. Six general reasons may be assigned for inefficiency in production—and five of them are furnished by imperfect management. The sixth is slacking on the part of the employe. These reasons are (1) power failure; (2) failures of equipment and repairs and like limitations; (3) lack of instructions; (4) lack of training; (5) failure to supply material; (6) personal slacking." The easy way to account for failure in production is to attribute it to the incompetence and delinquency of labor. We are quoting the above conclusion of trained investigators merely to show that executive management has sins of its own to answer for. It should only be necessary to understand these sources of trouble in order to provide a remedy. "Scientific management" has become a fetish in these days. But it means more than the mere regulation of labor. It must reach to the executive branches as well.

Electrical Pumping Saves Money

An article in a recent issue of a Pueblo newspaper describes the electrical installation at the South Side Water Works at Pueblo, Colorado, where during the year 1918 electrically driven, direct connected pump, of a capacity of 3,000,000 gallons daily was installed. The city is now preparing to install a second unit with 6,000,000 gallons daily capacity and it is the intention of the trustees to electrify the entire pumping system during 1919. All of the energy is supplied by the Arkansas Valley Railway Light & Power Company. The trustees estimate an annual saving of $10,000 when the plant is completely equipped for electrical operation.

Strike in a Municipal Electric Plant

The City Electrical Workers of Tacoma, Wash., recently went out on a strike which has threatened to interfere with practically every industry in the city. The electric plant is owned by the city and although every effort was made by the U. S. Immigration Commission and the U. S. Employment Service to bring the disagreeing parties together promptly it was not accomplished for many days.

Lifting Magnets

By J. Gintz, Jr.

THERE are many uses to which lifting magnets can be put. There are also many instances where an electrician is called upon to make one, and he finds himself at a loss as to what is necessary to build one; that is, how much iron would be required, the amount and size of wire to be used for the winding, etc.

Lifting magnets are divided into two classes; namely, first, permanent; second, electromagnets.

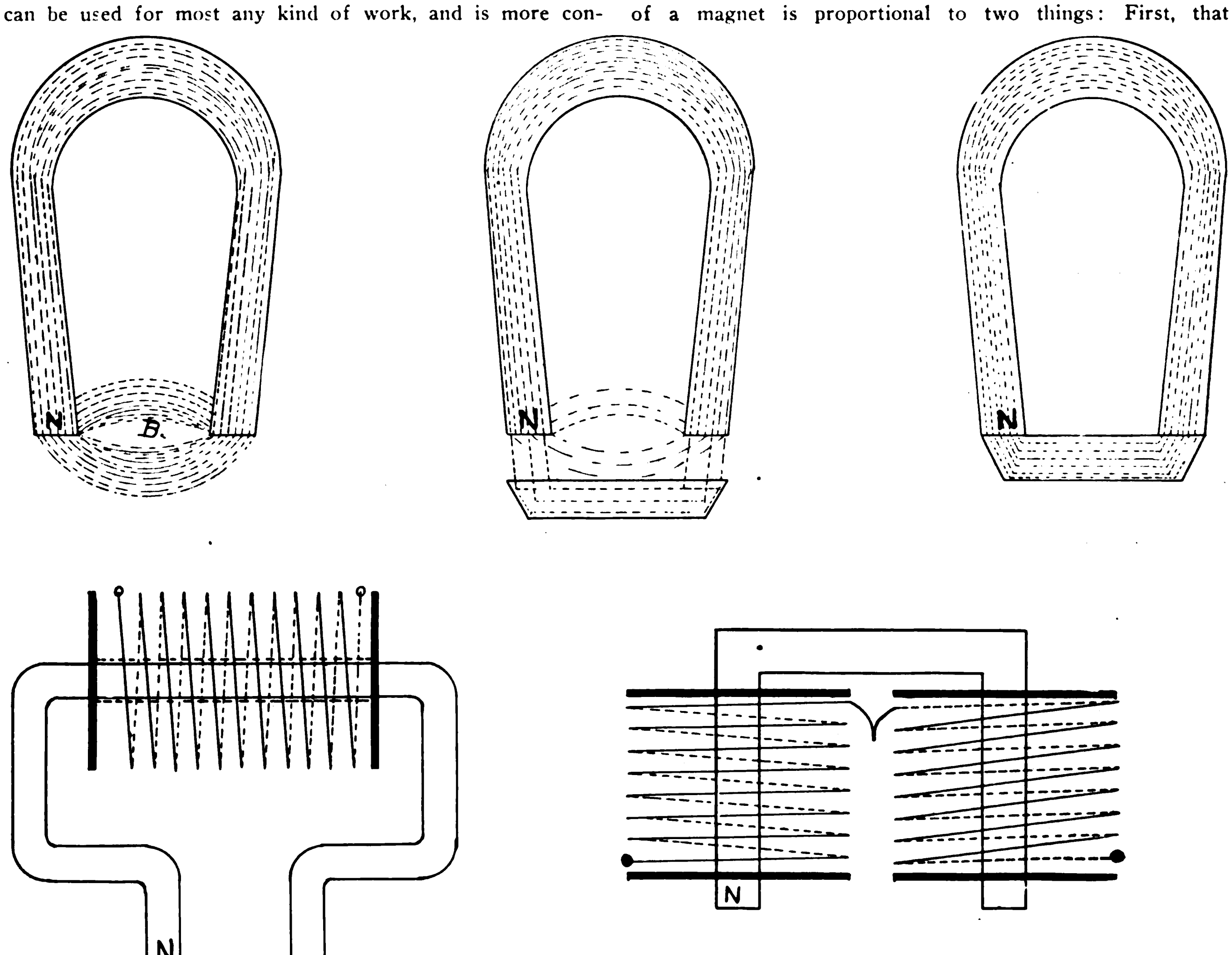
Permanent magnets are used for lifting or picking up small objects or to separate iron from brass filings or from other non-magnetic metals. The electromagnet lifting magnet can be used for most any kind of work, and is more convenient to handle, since it can be controlled so as to pick up and release its load by means of a switch. This feature is not possible with a permanent magnet, unless physical force is used to remove the particles which it has attracted.

The principle of the lifting magnet can be illustrated by means of a simple horseshoe permanent magnet as shown in Figs. 1, 2, and 3. Fig. 1 shows a permanent magnet without an armature or keeper, and the lines take any path possible from the north pole (N) to the south pole (S). In Fig. 2 an armature or keeper has been placed near the end or poles of the magnet (the distance between the poles and the keeper being less than the distance B in Fig. 1). It will be seen that some of the lines of force now make their way from the north pole of the magnet through the keeper and then to the south pole, while some take still another path as in Fig. 1. In Fig. 3, the armature or keeper has been put against the poles of the magnet, and now all the lines of force pass through the keeper from pole to pole, this being the path of least reluctance.

If this keeper or armature is free to move and is placed near the poles of a magnet so that the distance is less than B, Fig. 1, it will be drawn up to the poles as shown in Fig. 3.

The amount of physical force that will be required to pull the keeper away from the poles of the magnet (Fig 3) is considered the lifting power of the magnet. This lifting power or pull depends on the number of lines of force, and also in the shape of the poles, kind and amount of iron, and the quality of the keeper.

In general it may be stated that the lifting power or pull of a magnet is proportional to two things: First, that



Figures 1, 2, 3, 4 and 5

it is directly proportional to the area of the pole faces which are in contact with the keeper or armature; second, it is proportional to the square of the density per square inch in the minute air gap that may exist between the keeper and the pole faces, as can be seen from the following tables:

Lines of force per sq. in.		Lifting power per sq. in.	
Annealed Wrought Iron	Ordinary Cast Iron	Annealed Wrought Iron	Ordinary Cast Iron
125,000	72,500	216 lbs.	72.8 lbs.
122,500	70,000	208 "	67.9 "
120,000	67,500	199 "	63.1 "
117,500	65,000	191 "	58.5 "
115,000	62,500	183 "	54.1 "
112,500	60,000	175 "	49.9 "
110,000	57,500	168 "	45.7 "
107,500	55,000	160 "	41.9 "
105,000	52,500	153 "	38.2 "
102,500	50,000	146 "	34.6 "
100,000	47,500	138 "	31.2 "
90,000	45,000	112 "	28.1 "
85,000	42,500	100 "	24.9 "
80,000	40,000	88.7 "	22.2 "
75,000	37,500	78.0 "	19.5 "
70,000	35,000	67.9 "	20.0 "
65,000	32,500	58.5 "	14.5 "
60,000	30,000	49.9 "	12.5 "
55,000	27,500	41.9 "	10.4 "
50,000	25,000	34.6 "	8.7 "
45,000	22,500	28.1 "	7.1 "
40,000	20,000	22.2 "	5.5 "
35,000	17,500	20.0 "	4.2 "
30,000	15,000	12.5 "	3.1 "
25,000	12,500	8.7 "	2.0 "
20,000	10,000	5.5 "	1.4 "
15,000	7,500	3.1 "	0.78 "
10,000	5,000	1.4 "	0.34 "
5,000	2,500	0.34"	0.085"

Figs. 4 and 5 show two types of electromagnet lifting magnets, known as a 1-coil 2-pole magnet, (Fig. 4), and a 2-coil 2-pole magnet (Fig. 5).

Figs. 6 and 7 are two views of a typical lifting magnet such as is used for moving heavy masses of iron and steel in foundries, railroad shops, shipyards, etc.

In designing a lifting magnet it is almost impossible to arrive at a satisfactory result at the first trial, as the winding space which was allowed for the magnetizing coil may be too large or too small, and this would also cause the magnetic circuit to be out of proportion. There are a few suggestions and rules which may assist in designing a lifting magnet. They are:

1.—Make the magnetic circuit as short as possible.

2.—The cross-sectional area of the magnetic circuit should be as nearly uniform as possible.

3.—The iron used in the magnetic circuit should have a high permeability (see permeability table).

4.—Assume a magnetic density in accordance with the following:

Gray cast iron not exceeding 40,000 lines per square inch.

Wrought iron not exceeding 85,000 lines per square inch.

Cast steel not exceeding 85,000 lines per square inch.

Sheet iron or carbon steel annealed not exceeding 110,000 lines per square inch.

The above mentioned densities will be increased somewhat at the joints, as the pole faces are usually chamfered.

5.—The magnetic density being known, the area of the pole faces and the cross-sectional area of the magnetic circuit may be determined.

6.—Assume a space into which the magnetizing coil is to be wound. It may prove to be too large or too small, so several trials may be required.

7.—Calculate the magnetizing coil.

The permeability table is as follows:

The permeability of air is considered at 3.19 perms per inch cube, and from this standard the permeability of the various metals is as follows:

B *	Sheet Steel Annealed μ †	μ^R ‡	Cast Steel μ	μ^R	Wrought Iron μ	μ^R	Cast Iron μ	μ^R
10,000	1,996	625	1,774	556	2,576	833	497.6	156
20,000	2,775	870	2.278	714	4,252	1,333	609.3	191
30,000	3,416	1,071	2,791	875	5,091	1,596	583.4	183
40,000	3,866	1,212	2,967	930	5.547	1,739	488.1	153
50,000	3,796	1.190	2,954	926	5,318	1,667	370	116
60,000	3,611	1,132	2,657	833	4,351	1,364	266.7	83.6
65,000	3,420	...	2,500	797	4,070	1.275	201.3	63.1
70,000	3,283	1,029	2,255	707	3,436	1,077	....	...
80,000	2,715	851	1.745	547	2,453	769	....	...
90,000	2,080	652	1,276	400	1,436	450	....	...
100,000	1,490	476	851.7	267	743.2	233	....	...
105,000	....	...	....	...	532.7	167	....	...
110,000	937.9	294	481.7	151	338.1	106	....	...
115,000	....	...	360.5	113	....	...	....	...
120,000	526.4	165	....	...	....	...	....	...
125,000	370	116	....	...	....	...	....	...

* Flux density. Lines per sq. in.
† Absolute permeability. Perms. per in. cub.
‡ Relative permeability as compared with air.

Assume a magnet is to be designed to lift or hold a weight of 500 lbs. By following the rules as above stated the following equations will determine the necessary coil to produce a sufficient number of lines of force to lift the above weight.

Fig. 8 will show the shape of the proposed magnet core. It is made of wrought iron, and has a diameter of 2.5 in. As to its length, nothing definite can be said at this time.

The area of the magnetic circuit will be found as follows: $D^2 \times 0.7854$; where D is the diameter of the core on which the magnet is wound; then $2.5^2 \times 0.7854 = 4.9$ square inches. As the load to be picked up by the magnet is 500 lb. each pole

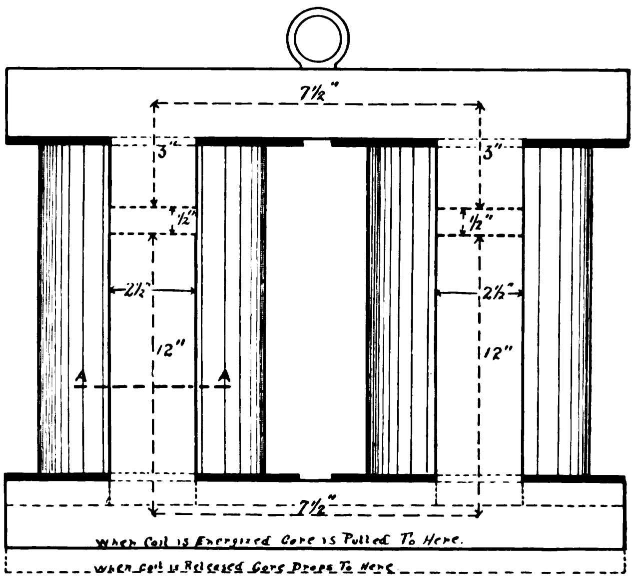


FIGURE 8

piece will be required to lift 500 lb. ÷ 2 poles = 250 lb. per pole or 250 lb. ÷ 4.9 sq. in. = 51 lb. per sq. in. Consulting the table under the head of "Lifting Power per Square Inch Wrought Iron Annealed" it will be found that 60,000 lines of force will lift 49.9 lb., and 65,000 lines of force will lift 58.5 lb. per square inch; so it will be assumed that 62,000 lines per square inch will lift 51 lb. The total flux will then be 63,000 x 4.9 = 303,800 lines of force.

From table 2 it will be found that the permeability of wrought iron at a density 60,000 lines of force is 4,351 perms per inch cube, and at 65,000 lines of force it is 4,070; so at a density of 62,000 lines of force the permeability will be assumed at about 4,100 perms. The permeability of air is 3.19 perms per inch cube. The dimentions of the core and coils will be assumed as in Fig. 8. The diameter of the average turns is shown at A, Fig. 8, and will be $4.5 \times 3.1416 = 14.14$ in. in length (approximately).

To find the number of ampere-turns to send or force 303,800 lines of force through an air gap of 0.5 in. per pole and an iron circuit of 25 in. (5 in. + 5 in. + 7.5 in. + 7.5 in. = 25 in) will be as follows:

$$I\,T = \frac{\phi \times l}{U \times A} \text{ where}$$

I T = Ampere-turns required.
ϕ = Flux produced per pole.
U = Permeability.
A = Area of magnetic circuit.

$$\text{Then } \frac{303{,}800 \times 25}{4{,}100 \times 4.9} = 323 \text{ Ampere-turns}$$

to force 303,800 lines of force through the iron circuit, and

$$\frac{303{,}800 \times 1}{3.19 \times 4.9} = 19{,}400 \text{ Ampere-turns}$$

to force 303,800 lines of force through 1 inch of air. This makes a total of $19{,}4000 + 323 = 19{,}723$ ampere-turns.

The next step is to find what size of wire will be required to assure 19,723 ampere-turns. The following formula will be used:

$$\text{Cir. mil.} = \frac{I\,T \times l}{E} \text{ where}$$

I T = Ampere-turns.
l = Length of average turns in inches.
E = Voltage on which the coil is to be operated. Then

$$\text{Cir. mil.} = \frac{19{,}723 \times 14.14}{110} = 2{,}535$$

Cir. mils. or a number 16 B and S gauge wire will be used to wind the magnetizing coils.

were added as long as the length of the average turn remained 14.14 inches.

It must be remembered that when a current is passed through a coil of wire heat is produced. A certain amount of surface will be required to radiate this heat so that the temperature of the coil will not become too high. On stationary coils about 0.5 of a watt per square inch is the usual allotment.

The radiating surface of the coils of this magnet is found as follows: Outside diameter of coil 2 in. + 2.5 in. + 2 in. = 6.5 in. (the thickness of the coil is 2 in). Then $6.5 \times 3.1416 = 19.4$ in. as the length of the circumference, and as the coil is 5 in. long, there will be $19.4 \times 5 = 97.0$ square inches as the outside radiating surface. The exposed surface at each end and the surface facing the pole piece can be considered as about 0.75 of the outer surface, so that $97 \times 1.75 = 169.75$ square inches as the total radiating surface per coil.

The maximum amount of watts and amperes that the coils may consume are as follows:
$169.75 \div .5 = 84.875$ watts per coil or 84.875×2 (coils) = 169.75 watts for both coils; then 169.75 watts $\div$ 110 volts = 1.54 amperes.

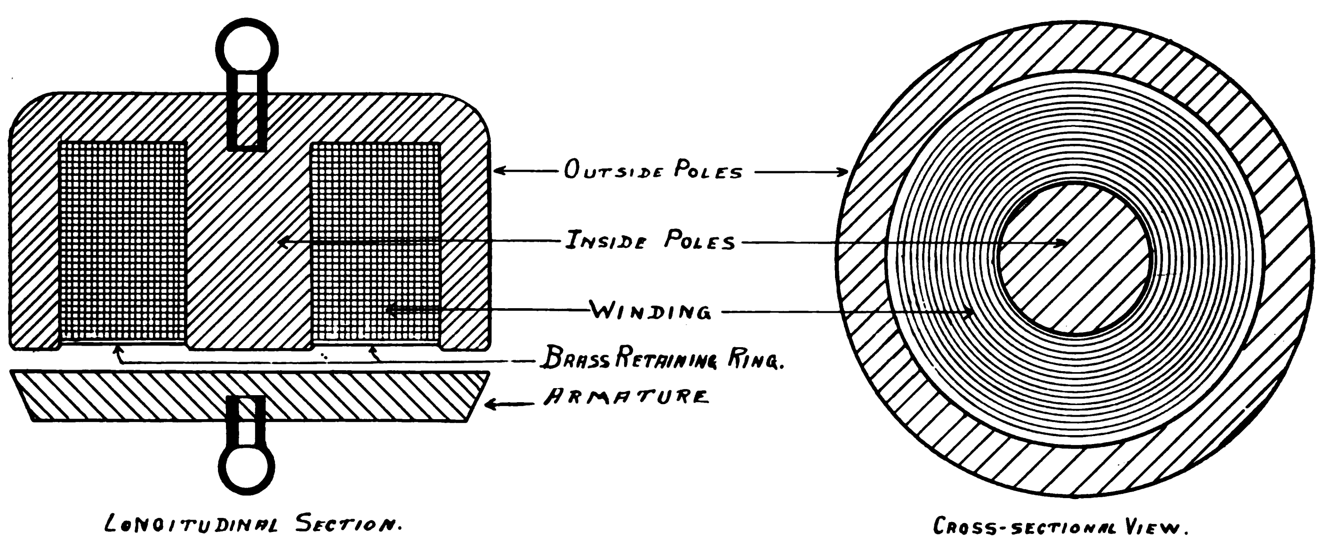
If the resistance of one pound of wire is 0.515 ohms, then

$$\frac{E}{R} \text{ or } \frac{110}{0.515} = 213 \text{ amperes would flow.}$$

The amount of wire required to allow 1.54 amperes to flow would be

$$\frac{213}{1.54} = 138 \text{ lb. or } \frac{138}{2} = 69 \text{ lb. per coil.}$$

It is now possible to check up and see if enough winding space was allowed, or if the entire design must be revised. As stated above, each coil was 5 inches long and 2 inches thick, this makes 10 square inches of winding space into which 69 lb. or $69 \times 108.7 = 7{,}500$ turns of wire must be placed. From the standard wire table it will be found that it is possible to put 249 turns of triple cotton-covered wire into



Figures 6 and 7

The next step is to determine exactly how many ampere-turns one pound of number 16 B and S gauge wire will produce. By consulting a standard wire table it will be found that a pound of No. 16 wire contains 128.14 ft.; this would make $128.14 \div 14.14 = 108.7$ turns. The resistance of one pound of No. 16 wire is 0.515 ohms, and if 110 volts were passed through a coil of 108.7 turns there would be $108.7 \times 110 \div .515 = 23{,}216$ ampere-turns produced. This number of ampere-turns would not be altered no matter how many turns

1 square inch, or 2,490 turns on the entire coil, which is about one-third of the required amount.

This can be changed very easily, as by lengthening the iron circuit the ampere-turns will increase as in the present problem the number of ampere-turns required for the iron circuit are 323 for a length of 25 inches. By increasing the length of the coil 15 inches instead of 5, the iron circuit becomes 45 inches and the ampere-turns increase to 680; but the circular mil area of the wire increases very little, from 2,535 to 2,581 cir. mils, which will still equal a No. 16 B and S gauge wire. Then by making the coils 15 inches long, all other dimensions remaining unchanged, the proper magnet for lifting 500 lb. will be completed.

Each coil contains 7,500 turns of No. 16 wire, with both coils in series across a 110-volt circuit.

Here and There in the Electrical Field

The Grand Prairie Electric Light Company, of Grand Prairie, Alta., Canada, plans to purchase a new engine and install the alternating current system.

The Eureka, Calif., division of Western States Gas & Electric Company is constructing a branch line to supply the electrical energy requirements of the Humboldt Transit Company. This line will be completed within the next week.

During 1918 electric dealers in cities served by the Arkansas Valley Railway Light & Power Company, sold 3,246 household electric appliances to customers of the company. Of this number, 1,757 were electric flatirons. This represents an increase of approximately 1500 K. W. to the business served by the company.

The Oklahoma State Utilities Association, will hold its annual meeting in Oklahoma City on February 14-16. J. F. Owens, vice-president and general manager of the Oklahoma Gas & Electric Company, is president of this Association.

The National Paper Product Company has completed its million dollar plant at Stockton, Calif., and started operations with 150 men. An additional 100 men will be employed as soon as possible. The plant has a capacity of 80 tons per day, a monthly payroll of $40,000 and utilizes electric power from the Western States Gas & Electric Company to the extent of 1400 horsepower.

The City Commissioners of Minot, N. D., have contracted for the installation of 28 three-light ornamental standards on the new steel viaduct over the Great Northern and Soo Railroads, current for which will be furnished by the Minot division of Northern States Power Company.

The town of Woodbury, Minn., has been connected to the lines of the Northern States Power Company, Stillwater division, and is now enjoying electric service for the first time. From twenty to twenty-five farmers are also being supplied from the lines which supply Woodbury.

The Fort Smith, Light & Traction Company, of Fort Smith, Ark., has closed contract with the Model Window Glass Company for the complete electrification of their plant, displacing gas equipment.

The fifth annual election of officers and directors of the Employees' Association of the San Diego Consolidated Gas & Electric Company, San Diego, Cal., was held recently. The following officers were elected for 1919: President, W. H. Ellison; vice-president, W. A. Lambert; secretary-treasurer, R. B. Tallman. Directors: J. A. Harritt, C. W. Wiggins, Otto Goldkamp, A. T. Peterson, H. W. Elder. Directors held over for 1919: E. W. Jones, J. E. Hayes, H. McConville, F. P. Kibler.

At the annual meeting and luncheon of the Jovian League of New York, held in the ball room of the Hotel McAlpin, the following officers were elected for the ensuing year: President, James M. Wakeman; vice-presidents, James R. Pollock and Walter Neumuller; secretary, J. Wynne Jones; treasurer, Lawrence L. Strauss. Directors: Arthur Williams, James R. Strong, James H. Betts, George Williams, Frederic H. Leggett and Frederick S. Hartman. Publicity Director, H. W. Casler. Judge Louis D. Gibbs, of the Bronx, was the guest of honor and delivered an interesting address. In the course of it he paid tribute to Theodore Roosevelt. "It was his clarion voice that aroused the American public to the impending danger, and when the history of this period is written, Roosevelt will be referred to as a spiritual, intellectual and physical giant."

The Michigan Engineering Society, in annual session at Flint, January 21-23, took steps to bring together all engineers in Michigan by appointing L. E. Ayers, of Ann Arbor, chairman of a committee to draw up a plan for increasing the activities of the State society. The committee is instructed to report in thirty days. It will study the functions of local, State and national societies and will attempt not only to correlate the local societies with the State organization, but will seek to correlate the State organization with national activities. The study of State and national engineering organization will be begun by addressing a letter to the several national societies.

Commutator Troubles and How to Cure Them

By T. Schutter

A COMMUTATOR may develop a short circuit between its bars, a ground between its bars and the hub, low or sunken bars, high or raised bars, also high mica between bars.

A short circuit may be caused in many ways. In modern machines the commutators are usually under-cut, that is the mica between bars is slotted, and it is the deposit of carbon and copper dust that will form a contact between one bar and the next and in this way cause a short circuit. This cause can be prevented by carefully conditioning the surface and using the proper kind of brush, which will be treated in the latter part of this article.

Another cause of a short circuit is that when trimming a Commutator very course sand paper is used, and some times even emery paper or cloth is used. Course sand paper will grind or cut fairly large chips of the commutator surface and imbed them into the mica between the bars, and as emery is a conductor, it will also cause a short circuit by being imbeded in the mica. The proper method of trimming a commutator is to use a very fine grade of sand paper, or a commutator stone, and when through using the brushes and their holders should be cleaned of all copper and sand dust, as this if left on it will ruin the newly made surface in a short time.

A ground in a commutator between the bars and the hub, can be avoided if the front end is kept free from oil. As a general rule, the insulating washers and rings which separate the bars from the hub, are made of micanite, which is more or less absorbent, and will absorb any oil which may creep from the front bearing along the shaft and find its way to these micanite insulators, and when the commutator or brushes are being trimmed the dust will adhere to this oil-soaked material and cause a ground, and in one case which the writter had to repair a hole large enough to insert a finger was burned between the hub and bars.

Another way a ground can be caused is by using a soldering solution which will attack the mica, that is it will be absorbed by the insulation when the heat of the soldering iron is applied. A very good solution to use when soldering the coil leads into the commutator bars is a mixture of resin and alcohol; resin being an insulator and the alcohol will evaporate by the heat of the soldering iron.

A low or sunken bar is caused by something striking against it, while a high or raised bar may be caused by the commutator not being properly tightened up when assembled, and when it revolves the centrifugal force has a tendency to throw the loose bar or bars out. When a commutator is assembled all lock nuts and screws are set up hard and then the commutator is heated to a very high degree and then all lock nuts and screws are tightened up again, as the heating causes all parts to expand; this process is repeated, and finally, it is laid before a fan and cooled as quickly as possible. This will cause all parts to shrink and there is little or no chance for high or raised bars after this process. High mica will happen more often on the older commutators than on the modern ones as they were not undercut, and in some cases the copper bars wear faster than the mica between the bars. This, of course, let the mica project and was called high mica; this, as well as low and high bars, caused chattering and sparking at the brushes.

When a commutator surface is rough and coppery-looking, it is caused by using an abrasive brush, which wears the commutator bars down very rapidly as well as the brush itself, and should it be a commutator of the undercut type the slots between the bars will be filled up with copper and carbon dust very quickly and cause a short circuit, as above explained. Hard brushes are very desirable, as they will soon produce a glossy, chocolate brown surface, which is the best that can be had, as it causes the least wear on both the bars and the brushes and there will be no cause for the slots in an undercut commutator to fill up as above mentioned. When a commutator is in this condition it can be kept so by using a piece of cheese cloth and a drop or two (not more) of oil to wipe the commutator off thoroughly each day while running. The surface may get much darker than chocolate brown (almost black) but it will still have a very glossy appearance.

When soft carbon or graphite brushes are used they will form a heavy deposit of carbon or graphite on the surface, which will bridge the mica or fill the slots of an undercut commutator and in this way cause short circuits. When soft brushes are used care must be taken always to keep the deposits wiped off, either by fine sand paper or cheese cloth.

There are various methods of making commutator bars, such as hard drawn, cold rolled, drop forged, cast, etc. Of the first three mentioned, there is little choice as to the best, but a drop forged bar is always preferred, and as to cast bars they are very inferior, as in many cases they are full of holes, from the size of a pin point to some very large ones, some times as large as one-half inch in diameter.

When a commutator made up of cast bars is finished off and made ready for connecting the armature windings into the bars, the surface may appear smooth and free from holes, but when the commutator is being turned down to a finished surface and made ready for running these cast holes may show on the surface. This is called a spongy or porous surface.

Again these holes may not appear until the machine has been running for some time, when small black spots will be noticed, and on examination it will be found that these black spots are little holes filled with carbon dust. If they are in the center of the bars (on the surface) they cannot do any harm, but if on the edges, the carbon dust which collects in them will soon bridge the mica insulation between the bars and cause arcing and burn these deeper and wider, and also cause a short circuit between the bars.

The holes in the center of the bars can easily be remedied by filling them with hot solder; the ones on the edges can also be filled with solder but care must be taken that the solder does not bridge to the adjacent bar as this will cause a short circuit. Should it so happen that there is a hole in two adjacent bars the mica should be cut away and the gap then filled with solder. When filled and the solder has hardened the bars are cut apart with a hack saw. This will leave a slot between the bars but it must also be filled with some insulating material. The usual filler is powdered mica mixed with shellac to a thick paste. It is then packed into the slot and allowed to set until hard, then it is smoothed down with fine sand paper. This method also applies to filling a hole between bars which was burned in; due to an open circuit in the winding.

A ground between the bars and the hub of the commutator may also burn a hole into the bars, and in many cases melt the bars and hub together at the point where the ground happened. The writer was called upon to repair such a ground and it was done as follows: To separate the bars from the hub where they were melted together, a one-half inch drill was used to drill in to the molten mass at various points and then the remainder was cut out with a small chisel. Of course, this made a large and difficult hole or gap to fill, but the bars and hub were separated and the ground was cleared. The filling was done as follows: While chiseling the bars and hub apart, the surface was not very smooth and for a filler a piece of cotton waste saturated with a mixture of powdered mica and shellac was packed in tight and solid. This repair was made some years ago but the machine was in use a few days ago and the same filler was still in place.

Notes from Canada

The municipality of Wellington, Ont., has purchased the local distribution system of the Nyles Seed Company and will secure a supply of power from the Hydro-electric Power Commission. An out-door type sub-station is being erected at this place which will also supply the town of Bloomfield.

A 44,000-volt transmission line is being erected from Trenton to Picton, Ont., by the Hydro-electric Power Commission. An out-door type sub-station is being erected at Picton and power will be turned on some time in February.

Toronto's street lighting will, it is said, be on a "peace basis" by March 1. There are some 15,000 lamps to be relighted.

The town council of Harwarden, Sask., is negotiating with the Torgenson Garage Company with a view to granting this company a franchise to install and operate an electric lighting system.

Mr. Samuel Chevrier, of Gravelbourg, Sask., is forming a company for the purpose of installing an electric light plant, with necessary distributing equipment, in that town.

The ratepayers of Ottawa, Ont., voted on January 1, in favor of taking over the Ottawa Electric Railway in 1923, when the franchise expires, and operating it as a municipal enterprise.

A public utilities commission has been formed in Galt, Ont., composed of four commissioners, combining the administration of the waterworks and hydro-electric departments under the one body.

Mr. J. W. Evans, of Revelstoke, B. C., has bonded the Mountain Chief Mine, at Renate, which is a gold, silver and ore producer, for $100,000, and plans to start on development work immediately, putting in a tramway from the mine to the Arrow Lake.

Historical Review of Steam Turbine Progress

The Westinghouse Electric and Manufacturing Company has just issued their Circular 1591, subjected "An Historical Review of Steam Progress." This publication was written by Mr. Francis Hodgkinson, whose commercial and engineering knowledge of the steam turbine is perhaps as broad as that of any man in America. The circular is a reprint on an article which appeared serially and is now gathered together in one publication with the intention of becoming a handbook on steam turbine progress. The early history of steam turbine engineering is gone into and the earlier machines installed in America are illustrated. From 1899 until 1917, each year's development is properly recorded as it occurred and the improvements noted. The booklet is profusely illustrated with views of all the different types of impulse and reaction turbines and the construction of blading, valve chamber, governor, throttle valve, coupling and oil cooler are shown in detail. This publication should be a valuable addition to designing and consulting engineers and is being used extensively in the Government training classes for junior engineers on steam engineering work.

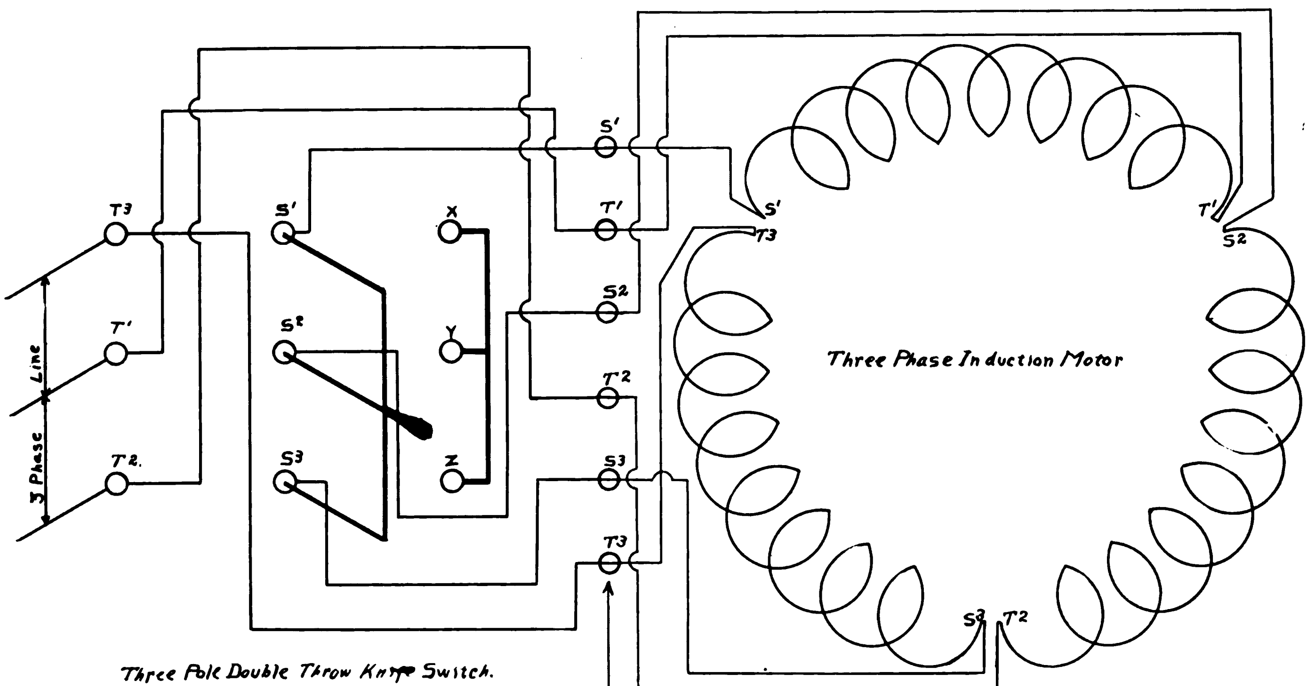
Three Pole Double Throw Switch

A correspondent asks for a diagram showing the connections for starting a three phase induction motor as a Y connected machine and when started to run it as a delta connected machine. The following diagram shows how this can be accomplished by using a three pole double throw knife switch, which is operated as follows:

The terminals of each phase or winding are brought out as follows:

S1 is the beginning of phase one (1).
S2 is the beginning of phase two (2).
S3 is the beginning of phase three (3).
T1 is the ending of phase one (1).
T2 is the ending of phase two (2).
T3 is the ending of phase three (3).

Terminals S1, S2 and S3 are connected to the blades of the switch, and the terminals T1, T2 and T3, also the three line wires, are connected to the jaws on the running side of the switch; the jaws on the starting side of the switch are bridged together.



Three Pole Double Throw Knife Switch.

By closing the switch so that the blades (to which terminals S1, S2 and S3 are connected) are in contact with jaws X, Y and Z the motor will start as a Y connected machine; when the motor has been started by throwing the switch to the other side so that the blades are in contact with the jaws to which the terminals T1, T2 and T3 are connected, the machine will then run delta connected.

Personal Notes

H. E. North, formerly with the Minneapolis General Electric Company, has been appointed manager of the Contract Department of the Oklahoma Gas & Electric Company, Oklahoma City, Okla.

Lieut.-Col. H. W. Byllesby was tendered a dinner last month by the officers and forty male employees of H. M. Byllesby & Co., at the University Club, New York, in honor of his return from service with the American Expeditionary Force abroad. Col. Byllesby related his experiences in the service, and declared that the second and harder phase of the war is now before us.

D. J. Young, of the San Diego Consolidated Gas & Electric Company, San Diego, California, has been appointed Vice-President and General Manager of the Tacoma Gas & Fuel Company, Tacoma, Wash., Olympia Gas Company, Olympia, Wash., and the Puget Sound Gas Company, Everett, Wash.

C. M. Brewer, manager of the Richmond division of the Western States Gas & Electric Company, has been appointed Vice-President and General Manager of the Mountain States Power Company, operating in Montana, Idaho, Washington and Oregon.

N. I. Garrison, manager of the El Reno, Okla., division of the Oklahoma Gas & Electric Company, has been appointed district chairman of the Public Utilities Association for the district around El Reno, embracing twelve counties.

Major William J. Hammer, one of the best known consulting electrical engineers, with offices at No. 55 Liberty Street, New York, has been appointed by the War Department a member of the General Staff Corps, and has removed to Washington. For some time past Major Hammer has been serving on the War Plans Divisions of the the War Department, but his appointment to the General Staff came as a complete surprise to him.

Mr. W. H. Finley, president of the American Association of Engineers, will address an open meeting of New York engineers at the Machinery Club, 30 Church Street, on Monday evening, February 10, at 8 P. M., on "Engineering Organization and Its Relation to Public Service." The meeting will be preceeded by a dinner at 6.30 P. M., and is under the auspices of the New York Chapter of the American Association of Engineers.

C. A. Hall has been promoted from assistant general manager to general manager of the Eastern Pennsylvania Railways Company and the Eastern Pennsylvania Light, Heat & Power Company, of Pottsville, Pa., by the J. G. White Management Corporation, New York, N. Y., the operating managers of the Pottsville properties. Mr. Hall succeeds L.

S. Cairns, deceased. In June, 1918, Mr. Hall entered the service of the two Eastern Pennsylvania Companies as manager of the electric light and power department and shortly thereafter was advanced to the position of assistant general manager. After leaving school in 1904, Mr. Hall entered the employ of the Consolidated Light Company, Huntington, W. Va. In 1907 he joined the organization of the Ohio Valley Electric Railway Company, Huntington, W. Va. He became superintendent of the Canonsburg Electric Light, Heat & Power Company, Canonsburg, Pa., in 1909, and following the purchase of this utility in 1911 by the West Penn Power Company of Pittsburgh, Pa., he was appointed local manager of that company in charge of the Canonsburg territory. Under Mr. Hall's management this property was entirely rebuilt and many improvements to the service made. He is a member of the National Electric Light Association and the American Institute of Electrical Engineers.

Elevator Manufacturers' Convention

The Elevator Manufacturers' of the United States held their semi-annual convention at the William Penn Hotel, Pittsburgh, recently. Among the subjects discussed were cost systems, co-operative service, elevator regulations, service stations, and the prospects of the industry. Among the features of the occasion were a banquet, a theatre party, and a trip to the works of the Westinghouse Electrical & Manufacturing Company.

The following officers were selected for the coming year: President, I. N. Haughton, Haughton Elevator Co., Toledo; Vice-President, O. P. Cummings, A. B. See Electric Elevator Co., New York; Secretary, Frank A. Hecht, Jr., Kerstner & Hecht Co., Chicago; Treasurer, J. H. DeVere, Ohio Elevator Co., Columbus.

Convention of the Indiana Engineers

The Thirty-ninth Convention and Annual Meeting of the Indiana Engineering Society, was held at the Claypool Hotel, Indianapolis, January 23-25. The first session, on Thursday afternoon, was devoted to a discussion of highway construction and maintenance, and kindred topics. The Thrusday evening session was devoted to the economic welfare of the engineer, and was held jointly with the American Association of Engineers. At the Friday and Saturday sessions, the local section of the American Society of Mechanical, Civil and Electrical Engineers participated. Friday afternoon Mr. Charles Brossman, of Indianapolis, Consulting Engineer on Public Utility Plants, U. S. Fuel Administration of Indiana, read a paper on "Lessons from the Fuel Administration and Public Utility Plants," the discussion being led by Mr. C. P. Baldwin, of Detroit. Mr. H. O. Gorman, chief engineer of the Indiana Public Service Commission, Indianapolis, presented a paper on "Public Utilities in the War Period." At the Saturday morning session three interesting papers read were the following: "The Year's Progress in Electrical Engineering in the Allied Fields," and "Electrical Pumps in Municipal Water Work," by Prof. D. D. Ewing, Purdue University, Lafayette, and "Some Recent Technical Developments in Telephony," by Prof. R. V. Achatz, Purdue University, Lafayette.

St. Louis Engineers in Annual Meeting

The St. Louis Chapter of the American Association of Engineers was installed at a banquet at the Planters' Hotel on the evening of January 18th, with about one hundred and fifty members enrolled. H. W. Clausen, vice-president of the American Association, presented the charter and spoke on "Social and Business Problems of the Engineer"; C. E. Drayer, national secretary, on "What A. A. E. is Doing"; Professor E. J. McCaustland, of the University of Missouri, on the need of the engineer to study his economic condition and to take steps to improve it. Mr. Baxter Brown, President of the Engineers' Club of St. Louis, extended the greetings of the local club and invited the St. Louis Chapter of the American Association to co-operate with the local club, particularly in its efforts along civic lines. A communication was read addressed to the local Chamber of Commerce from the Engineers Club of St. Louis urging upon the Chamber the appointment of an engineering committee and that reports on civic questions involving engineering practice be not made without obtaining engineering advice.

Election of permanent officers for the new chapter resulted as follows: Lef Winship, president; F. L. Flynt, first vice-president; C. G. Harrington, second vice-president; R. B. Kerr, secretary; George Grimm, Jr., assistant secretary; C. P. Calvert, treasurer.

Directors: J. F. Peters, W. E. Playter, E. F. Collins, Prof. E. J. McCaustland, University of Missouri; L. T. Maenner, H. L. Hopper.

Legal Decisions in Electrical Fields

Constitutional Law Impairing Street Railway Franchise—Revocation. The grant by a county board of a right to locate, construct, maintain, and operate an interurban electric railway along a state highway, without specifying any limit of time, is held in Northern Ohio Traction & L. Co. v. Ohio *ex rel.* Pontius, 245 U. S. 574, 62 L. ed. 481, 38 Sup. Ct. Rep. 196, L.R.A.1918E, 865,—unless there are controlling provisions in the state Constitution or statutes, or a prior adjudication by its courts to the contrary,—to constitute, when accepted, a perpetual franchise, protected by U. S. Const. art 1, sec. 10, against revocation by subsequent resolution of such board.

Evidence—Derailment of Car Presumption of Negligence. The derailment of an interurban electric car to the injury of a passenger who is free from contributory negligence is held to raise a presumption of negligence on the part of the carrier, in the Iowa case of Lewis v. Cedar Rapids & I. C. R. & L. Co. 167 N. W. 588, L R.A.198E, 826.

Master and Servant—Liability for Act of Servant Lent to Another. An express company which lends by the day a team, wagon, and driver to an electric company engaged in constructing an electric line is held not liable in Pullman v. Express & Standard Cab Co. 259 Pa. 393, 103 Atl. 218, for injury to an employee of the electric company by the negligence of the driver in passing out a tool from the wagon, where the electric company directs the activities of the driver while the team is in its service.

The question as to who is responsible for the act of the driver of a hired vehicle is treated in the note accompanying the foregoing case in L.R.A.1918E, 118.

Negligence—Electricity—Pole in School Yard—Liability. Those responsible for maintaining within a school yard a pole carrying electric wires are held not liable in the Maryland case of Grube v. Baltimore Atl. 948, annotated in L.R.A.1918E, 1036, for injury to a bright boy ten or eleven years old, who, knowing that climbing the pole was not permitted, reached the climbing spikes from a fence and ascended the pole until he came in contact with a wire, which burned him and caused him to fall, to his injury.

Street Railway—Joint Use of Tracks—Act of License—Liability. A street railway company which makes an agreement with another company, under the authority granted by Ohio Rev. Stat. Sec. 3443-17, for the joint use of its tracks, is held liable for injuries caused by the actionable negligence of its licensee thereon, in Quigley v. Toledo, R. & L. Co. 89 Ohio St. 68, 105 N. E. 85, annotated in L.R.A.1918E, 249.

ELECTRICAL ENGINEERING

VOLUME LIII MARCH, 1919 No. 3

Quarrying and Working Stone by Electricity

BELGIUM was the first country that made any general application of electric power to the quarrying and working of stone. Some years ago, before the country was invaded and its industries ruined, there were immense quarries and stone-dressing plants in which there were model equipments, all of the machinery, even the gang saws, having their individual motor drives. In the United States the substitution of electric for steam power is steadily increasing in stone plants. It offers many advantages in works of this nature which must, of necessity, be widely scattered. The invention of the electric-air channeler has made it possible to take the electric power even into the quarry pits. Most lines of business can be established in the most convenient location, taking into consideration the availability of labor and power and transportation facilities. It goes without the saying, however, that a quarry must be opened and operated where the deposit of stone is found, and this is often in a most inaccessible location. The cutting plant must often be close at hand. While the quarry may be so situated as to make the obtaining of fuel costly, electric power from central stations may be readily available. Or there may be a water power close at hand that can be developed. For many years the Vermont Marble Company, perhaps the greatest marble producing concern in the world under a single management, operated its enormous plants by steam power. These were far from the coal mines, and fuel was costly. In addition to this, there was a magnificent water power close to the principal quarries and mills. A few years ago one of the most complete hydroelectric powers in the country was developed, and this has solved the problem of convenient and economical operation.

In Great Britain, the stone industry is singularly unprogressive. The quarries and cutting plants have adopted few of the most improved methods of getting out and working stone, such as channellers and carborundum machines. On the contrary, they depend to an almost unbelievable extent upon hand labor. An anomaly is found in the fact that the slate industry in Great Britain is far more progressive than the stone industry, while in this country it drags far behind. The leading Welsh slate quarries began the electrification of their plants some years ago, and although the industry has undergone a period of unexampled depression, it is, from the standpoint of power and equipment, in a far more favorable position than the American slate industry.

Few of the British manufacturers have specialized in electrical appliances from stone quarrying and working. In this country almost every variety of stone machinery is designed either for electric or steam drive. We have electric-air channelers, electric hoists, and all saws, planers, copers, air-compressors, rubbing beds and polishers can be had with electric drives. As a further means of economy wherever electric power is available, there have lately been perfected electrically driven shovels or draglines for use in stripping overburden preliminary to quarry operations. These are also employed in mining coal, excavating, dredging, reloading coal and coke, making railroad cuts, and similar work.

The advantages arising by the use of the electrically driven shovel and dragline are as follows: lower operating cost, when fuels are scarce, expensive and hard to transport; a fewer number of operators are required; fuel is not an essential; there is no water to supply or freeze; no boiler, or boiler-troubles, no smoke, no sparks, no objectionable noises and more material can be handled.

A complete line of shovel and dragline equipment which meets the especially severe service encounterd in such work, has been resigned by the Westinghouse Company. Simplicity is another feature of the apparatus tending to give it reliability in operation without skilled and frequent attention. Both alternating and direct-current equipments can be furnished. In general, the location of the shovels make alternating-current equipment preferable because alternating current can be transformed more economically, and by using the alternating-current motors the necessity of converting alternating current to direct current is eliminated, resulting in simpler equipment.

The motors are of the wound-rotor type, capable of exerting powerful effort at the instant needed in the cycle of operation. Each motor is mounted on a massive frame with a strong shaft and amply large, well supported bearings of the oil-ring type. The rotating part is of small diameter and consequently has a low flywheel effect, which permits rapid starts, stops and reversals. The motors have few wearing parts and require little attention except for an occasional oiling. The controllers are simple and compact and are designed and arranged that the operator can, by manipulating his master switches, cause the shovel to respond to his very wish and with facility. By means of the protective features of the controllers, the shovel or dragline can be operated at its maximum rate of operation without injury to attendants or equipment and without loss of time. On account of the ease and simplicity of control and the savings in power cost, by the use of these motor-driven shovels and dragline equipment, not only can more material be handled, but more material at a lower cost per cubic yard.

Another newly designed form of electrically operated stone-handling plant is a skip hoist, which consists of a bucket running on inclined or vertical tracks, and hoisted by means of a steel cable attached to an electrically driven drum. The bucket consists merely of a rectangular steel box open at the top and fitted with guide rollers and hoist bale. The bucket is started by a rope attached to the motor controller, or, if preferred, a push button control, such as is used for "inching" with electrically driven printing machinery, can be installed. Automatic control is fitted to the bucket so that it discharges on reaching a given position and returns to the pit. It is possible also to synchronize the movements of the bucket with a filling device, so that as soon as a desired amount of material is loaded the bucket automatically starts. This hoist can be used with a small electric car to move the material a short distance to the loading hopper, or it can be used with a drag line bucket. It is claimed that a 35 cubic feet trolley hopper car on a 130 foot haul, traveling at a speed of 400 feet per minute, can make a round trip in two minutes, including filling and dumping, assuming that the material will flow by gravity into the car. This equals 40 tons per hour for the extreme, or 20 tons per hour for the average haul. A skip consisting of two buckets, one going up whilst the other is coming down, can make a trip in 90 seconds, including filling and dumping. If the buckets are 35 cubic feet capacity each, it would give 28 tons per hour at 50 cubic feet per ton and a 50 foot lift. The 20 cubic feet single bucket skips, on a 50 foot lift at 40 feet per minute, can handle 8 tons per hour, and this size of hoist only requires a 6 horsepower motor. Only one attendant is required to fill the hopper and start the hoist, and where a continuously operating excavator is used, and automatic filling adopted, one man is sufficient to handle even the largest plant.

Mention has been made above of the electrical equipment of the Vermont Marble Company in its quarries at Proctor and West Rutland. This method of operation has been found greatly superior to the use of steam power. In the Vermont quarries there are used in all about 100 electric channellers, including about two dozen of the old double-lever type, which are driven by direct-current motors, whereas the electric air machines are uniformly equipped with 12 horsepower induction motors. These motors have phase-wound rotors and external resistance connected through slip-rings, and are specially adapted for conditions requiring frequent starting under load with a relatively low starting current. In addition to the channelling process, the bottom of the block of marble is perforated by means of gadder drills, the holes being usually driven either along or parallel to the "rift" or natural cleavage lines, thereby rendering it possible to loosen the block by means of levers or wedges. There are 70 electric air drills for this work, operating on the same principle as the electric air channellers, but the drill proper and the motor-driven air compressors are separate portable units connected only by flexible air tubing. The load conditions are not severe, and the compressor is direct geared to a two-speed 5.5 horsepower induction motor. While most of the quarries are open workings, some extend for a considerable distance underground. In the West Rutland Quarry electric lighting is required, and an electric locomotive is used to haul the blocks of marble from the underground working face to the base of a slope hoist, which in turn lifts them to the surface. This engine is operated on 230 volts, direct-current, supplied through a motor generator set to a guarded feeder wire running along one side of the track, about 78 inches from the ground. The ventilating fan in this quarry is also electrically driven, as are also the pumps for lifting the water which accumulates. The hoisting ing motors for the derricks are rated at from 25 to 165 horsepower. More than 20,000 blocks are handled annually, the largest weighing about 55 tons. When the blocks have been hoisted to the surface they are deposited on flat cars and hauled either directly to the mills or to yards, where they are stored for future use.

The blocks are removed from the flat cars by means of electrically operated cranes and transferred to the mills. Direct current motors are used for the storage yard cranes, which are in some cases equipped with five motors, viz., one bridge motor of 35 horsepower, two hoist motors each 30 horsepower, and two trolley motors each 7½ horsepower. The crane has a bridge span of 160 feet and a capacity of 50 tons.

When the blocks of marble are transferred to the mill for sawing, they are delivered to the gang saws by a specially designed trolley-type locomotive crane, which travels on tracks running lengthwise through the mill building between two rows of gangs. The overhead yard crane removes the blocks from the flat cars in the yard and deposits them on a short heavy car, which is in turn placed on the tracks of the small transfer car, which is then moved into the mill by the crane, and the car carrying the blocks is finally run off on to the sawing beds. This crane is equipped with travel, hoist and turning motor, and has also a motor operated winch for pulling the block-carrying cars on to the transfer car after the sawing operation is completed. There are more than 300 electrically operated gang saws in service. In some instance a 6 foot diamond circular saw is employed in cutting and trimming marble slabs. It is provided with two motors, one of 25 horsepower for rotating the saw, and another 3 horsepower unit driving the feeding mechanism. There is also an electric carborundum machine in use for cutting grooves in pieces of marble. The bedplate has a slow reciprocating travel similar to that of a planer, and the adjustable grinding elements are carborundum wheels of various sizes and shapes. As with the saws, it is independently driven, a 20 horsepower induction motor driving both tools and bedplate. About 65 electrically operated rubbing beds are at work in the different shops. The older of these installations consist of groups of five or six machines driven through counter-shafting by 50 horsepower motors. The individual drive system, with its inherent economy, is now largely used for this purpose. In the more recent additions to the shop machinery it is usual to provide a 25 horsepower motor, belt-connected to each pair of rubbing beds. The squirrel-cage type of induction motor was adopted for this work and for practically all finishing shop drives. There are several hundred pneumatic hand tools used in the shops, and the air is supplied to them at from 50 to 60 pounds pressure by motor-driven air compressors. Overhead electric travelling cranes of the usual types are found in both shops and yards.

The flexibility of motor drive is well illustrated in this large installation. It has been clearly proved that the efficiency of the electric system is unaffected by temperature changes, which must always be considered with steam or air lines, and the laying of additional wire or cable to supply current to new machinery or to meet changes of location of any existing machine can be safely, easily and rapidly accomplished without interfering in any way with the operation of the remainder of the quarry equipment. It is found that with individual motor drive the energy consumption of each machine is limited to its period of actual operation, and the generating equipment need only be designed for the average maximum demand of the entire system. With steam or air, however, the boilers or compressors at each quarry would have to maintain full pressure throughout the working day, even at periods of low loads on the machinery or during changing or adjusting tools on individual machines. The conditions in a quarry are not by any means ideal for the operation of motors, due to the difficulty of completely protecting them from moisture, dust, mechanical injury or vibration strains; but the Vermont marble quarries show that enforced stoppage of work due to motor troubles, even of individual units, is exceedingly rare, and that the repair expenses for well-designed open type modern motors, in constant use over long periods, is confined largely to the occasional re-winding of the smaller pump and drill motors. For the larger units it is practically negligible. In this quarry system there are now in service a total of about 570 motors, ranging in capacity from 2 horsepower to 250 horsepower, with an aggregate rating of approximately 14,000 horsepower. Direct-current units are in many cases applied to hoists, cranes and locomotives, and constitute about 25 per cent of the total motor equipment. The remainder are polyphase induction motors, operating at 220, 400, or 2,300 volts on three-phase 60-cycle circuits.

Modern Lighting Awakens French Village

Lieut. Robert Montgomery, of the 140th Infantry, now Town Major of Boncourt, France, formerly commercial manager of the Louisville Gas & Electric Company, writes:

"To-day a French woman came into my office and said 'Monsieur, I would like to have electric lights installed in my house 'tout de suite, s'il vous plait!'

"For a moment I had to pinch myself for I wondered if I was still in a French village or back in the office of the Louisville Gas & Electric Co.

"When I came to this village I noticed a transmission line passed the place so I soon acquired sufficient material to wire my office and my room, after securing permission from the proper authorities. There are 60 officers, 2,000 men and 400 horses billeted in the village and our signal platoon had soon strung wire into the rooms of all the officers, the quarters of the men and some of the stables, so now all of the American forces in the village are provided with Mazda lamps.

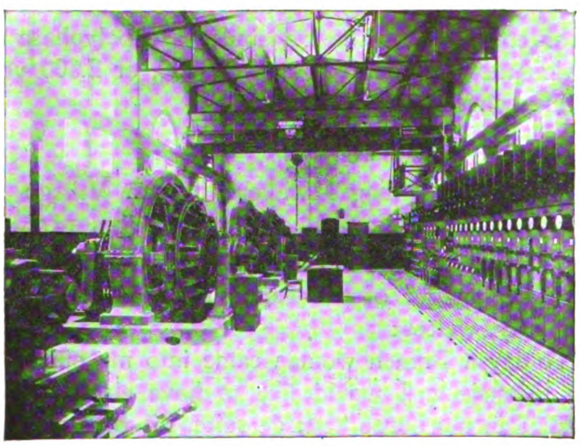
"The old ladies here and there have brought their knitting near the lights in the quarters of our troops, and found they could count the stitches as easily as were the sun shining—folks don't go to bed so early now. The three 40-watt lamps, one at each intersection of the streets, enable one to get about at night without bumping into a jackass or the town pump. There is a big contrast between their 'petrol' and our electric lights.

"Now the old ladies are all coming to see the 'American Major de Zone' concerning the wiring of their homes—and for once I have to turn away electric business as only our temporary lighting can be served from the line.

Railway Converter Substations

By C. E. Lloyd

DIRECT current railway substations are essentially very similar, since they all perform the same general functions, that is, supply power to propel cars and at the same time provide for safety, convenience of operation and economy. Necessarily, various substations differ widely in arrangement in details to best meet various local conditions. Naturally, it is the aim of each and every operating engineer to produce the substation most nearly approaching the ideal for his conditions at a minimum initial cost, to which end the operating engineer and manufacturer must co-operate closely, which will materially reduce the necessity of building special apparatus and incidentally reduce the price of standard apparatus.



Rear View of Westinghouse Substation Switchboard

The rotary converter is generally applicable and preferable to other classes of converting apparatus for railway service, requiring 600 and 1200 volts D. C. This statement is made unreservedly, since the converter has proven its reliability from an operating standpoint while its efficiency, including transformers, is from five to eight per cent better than that of a similar motor generator without transformers. In cases where a motor generator requires transformers, a greater efficiency advantage is obtained from the converter outfit. The railway substation, at least for interurban work, operates at comparatively poor load factor and in consequence a further advantage is gained with the converter outfit, since a greater saving in efficiency maintains at the lighter loads. Practically the only conditions which may preclude the use of the converter are two in number, as follows:

First: Where alternating current feeder line conditions are very poor, having for instance, excessive ohmic drop, severe surges, wide frequency fluctuations, etc., on which synchronous apparatus would probably prove unstable, the induction motor generator is the proper application. Today, this application is rarely met, since a system to be consistently efficient, must afford alternating current lines with comparatively little loss and be comparatively free from frequency variations, surges, etc. The choice in converting apparatus, therefore, usually narrows down to synchronous motor generators, or rotary converters.

Second: Where the line power factor is very poor it may be desirable to raise it with the converting apparatus, operating partially as a condenser. As the rotary converter is purely a unity power factor machine, a separate condenser is required to produce the same results as a synchronous motor generator, having its motor designed to operate partially as a condenser. Where the first cost and efficiency of the motor converter with separate condenser are equal to or better than the first cost and efficiency of a generator, the former is preferable.

The type of transformers selected depends almost entirely upon local requirements. The oil-insulated, self-cooled transformer is most universally used, especially in the smaller sizes, on account of its simplicity, due to its not requiring any additional apparatus for cooling purposes. If water is to be had in sufficient quantity at little or no expense, it may become desirable to use the oil-insulated, water-cooled transformer, except in the smaller sizes, where this type of transformer is more expensive than the self-cooled. In some localities, fire insurance rates are considerably reduced where transformers do not require oil. In cases of this kind, assuming moderate voltages, not to exceed 33,000 volts, the air-blast transformer is used. This type of transformer may also be applicable and desirable in large sizes, from a cost standpoint, even though there is nothing to be gained by lower insurance rates. It is, however, a safe rule to use oil-insulated, self-cooled transformers unless some marked advantage is to be gained, such as lower first cost or reduced insurance rates, by the use of one of the other types.

The phase selected may be dictated by local conditions. However, since the stationery transformer is possibly even more reliable than the rotary converter, there is little to be gained by the use of single phase in preference to three-phase transformers unless the first cost is equal or less. Roughly, in the self-cooled type, there will be a saving in the three-phase transformer in voltages below 33,000 for converters up to 1,000 kw. capacity. Above this size, single phase are practically no more expensive than three-phase transformers and are therefore, recommended. In the oil-insulated, water-cooled and air-blast, the three-phase transformer is always less expensive.

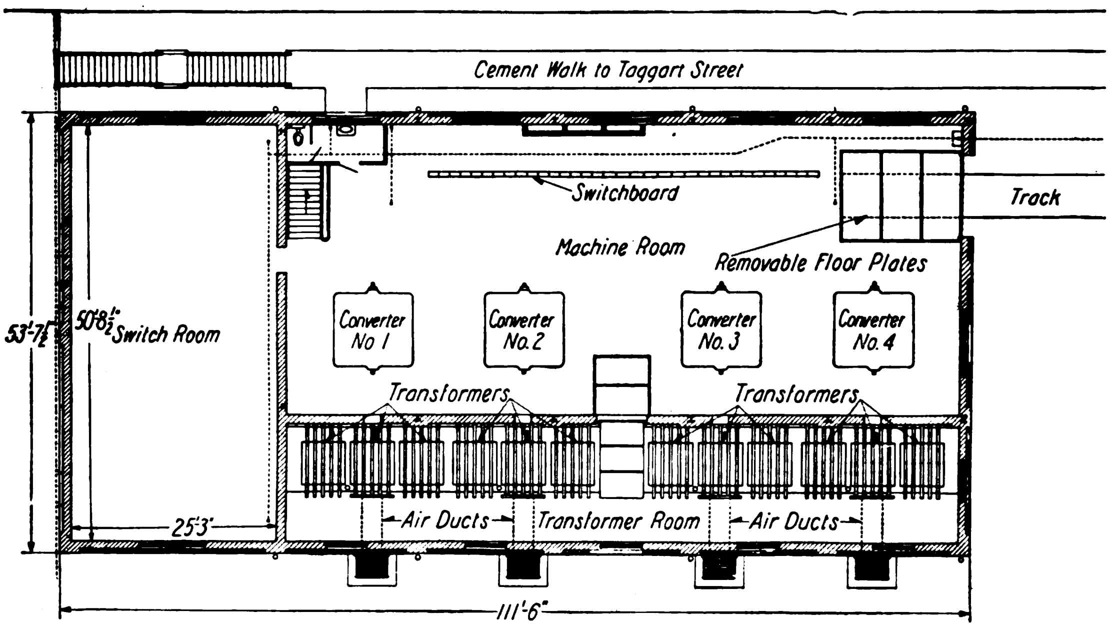
Reactance, either inherent or external to their transformers, is required by compound railway converters for compounding purposes. Transformers with inherent reactance are recommended in preference to those with normal reactance and external reactance coils, primarily due to lower initial cost.

Upon the selection of switching equipment very often depends the success or partial failure of a substation. The switching equipment must be selected with a due regard for maximum simplicity, convenience and reliability. While essentially standard switching equipment is applicable in practically every case, there are very often local conditions which warrant and require additional protective apparatus for the best results. There is no universal rule to follow in the selection of switching equipment. It can only be selected by competent engineers after careful study of individual local conditions.

A. C. circuit breakers must be selected not only of sufficient ampere capacity, but must be capable of rupturing the maximum capacity available under short-circuit conditions. The liability of short-circuit trouble between the high-tension breaker and the low-tension side of the converter is very remote; in fact, so remote that protection for such an occurrence is not recommended. Consequently, the impedence in the converter transformer should be taken into consideration in figuring the current under short-circuit conditions. Assuming, therefore, the standard converter transformer having 15 per cent inherent reactance, the maximum line current that can be taken by a converter operating from this transformer, under short-circuit conditions, will be approximately seven times normal. Therefore, a breaker capable of rupturing seven times normal three-phase line current is recommended for the standard transformer and rotary converter outfit.

D. C. circuit breakers and switches are rated on the basis of the maximum current they will carry for one hour or more, not to exceed temperatures approved by the Underwriters. Since standard converters are rated on the basis of 150 per cent load for two hours the rating of the circuit breakers and switches should correspond to this value. The calibration range of the D. C. breakers should be considered, as it is good practice to set the machine breaker, where automatic, comparatively high, with the feeder breakers set as low as practicable.

A. C. and D. C. meters should be carefully selected to meet the particular application requirements. D.C. ammeter scale equal to the momentary swing capacity of the converter is recommended. It may, however, be desirable to shorten this scale in some cases, in order to obtain better readings on average loads.



Plan of Taggart Street Substation, Pittsburgh Railways Company

Protective devices as follows are recommended for all installations if the best results are to be obtained.

1—A. C. machine breaker with low-voltage release and pallet switch attachment.

2—D. C. machine breaker with low-voltage attachment.

3—Reverse current relay.

4—Reactive factor meter.

5—D. C. feeder breakers.

6—D. C. feeder resistance.

Adjustment of protective devices is recommended as follows:

1 (a) The alternating current machine breaker should be automatic. At least in sizes of 1,000 kw. and below, this breaker should entirely protect the converter from excessive swing loads, and in consequence, should be equipped with an instantaneous

trip. In general, this will require a high setting, it being satisfactory to work at any value within the guaranteed swing capacity of the machine. In sizes larger than mentioned above, applications may require definite time or inverse time limit trip, which may be entirely satisfactory.

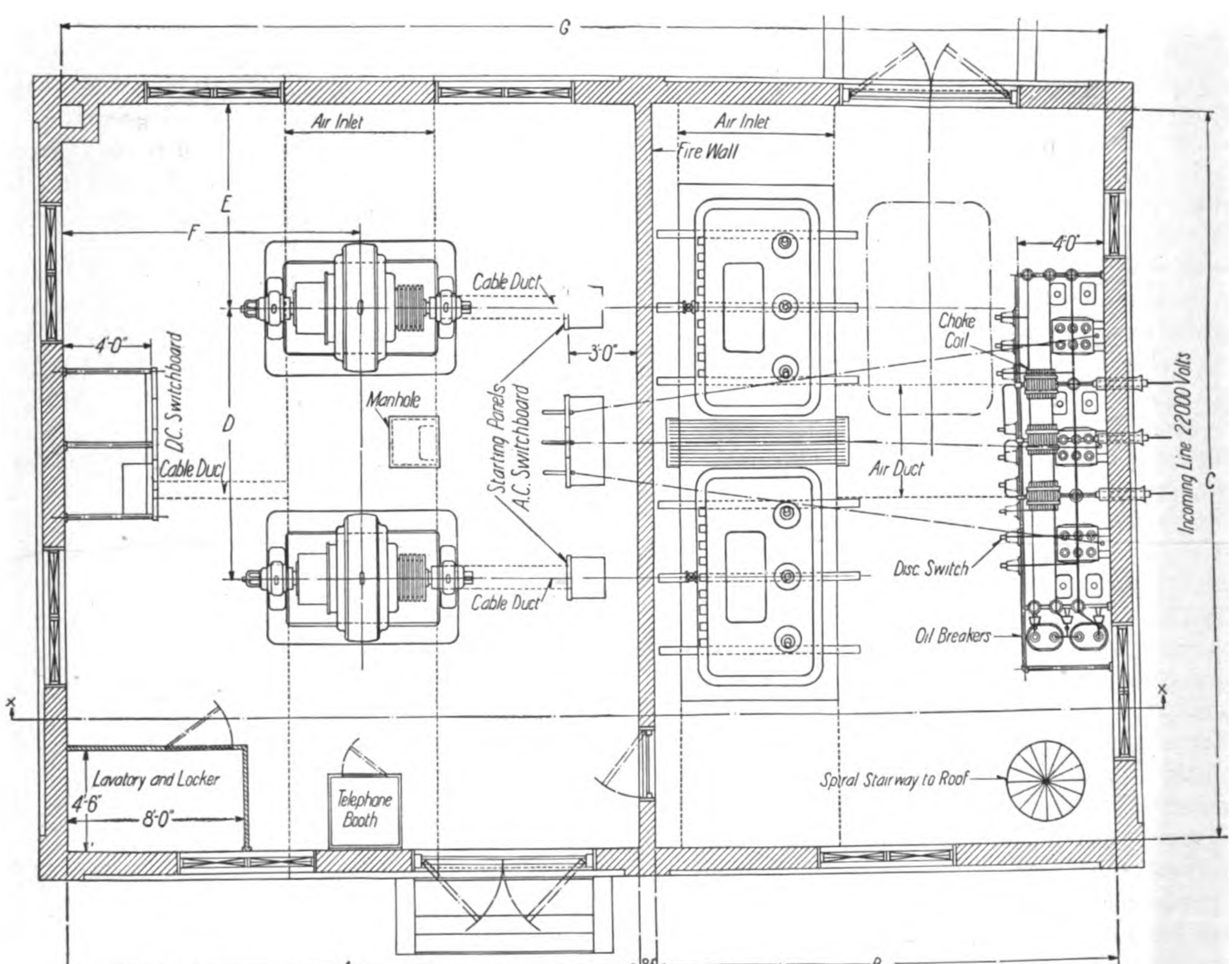
(b) The pallet switch should connect the alternating current and direct current breakers electrically in a manner to cause the direct current breaker to open upon opening the alternating current breaker. The speed limit switch is connected in series with the pallet switch, which also opens the direct current breaker upon operating.

(c) The low-voltage release should be adjusted to operate at as high a voltage as is practicable for the application. It is essential, especially for commutating pole converters, to disconnect them from the line when the alternating current voltage drops an appreciable amount, since the restoration of the normal voltage presents conditions similar to switching the converter from the starting to the running position in starting with its brushes on the commutator, under which condition a flash invariably results.

2. The D. C. machine breaker, at least in sizes of 1,000 kw. and below, should be arranged to insure its remaining closed until opened by the alternating current breaker or speed limit switch. In these cases it is usually the best practice to make the direct current breaker non-automatic and protect from severe overloads by proper alternating current breaker and direct current feeder breaker settings. With the larger railway machines, applications may require automatic direct current machine breakers, which may be entirely satisfactory.

3. The reverse current relay should in general be connected to trip the alternating current breaker, which will in turn open the direct current breaker. With the large machines, applications may warrant tripping the direct current breaker only upon reversal of current, providing it will not be caused by failure of the alternating current source of supply.

4. The reactive factor meter is essential for obtaining proper converter power factor. This is particularly essential, since at normal and overloads, converters must be operated at close to unity power factor. As an illustration, the heating on the tap coals of converters, which are, of course, the limiting parts, is increased by approximately 50 per cent at 97.5 per cent power factor.



PLAN OF SUBSTATION FOR SMALL UNITS

5. The direct current feeder breakers should be automatic instantaneous trip, except where the feeder breaker is equivalent to the direct current machine breaker and the machine is protected from excessive swing load by the alternating current machine breaker. Invariably, synchronous converters will satisfactorily commutate very large momentary currents, providing the direct current machine breaker does not open, while they will flash at no greater currents if the direct current machine breaker opens. It is obvious, therefore, that the low instantaneous overload setting of feeder breakers, where available, thereby obtaining selective action between the feeder and the machine breaker, is productive of good results. This is due to the cushioning effect of the feeders in circuit and prevents the entire load being thrown off the machine instantaneously.

6. Proper direct current feeder resistance is a most important point where short circuits are liable to occur. In this connection it should be remembered that in a case of severe short circuits, the current increases so rapidly compared with the speed at which the breaker opens, that the current values go far beyond the breaker setting. In the case of a short circuit immediately outside the substation, where the feeders are tapped at this point, the current may easily reach five to ten times the normal rated current, assuming the ordinary type of carbon circuit breaker is in use; and this current value will be practically independent of the circuit breaker setting. With circuits subject to frequent and severe shorts, such as in many installations, it is desirable to connect the feeders from the substation to the trolley at some distance, in order to have some resistance between the converter and point of short circuit, even should the short occur directly at the point of feeder trolley connection.

The relation of direct current trolley feeder taps to the source of power, or conversion, is of greater significance than is generally recognized. However, after careful consideration, the benefits to be derived from placing these taps at reasonable distances from the apparatus are readily appreciated, as the reasons are both simple and logical.

It is common knowledge that a rotary converter or direct current generator will "buck" or flash over, if "dead short-circuited" across its positive and negative terminals. Now consider the positive feeders as a continuation of the positive terminal, and the negative return as a continuation of the negative terminal. It is evident that a short circuit near the substation on these feeders (or extended terminals) will cause the converters or generators to flash-over. Now follow the feeders (or extended terminals) a mile, and short circuit them. The chances are, unless the feeders are large, the machines will not flash over.

There has been no change made in the converter, generator or switching devices in either of the above cases, but notwithstanding this, the results have been inconsistent. The answer is simple. In the last case there was no flash-over, the feeders (or extended terminals) having supplied enough reactance and resistance to limit the current required by the short circuit to within the capacity of the machines.

No type of converting apparatus is free from flash-overs, providing the provocation is sufficiently great. There are, of course, other reasons for flash-overs besides "close-in" taps, but at least 75 per cent and perhaps 90 per cent of the flashing nuisance is traceable to this cause. In consequence, producers of electrical railway power owe it to themselves, as well as to the manufacturers of their apparatus, to protect their machines in this simple, inexpensive and fundamental way, in addition to the use of the protective features mentioned above.

The question naturally suggests itself, What rule should be followed in fixing the tap distance from the machines? Unfortunately no general or universal rule or formula has been advanced. So many variables enter into the solution of the problem, that it will prove quicker and more definite to solve each case by removing the "close in" taps until the resistance of the circuit becomes great enough to cushion and protect the machines. The principal variables which enter into the solution of tap distances are as follows:

1. Capacity, or energy, behind the rotary converter. —It is obvious that for a given size of converter, the greater the capacity at the source of generation, the greater will be the damage resulting to the converter in case of trouble, and the nearer the converter and the alternating current capacities agree, the less serious will be the damage resulting from trouble.

2. Capacity of converting apparatus.—The larger the converting apparatus, the less sensitive it is to D. C. line troubles, since, for instance, feeder short circuits are a smaller proportion of its capacity, and therefore the machines are less subject to flash-overs from this cause, at least.

3. Voltage of system.—The lower the voltage of a given system, the nearer the taps may be placed to the machines. In general, on a given system, tap distances for 1200-volt service should be at least twice those of 600-volt service.

4. Size of feeders.—The larger the feeders, the greater the tap distances should be from the machines.

5. Disposition of feeders.—When possible, the distribution of feeders should be such that each will carry a reasonable proportion of the station output; that is, where several feeders originate in one station, no excessive proportion of the station output should be handled over any single feeder. Any trouble on such a feeder reacts on the entire substation and is frequently responsible for flash-overs.

6. Size of rails.—The heavier the rails, obviously, the greater should be the tap distances.

7. Bonding.—Broken bonds and poor ground connections have been known to result in flash-overs.

Such cases, however, are not frequent. Obviously, the bonding has a direct bearing on proper tap distances.

8. Sizes of cars.—It is evident that with a given substation unit, the heavier the car equipment and the larger the motor rating, the greater will be the "drag" on the substation equipment and the more destructive the effects in case of motor troubles. The rating of the car equipment has therefore a bearing on the proper tap distances, especially when the substation units are relatively small, as compared to the motor ratings.

From the foregoing, it will be seen that to evolve a formula to cover such a diversity of conditions would prove itself a problem, and the results, until proven, could not be accepted as much more reliable than a guess. In general, experience has shown that on 600-volt systems the first tap should not be nearer the machine than 2500 feet, and on 1200-volt systems, 5000 feet. Should flashing persist, these distances should be increased until the flashing stops. The line losses due to these tap distances are of little consequence when compared to the loss on account of flash-overs, including the time and expense involved in cleaning up the damaged apparatus. Furthermore, the car equipment is benefited by being worked at a more uniform voltage.

Bonuses for Fire-Room Efficiency

If a fireman is to become an expert in coal economy, it must be worth his while to learn, and worth while for someone higher up to teach him. Rewards for coal-saving are paid by the Charles Pfizer Company, of Brooklyn, according to an ingenious scheme applied by F. S. Jones, works engineer. For the watch engineers, a bonus of 10 per cent of their pay is given, conditioned on the maintenance of an evaporation rate of 8.4 lbs. of water from and at 212 degrees F per pound of coal. This requires that their responsibility for the cleanliness of boiler surfaces, inside and out, shall be taken quite seriously, and that each man should see that the fireman on his watch should maintain his fires in proper condition. The firemans' bonus in turn depends on their maintaining an average CO_2 per cent of 11.6, as shown by analysis of gas drawn continuously during each watch. Coal passers, too, receive a bonus if they keep the firing floor in good order and lose no time. In all cases, a man who cannot or will not earn his bonus regularly is not retained.

The Pfizer plant manufactures chemicals, and hence uses electric power and steam at high and at low pressures. Its boiler plant consists of two 380 horsepower boilers, equipped with Westinghouse underfed stokers and forced draft blower, and eight 150 horsepower hand-fired boilers, of which but two are kept on the line as a stand by when cleaning fires. The new stoker-equipped boilers are served by a coal-conveyor, which later will be extended to serve two additional boilers. Ashes are removed by a dump-bucket run under the boilers on a car whenever the stoker ash-dumps are opened. It is lifted and dumped into a motor truck by an electric hoist. Feed water is taken from deep wells on the premises. Steam at 80 lbs. is used for cooking, and for power in high-speed reciprocating engines. Exhaust steam at 4 lbs. is used for heating and drying. Bituminous run-of-mine coal is burned.

Hydroelectric Power in France

The best estimates place the hydroelectric resources of France at 5,000,000 primary horsepower, and from 4,000,000 to 5,000,000 secondary; the first of these being available the year round, and the second available for six months of the year, writes Consul Tracy Law, from Paris. Of this total, only 750,000 horsepower had been developed in 1913. During the war, on the initiative of the Government, 415,000 additional horsepower was developed rapidly, and at present other projects are under way from which 125,000 horsepower should be realized in 1919, and 225,000 horsepower by 1921. This would carry the total waterpower development to some 1,600,000 horsepower.

At present the steam power employed in France for all purposes is 11,000,000 horsepower, from which it will be seen that ultimately the pressing question of fuel may find its solution in the development of hydroelectric force. The utilization of waterpower is being strongly agitated.

Sicilian Electrical Company Enlarges

A company formed to produce and distribute electricity from water power in the eastern provinces of Sicily has been so successful even during wartimes that it recently decided to enlarge so as to include in its scope the entire Island of Sicily, according to the last bulletin issued by the Italian Bureau of Public Information. The "Societa Elettrica della Sicilia Orientale" was established in 1907, and by 1917 its capital was $3,000,000 and its income $1,000,000. Despite the decrease in industrial development, due to the war, the company was able to declare a dividend of 5 per cent in 1914-15-16, and in 1917 a dividend of 6 per cent. The enlarged scope of the company has necessitated an immediate increase in capital to $6,400,000, and by 1919 the company expects to have a capital of $8,000,000.

Mica from Guatemala

Trade Commissioner W. M. Strachan reports that a good grade of mica has been located in the Department of Quiche. Three or four tons have been shipped to the United States in an experimental way. The workings at present are all at the surface. The mica contains a very low percentage of iron and splits into large sheets.

Central Light and Power Plants

PRELIMINARY figures of the forthcoming quinquennial report on the central electric light and power stations of various states have been given out by Director Sam L. Rogers, of the Bureau of the Census, Department of Commerce. They were prepared under the supervision of Eugene F. Hartley, Chief Statistician for Manufactures. The statistics relate to the years ending December 31, 1917, 1912, and 1907, and cover both commercial and municipal plants. They do not, however, cover electric plants operated by factories, hotels, etc., which generate current for their own consumption; those operated by the Federal Government and state institutions; and those that were idle or in course of construction.

The report shows a pronounced growth in the amount of business done by the electric light and power stations in New Jersey. Their total income in 1917 was $23,480,320, representing an increase of 114.5 per cent since 1912, as compared with an increase of 83.9 per cent during the period 1907-1912. The income from electric service alone in 1917 was $20,188,244, an increase of 90.7 per cent for the later five-year period, as against 79.1 per cent for the earlier. The total output of the stations was 781,230,790 kilowatt hours, an increase of 103.5 per cent between 1912 and 1917, as against 173.2 per cent for the preceding five years. The total expenses, including salaries and wages, amounted to $18,760,138, an increase of 100.7 per cent for the period 1912-1917, as compared with 103.3 per cent for the preceding five years. The relative increase in the amount of current generated was greater at each of the five-year periods than the increase in the income for electric service or in that for the total expenses. The stations employed 5,065 persons, to whom were paid salaries and wages aggregating $4,821,852. The rates of increase in the number of persons employed were 69.5 per cent for the period 1912-1917 and 69.9 per cent for the preceding five years, but the rates of increase in salaries and wages were considerably greater—94.5 per cent and 80.9 per cent for the later and earlier periods, respectively. The total primary horsepower, 96 per cent of which was derived from steam engines, was 367,743 in 1917, an increase of 53.5 per cent during the period 1912-1917, as against 155.9 per cent for the preceding five years. The kilowatt capacity of the dynamos was 249,521, an increase of 39 per cent between 1912 and 1917, compared with 154.3 per cent between 1907 and 1912. The horsepower of the stationary motors served was 262,858, an increase of 209.2 per cent over 1912, as against 208 per cent for the preceding five years. As in the cases of most of the States, the number of arc lamps used for street lighting shows a decrease, while a pronounced increase appears in incandescent lamps.

The figures for Oregon are fairly comparable for 1912 and 1917. The decreases shown for the period 1907-1912 are due mainly to the fact that certain establishments reported as central electric light and power stations for 1907 were later taken over by electric railways and were therefore reported with them for 1912 and 1917. From 1912 to 1917 the total income increased by $1,154,594, or 81.2 per cent; the expenses, by $1,070,431, or 88.8 per cent; the horsepower, by 22,691, or 49.3 per cent; the kilowatt capacity of the dynamos, by 15,501, or 47.8 per cent; and the output of stations, by 49,097,631 kilowatt hours, or 83.5 per cent. As in the cases of practically all the states, the use of arc lamps for street lighting shows a pronounced decrease.

The actual increases shown for Nebraska from 1912 to 1917 are in excess of the large increases for the prior five-year period. The remarkable addition of 76 plants from 1907 to 1912 was exceeded in the later period, when 154 new stations were added, 85 commercial and 69 municipal. The actual gain, however, was only 123, because of combinations in single reports of a number of plants reported separately in 1912. The total income in 1917 was $4,860,874, an increase of 73.4 per cent over $2,802,614 in 1912. In 1917 the expenses were $3,911,923, compared with $2,239,542 in 1912, the relative increases being 74.7 per cent from 1912 to 1917 and 93.4 for the preceding five-year period. In 1917 there was a total of 112,-103 horsepower, compared with 52,168 in 1912, the proportionate gains being 114.9 per cent from 1912 to 1917 and 73.8 per cent from 1907 to 1912. Steam formed 79.5 per cent in 1917 and 81.4 per cent in 1912 of the total power reported. The dynamos show an increase in capacity from 34,586 kilowatts in 1912 to 78,227 kilowatts in 1917, or 126.2 per cent. The output of stations increased from 56,299,682 kilowatt hours in 1912 to 129,531,131 kilowatt hours in 1917, or 130.1 per cent, compared with 76.2 per cent from 1907 to 1912. The number of arc street lamps decreased from 2,451 in 1912 to only 178 in 1917. On the other hand, the number of incandescents, etc., increased from 12,149 to 27,752, or 128.4 per cent.

The figures presented for Florida show that the increases from 1907 to 1912 have continued during the later five-year period. There was a remarkable increase of 40 in the number of new establishments in the state since 1912, 28 commercial and 12 municipal, although, by reason of the combinations in single reports of a number of plants that reported separately in 1912, there was a net gain of only 32 in number of stations from 1912 to 1917. The total income in 1917 was $2,376,908, almost wholly for electric service, representing a gain of 74.6 per cent since 1912, while the total expenses were $1,684,599, an increase of 60 per cent. The corresponding increases from 1907 to 1912 were 108.1 and 119 per cent, respectively. In 1917 the total horsepower, of which 86.7 per cent was steam, was 58,195, a gain of 72 per cent since 1912. During the same period the kilowatt capacity of the dynamos increased from 23,619 to 37,812, or 60.1 per cent. The output of stations in 1917 was 50,887,992 kilowatt hours, compared with 25,895,751 in 1912, and the relative gains for the two five-year periods were 96.5 per cent and 120.1 per cent, respectively. From 1912 to 1917 there was a slight increase (3 per cent) in the number of arc street lamps, compared with 165.6 per cent for the incandescent and other varieties.

The figures presented for Kentucky show increases in practically all items from census to census. The increase of 36 in the total number of establishments shown for the later five-year period is not truly representative, since 23 establishments that reported separately in 1912 were included in combined reports in 1917, while 60 new plants have been added since 1912. In 1917 the total income, almost wholly for electric service, was $4,436,445, compared with $2,754,115 in 1912, an increase of 61.1 per cent; from 1907 to 1912 the percentage of increase was 65.8. The total expenses in 1917 were $3,531,547, an increase of 57.3 per cent since 1912; the increase from 1907 to 1912 was 74.3 per cent. The total horsepower, nearly all steam, increased from 41,984 in 1907 to 87,767 in 1912 and to 98,752 in 1917, the rates of increase being 94.8 per cent and 20.8 per cent, respectively. The increase in the kilowatt capacity of the dynamos kept pace with that in horsepower. In 1917 the capacity of the dynamos was 69,442 kilowatts; in 1912, 54,062; and in 1907, 29,140; the increase amounting to 28.4 per cent and 85.5 per cent for the later and the earlier five-year periods, respectively. The output of the stations in 1917 was 122,630,433 kilowatt hours, compared with 75,593,179 in 1912, an increase of 62.2 per cent. The number of arc street lamps decreased from 7,332 in 1912 to 6,757 in 1917, or 7.8 per cent, while the incandescent street lamps increased from 5,278 to 10,890, or 106.3 per cent.

The figures for Tennessee show that the actual increases, although large from 1907 to 1912, were much greater for the later five-year period; so also were the proportionate increases in most particulars. From 1907 to 1912 the number of stations increased from 78 to 90, while in 1917 there were 106 plants. Thirty-one new plants have been added since 1912, but a number of those that reported separately in 1912 were merged into combinations before 1917. The income in 1917, practically all for electric service, was $4,937,285, an increase of 101.7 per cent over $2,448,218 in 1912. In 1917 the total expenses were $4,436,698, compared with $1,753,875, the relative increases for the five-year periods 1912-1917 and 1907-1912 being 153 per cent and 98.7 per cent, respectively. The total horsepower was 201,912 in 1917, compared with 68,994 in 1912, or an increase of 192.7 per cent. In 1917, waterpower formed 65.2 per cent of the total, compared with 40.2 per cent in 1912, having increased from 1,240 horsepower in 1907 to 27,750 in 1912 and to 131,652 in 1917. The dynamo capacity of the stations increased from 49,640 kilowatts in 1912 to 145,335 in 1917, or 192.8 per cent. The output of stations in 1917 was 564,914,272 kilowatt hours, and in 1912, 75,544,893 kilowatt hours, an increase of 647.8 per cent, compared with a gain of 116.8 per cent from 1907 to 1912. The number of arc street lamps decreased from 3,938 in 1912 to 2,861 in 1917, or 27.4 per cent, while the incandescents, etc., increased from 6,732 to 15,099, or 124.3 per cent.

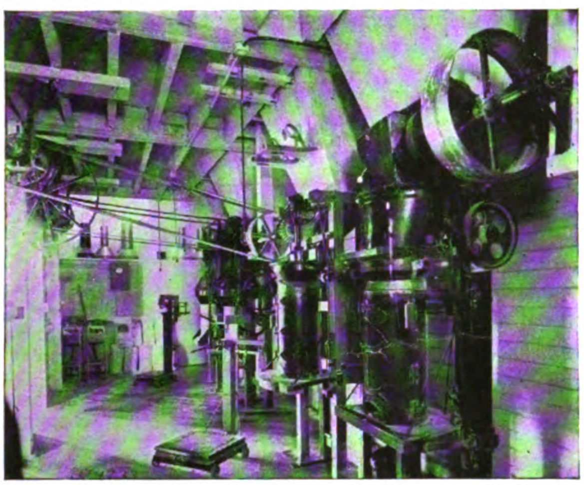
Large increases are shown in substantially all items in Oklahoma for both five-year periods covered by the table, but the increases from 1912 to 1917 are in most cases proportionally less than those for the preceding five years. The number of stations increased from 130 in 1912 to 201 in 1917. The actual number of new establishments added since 1912 was 83, of which 43 were commercial and 40 municipal; but, as the result of a number of combinations in the commercial systems and of various other changes, an increase of only 71 establishments, 43 of which are municipal, is shown by the figures. In 1917 the total income, 97.8 per cent of which was for electric service, amounted to $4,306,782, the percentages of increase being 82.6 and 113.1 for the periods 1912-17 and 1907-12, respectively. The total expenses in 1917 were $3,541,443, the percentages of increase for the later and earlier five-year periods being 87.5 and 84.1, respectively. The total horsepower in 1917 was 80,997, an increase of 50.2 per cent as compared with 1912, and during the preceding five years the rate of increase was 138.4 per cent. Although steam supplied the greater part of the horsepower in 1917, the figures show a very great proportional gain in the power derived from internal-combustion engines—from 200 horsepower in 1907 to 5,966 in 1912 and to 12,860 in 1917. The total dynamo capacity, 57,783 kilowatts in 1917, shows an increase of 50.9 per cent as compared with 1912, the rate of increase during the preceding five-year period being 147.1 per cent. The output of current generated in 1917 was 100,737,632 kilowatt hours, representing an increase of 106.3 per cent over 1912, as against 95.4 per cent for the period 1907-12. The number of arc street lamps decreased from 3,303 in 1912 to 1,925 in 1917, or by 41.7 per cent, while the incandescent lamps increased in number from 8,334 to 13,763, or by 65.1 per cent.

Western States Company Shows Large Increase

During the year 1918 the Stockton, Cal., division of the Western States Gas & Electric Company added 1,090 electric consumers to its lines. There was an increase of 7,063 horsepower in connected load, of which 5,339 horsepower represents the increased load in motors.

Electric Power in a Flour Mill

THE Pasco Flour Mill Company, organized in 1916, at Pasco, Wash., attribute their great success, which has come in a comparatively short time, to the fact that its officers have been closely identified with the flour milling and grain business of the Pacific Northwest for the past thirty years, and to the wisdom of locating the mill at Pasco. It is in the heart of the best milling wheat-producing district of Washington and Oregon, with unexcelled transportation facilities. Wheat of the proper varieties and grades can be secured readily to make the various grades of flour demanded by the different sections of the entire country. The soft white wheat for making flour so much demanded in the southeastern and southern states, and the strong variety for the Pacific Coast and California territory, can be secured at all times on account of the splendid location of the Plant. The location is also favorable for the distribution of the mill's products to all markets.



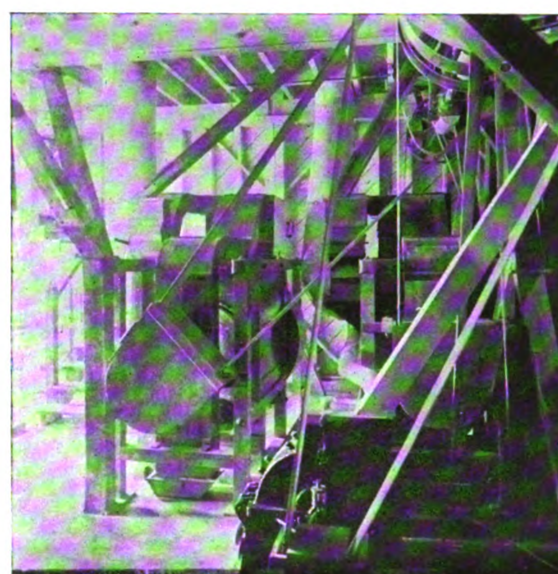
FLOUR AND WHEAT PACKERS
Electrically operated devices in a Pacific Coast flour mill recently completed

Soon after the organization of the Pasco Company, plans for the plant were submitted, and actual construction was immediately begun. The plans anticipated a two-unit flour mill with ample warehouse and elevator facilities for a 1,000-barrel plant. At the beginning it was planned to install only one unit at a time, and to operate only the first unit until increased business called for additional capacity; but the first season being an exceptional one, the second unit was begun soon after the completion of the first, so that by February 1, 1917, the entire capacity of the mill was in full operation, day and night. All motors are equipped with the latest safety appliances to insure absolute safety in operation and eliminate all hazards from fire. Eight Westinghouse motors, ranging in size from 2 h.p. to 100 h.p., drive the machinery for the entire mill. The wiring for both power and light is in metal conduits.

The rolls, sifters and purifiers of the first unit are of the Barnard and Leas Manufacturing Company, of Moline, Ill.; the second unit being equipped by Nordyke & Marmon, of Indianapolis, Ind. The cleaning machinery consists of two Printz & Rau separators and two Monitor scourers, manufactured by the Huntley Manufacturing Company, of Silver Creek, N. Y., and the latest improved Wolf Dawson wheat washer, manufactured by the Wolf Company, of Chambersburg, Pa.

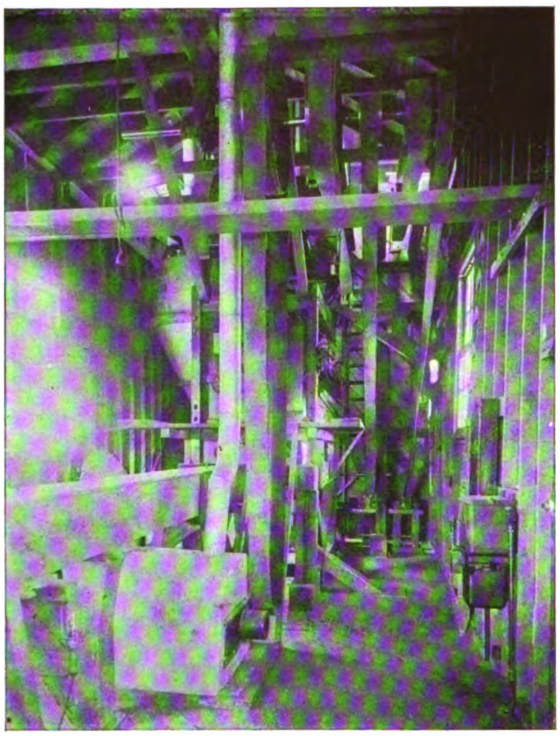
In the so-called wheat end of the mill, five stands of elevators with a capacity of 175 bushels, a Printz & Rau separator, one 16 ft. 9 in. conveyor, two Monitor scourers with a capacity of 200 bushels, one Williams grinder, one Wolf Dawson scourer with a capacity of 175 bushels and one 9 in. dampening conveyor and blender are operated by a 40-h.p. slip-ring CW Westinghouse motor.

The wheat received for milling is handled directly from the cars to the elevators, while the transfer of wheat and flour to the warehouse is accomplished by electrically driven portable elevators. An unusual scheme is used to move cars on the switch, back and forth to different loading and unloading doors in the warehouse. A counter-shaft extension from the main shaft in the mill has a steel drum attached to the end that projects to the platform. Attached to this drum is a $1\frac{1}{4}$-in. rope which is hooked to the car intended for moving. The direction of the pull from the drum is made by changing the wind of the rope on the drum.



SEPARATORS, ELEVATORS AND CONVEYORS
Operated by a 15 hp. CS type Westinghouse motor, in the Pasco mill

This scheme has increased the unloading capacity from four cars to six cars per day. One 40-h.p., 440-volt, 3-phase, 60-cycle, 1,700-r.p.m. Westinghouse type CS motor, with complete starter, overload, and no voltage release, drives the main shaft. Connected to this shaft is a three-ton-per-hour steam barley roll with a cleaner and three elevators. From the same drum described above, a power scoop is operated in unloading cars of bulk wheat into the bulk elevator hopper, unloading 1,200 bushels per hour. Two men using the scoop do the work of six scooping by hand, and the cars are thoroughly emptied. It is also planned to use the same motor to drive the belt conveyor from the warehouse to the bulk elevator hopper, and thus save the labor and



SCOURERS AND GRINDERS IN A FLOUR MILL
Part of the equipment of the Pasco plant operated by a 40 hp. Westinghouse motor

expense of trucking sacks of wheat there for storage. This will save two cutters (men who open the sacks and pour the wheat into the hopper) and four truckers.

The wheat is conveyed from the elevator to the mill to be converted (by the various machines) into flour by one 36 ft. 9 in. conveyor, operated by a 3-h.p. type CS Westinghouse motor 1,155 r.p.m. The plant is steam-heated from a 60-h.p. high-pressure boiler, which also furnishes heat for the office and warehouse.

When the company began to operate, all the piling of loaded wheat sacks or even empties was done by man power, using a block and tackle. The same method was also used to unload wheat from the cars to the warehouse. Since then they have installed a piling machine which piles any size sacks of flour from 24 to 140 pounds. This machine is of steel construction and can pile as high as 16 feet. Four men (one man on the pile and three truckers) can pile 800 barrels or 140 jutes in four hours with this piling machine. By the old operation it would take six men approximately ten hours to do the same work. This machine is operated by 1/3-h.p. type Westinghouse motor, speed 440 volts, 60 cycle, 3 phase, 1,130 r.p.m.

A reference is made to one more example to show how thoroughly the Pasco Mill is equipped with modern, up-to-date machinery. A McCahey Sure Count Truck Counter, manufactured by the J. J. Ross Milling Company, is installed in the floor of the warehouse entrance and is used to count the sacked wheat and flour coming into and going out of the warehouse. The truck on entering or leaving the warehouse runs over this counter, pressing a rod which is connected to an indicator, thus registering the load. This saves time and insures accuracy.

The Pasco Flour Mills Company has a very wide market for their product, and at present they are shipping to all parts of the United States. The field covers the Atlantic coast including Boston, New York, Philadelphia, Atlanta and Savannah; the Gulf of Mexico, New Orleans and Galveston. In the west they ship to Southern California and Northern Washington.

Hydroelectric Plant at Shawinigan Falls

A project is on foot in Quebec for a new railroad to run from St. Felicien to the Ungava region, reaching a number of large lakes near Hudson Bay. This district is rich in minerals and timber. In reporting on the plan, Consul E. Verne Richardson, of Quebec, says that there are many important water powers that may be developed. He recalls that the largest privately owned hydroelectric installation in all Canada is, according to official reports, in the Quebec consular district, not 100 miles from Quebec city, at Shawinigan Falls. This plant carries a load of 205,000 horsepower, supplies 76 distribution systems and serves triangular area with a base of 140 miles and a depth of 75 miles. The head of water at Grande Mere, Shawinigan, is 83 feet. This single instance of hydroelectric enterprise is mentioned as showing what may be done along the streams of the Ungava district, where the elevation is, at many points, from 1,000 to 2,000 feet above sea level, and where there are undoubtedly natural falls readily susceptible of conversion to industrial uses. That a great height of fall is not essential to economic success is proved at Cedars, Quebec, where one of the largest power plants in the Dominion is operating with a water head of but 30 feet.

Municipal Plant Forced to Raise Rates

The United States Reclamation Service, which has been supplying electricity to Williston, N. D., has submitted a new contract for acceptance by the city, 25 per cent higher than the rates paid heretofore. The city must either pay the increased rates or do without electricity.

Static Interference and the Wireless

ROY A. WEAGANT, Chief Engineer of the Marconi Wireless Telegraph Company of America, presented a technical paper describing his discovery of a new law of Nature and inventions relating to the elimination of static interferences in wireless communication before a special joint meeting of the Institute of Radio Engineers and the New York Electrical Society. The meeting was held March 5 in the large auditorium of the Engineering Societies Building, 29 West Thirty-ninth Street, New York. Among those present were many well-known experts in the art of radio communication and others prominent in the development of electrical communication.

Mr. Weagant's paper was entitled "Reception Through Strays and Interference." It was a highly scientific treatment of the subject, covering in detail methods and electrical circuits invented by him and employed by the Marconi Company at its various long-distance wireless plants located in the United States.

Reviewing the conditions which prevailed in wireless communication prior to his inventions, Mr. Weagant said: "Since the birth of wireless telegraphy serious difficulty in reception has existed, due to natural electrical disturbances. These disturbances commonly called 'static,' 'atmospherics' or 'strays,' produced in the receiving telephones cracking noises, which often drowned out the incoming wireless signals.

"As the distance over which wireless telegraphy was worked increased, it became necessary to use longer wave lengths. This increased the troubles resulting from static so that in the case of more important long-distance circuits, such as those operating between Europe and the United States, static caused such great interruptions to the service that the continuity of communication compared unfavorably with that of cable working.

"An idea of the magnitude of the problem that existed," he explained, "may be gathered from the fact that during the summer months, the energy collected from static at wireless receiving stations was often more than a thousand times as great as that of a normal wireless signals received at the same station."

Describing the natural phenomena surrounding static disturbances, Mr. Weagant said: "It was found that static disturbances were most severe in summer and less troublesome in winter; also that they displayed a daily variation in intensity, being at minimum between sunrise and noon and increasing very rapidly to a maximum about sunset; from then on remaining practically constant until shortly before sunrise, when the intensity fell off very sharply to a minimum again."

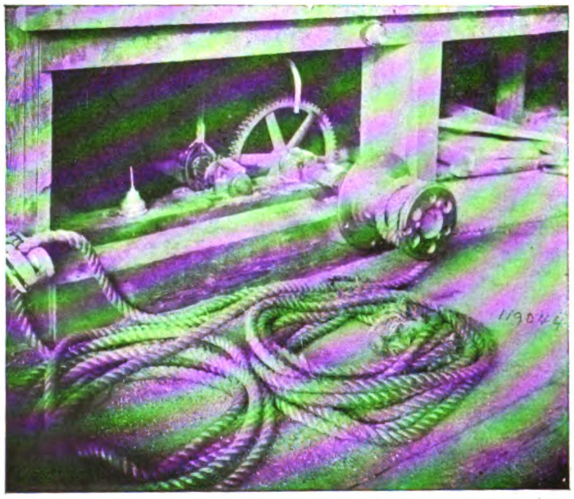
He noted that accumulated experience had shown these static disturbances to be more severe in locations near or in the Tropics than in the Temporate or Frigid Zones; also that at any given location they vary from day to day, somewhat in accordance with the variation of temperature, being greater on warm days and less on cold days.

Mr. Weagant called attention to the vast amount of study that had been given by many leading scientists and experts to the nature and origin of these static disturbances and also referred to the innumerable attempts made to secure methods of reducing or eliminating their deadening effects at wireless receiving stations. Of his own investigations, he said: "So far as I am aware, no success of a major order was obtained with any of these attempted methods prior to my inventions and work in this field."

That portion of Mr. Weagant's paper which dealt with his discovery of a new law of Nature secured the closest attention of the scientists present. Stripped of its technical phraseology, this discovery may be described as follows:

Since the inception of the wireless art, "static" has persisted in dominating the wireless signals, forcing itself upon the radio receiving instruments with such strength that frequently the signal was completely submerged and only the static could be heard. All prior attempts to minimize the crashes of static had likewise minimized the buzz of the telegraph signal, thus producing the same net result on the human ear and offering no advance in the perfection of communication. For years, investigators in this field had considered the characteristics of the signal wave and the static wave to be the same. But Mr. Weagant held an opposite view, believing that a difference existed between the signal and static waves. He realized that once the difference could be determined and defined, engineering methods of taking advantage of this difference could be devised. The discovery of this difference was the gigantic problem.

Unremitting study, investigation and experimenting



DEVICE FOR MOVING CARS ON A SWITCH
Drum attached to counter shaft extension electrically driven, in the Pasco plant

led Weagant to the solution, which followed his discovery that static waves, instead of moving horizontally in space as do the wireless signal waves, actually move in a vertical direction, from a source either overhead or underfoot. With the determination that the static waves propagate at right angles to the direction of wireless signal waves, he had found the much looked for point of difference; the new electrical principle; the discovery of a new law of Nature.

The next step required devising means for taking advantage of the discovery. To overcome the static interference, Weagant invented a new type of antenna or aerial wire, for the reception of electromagnetic waves which, at one stroke, did away with the need for the huge steel masts or towers formerly used at all wireless stations. The Weagant type of antenna is placed but a few feet above the ground and consists of two rectangular loops of wire, separated, but in alignment with each other.

The static waves originating overhead and moving earthward, reach both loops simultaneously, while the signal waves, traveling horizontally from a given direction, set into vibration, first, the loop nearest the direction from which the message is coming; and then actuates the second loop. In other words, the static waves arrive at both aerials at the same instant, while the signal waves arrive at the two aerials at different times.

This method of operation sets up in both loops static currents which are in phase or in step with each other, while the signal currents set up are out of phase. By a proper arrangement of electrical circuits in the receiving instruments, located between the two aerial loops, the in-phase static currents are balanced out, or cancelled; while the out-of-phase signal currents combine and remain in the circuits operating the wireless receivers which record the incoming messages.

In summary of his paper, Mr. Weagant said: "Continued use has established beyond question that the performance of my system is not occasional or accidental but is reliable and consistent. With the new system of reception, trans-Atlantic radio telegraphy can now be carried on free from interruptions caused by 'static' of any kind whatsoever, excepting only local lightning. Since the cables are also interrupted by local lightning, it follows that continuity of communication equal to that of cable operation is now possible by radio telegraphy. Wireless has the further advantages of cheapness and greater speed of operations."

Referring to the future of wireless telephone, Mr. Weagant stated: "The great barrier in the way of practical and successful radio telephony has also been removed for 'static' has interfered with wireless telephony to a much greater extent than with radio telegraphy."

Describing the appearance of his new receiving system, Mr. Weagant said: "It is pleasing to be able to state that arrangements have been perfected which are of such small dimensions that the entire equipment, including aerials, can be readily mounted on this lecture platform and receive radio messages from across the ocean."

Commenting upon Mr. Weagant's paper, Mr. David Sarnoff, commercial manager of the Marconi Wireless Company of America, writes as follows:

"Some time ago I asked Mr. Weagant to tell me, if he could, the particular thought or idea responsible for his faith in the ultimate solution of the static problem. I asked the question specifically because of the apparent disbelief of so many others that a real solution of this vexatious problem could be obtained.

"In answer to my question, Mr. Weagant stated that he had always considered Nature reasonable and logical; it followed, therefore, that it would not, on the one hand, bestow upon mankind a boon, such as electrical communication through space; and, on the other hand, place in its way a deadly barrier, such as static has been, without offering means of nullifying it and obtaining the full advantages that space communication offers to the world. It was this implicit faith in the justice of Mother Nature which spurred Mr. Weagant on in his determination to master the disturbing elements. The task has, perhaps, helped to add a few gray hairs to his otherwise young head. He told you himself how he reached his goal, and I merely wish to call attention to the original inspiration and conviction characteristic of the man.

"In my judgment, the elimination of static interference marks the most important practical advance in the radio art since Marconi's original invention. International radio telegraph communication, a child of the past, will now grow rapidly to sturdy manhood. Radio telephony over long distances and across the oceans—impracticable heretofore—is now in full view, and commercial wireless telephone service between the United States and Europe may confidently be expected.

"Think what this means! Electric signaling, now more than three score years old, has not provided means for talking to our friends across the great oceans. Whatever we had to say, others said for us by telegraph code. And now, for the first time in the history of electrical science, the spoken word may be uttered by us in our own language and heard by the desired ears across the oceans. Gentlemen, I predict that transoceanic radio telephony will in time revolutionize international, business, diplomatic and social intercourse in the same way that the Bell telephone revolutionized our daily affairs on this continent.

"Mr. Weagant made reference in his paper to the possibility of conducting long-distance wireless communication with less power at the transmitter than is now generally employed. This, it seems to me, should logically follow as one of the results of his great invention, and one is now justified in expecting that, before long, communication across the Atlantic may be carried on successfully with transmitters of, say roughly, fifty kilowatts, or perhaps less, and receivers of the compact type described by Mr. Weagant.

"Nothing brings nations and peoples closer together than reliable, rapid and cheap communication, and wireless now promises to be the International Courier fulfilling these three vital requirements. The present high cable rates between widely separated countries has limited the amount of news or press matter exchanged between the United States and such countries as, for example, China, Japan and Australia. The mail service is, of course, too slow to record important events.

"With the elimination of static interference and the possibility of reduced power at the transmitters, it is conceivable to me, and no doubt to many others, that two or three long-distance transmitting stations, located in the most important and suitable parts of the world, could be devoted to the exclusive transmission of daily news or press matter, broadcasted to all the countries, where, with the use of the proper receiving system, the broadcast messages could be received by all and published in the press of the world.

"Cable companies and the interests they represent have long made use of their favorite argument that communication by wireless is not secret, whereas by cables it is. Of course, I need not tell practical men that no system of communication is really secret; but the very fact that several transmitting stations can simultaneously communicate with the entire world, gives to wireless an advantage that the cables never had and never can possess."

Instructions for Electric Welding

The British Board of Trade has now published for official use an instruction to surveyors of vessels on the subject of making repairs to the boilers of passenger steamers by the electric or oxyacetylene processes. The instructions are given below:

The repairing of the boilers of passenger steamers by the above processes has been tentatively in operation for a considerable period and, in view of the experience gained, the surveyors are informed that, provided the work is carried out to their satisfaction by experienced workmen, these processes may be employed, within limits, for repairing cracks in furnaces, combustion chambers and end plates of boilers, and in the same parts for reinforcing the landing edges of leaky riveted seams which have become reduced by repeated chipping and calking.

In some old furnaces which have been repaired by the above processes it has been found that, after a few months' working, cracks have again developed at parts adjacent to those welded; probably owing to the original material of the furnace having become fatigued and worn out by long and severe usage. In dealing with old furnaces therefore, this fact should be taken into consideration.

It has also been brought to the notice of the board of trade that a shell plate of a cylindrical marine boiler cracked recently through a solid part where some surface welding had been done by the electrical process two years ago. The welding had extended for a length of about 12 inches along the outside calking edge of one of the middle circumferential seams at the bottom of the boiler, the leaky edge of the seam and the adjoining shell plate having been covered (soldered) by metal deposited by this process in the usual way. The shell plate was 1 5/32 inches thick and the crack, which followed the line of surface welding, extended in a circumferential direction for a distance of 2 feet 9 inches, the welded part being situated midway along the crack.

For the present it is not proposed to prohibit, within limits, the reinforcement of the circumferential seams of boiler shells if the end plates are well stayed but no welding should be done to these parts by any process which may cause local heating over an appreciable area of the plate, such as the oxyacetylene, oxyhydrogen, or other similar methods.

In no circumstance should any part of a boiler of a passenger vessel be welded if wholly in tension under working conditions, such as a stay or the shell plate at a longitudinal seam, the failure of which by cracking at the welded part might lead to disastrous results.

In any case in which the proposed repairs to the boilers of passenger vessels by either of the above processes are of an uncommon or unusually extensive character, the particulars should be submitted for the board's consideration and approval.

After repairs by welding have been completed, the parts at or adjacent to the welds should in all cases be well hammer tested; and, unless the welding is of a trifling character, a hydraulic test of not less than one and a half times the working pressure should be applied to the boiler after the hammer testing has been effected.

Saving Electricity in Amsterdam

The non-arrival of British and German coal in the Netherlands has made an acute shortage of fuel, and measures to reduce consumption have been adopted. The city of Amsterdam put into force on January 6 the following regulations, with a view to saving electricity: Cafes, restaurants, shops, and stores will be allowed to use only half as much electricity as they have been allowed since October 30 last. Private residences will have to reduce the use of electricity to 65 per cent of the amount used in November, 1918. All factories, etc., will also have to reduce their consumption of electricity to 65 per cent; furthermore, they may not use any electricity whatever for industrial purposes between 4 P. M. and 10 P. M. This restriction in hours does not apply to factories engaged in the preparation or manufacture of foodstuffs; such factories may recommence the use of electricity at 6 P. M., and the amount of electricity which they may use will be determined by the State Coal Bureau.

Electrical Goods in China

THOSE who have never been to China are likely to think of this nation of ancient civilization as it was presented to them in their school geography. They have not comprehended a change in other parts of the world similar to that in our own. As a matter of fact, however, there has been a gradual development in that country due to more intimate contact with foreign civilization, to better transportation facilities, and to a slowly increasing earning power.

In the sale of electrical goods, prime movers; machinery, propellers (as boilers, turbines, etc.), the pre-war years showed the imports from the United Kingdom to represent 65 per cent of the total, while the direct imports classified under "electrical materials and fittings" showed that less than 8 per cent came from the United States.

The people of China have shown a progressive tendency and with its great population and increasing purchasing power, an increase of a very small percentage of the people will make a large aggregate. As an instance, it is shown that one per cent of the population aggregates three times the population of New Zealand alone. Not only do the numerous wealthy merchants and officials appreciate modern conveniences and comforts, but as one passes along the streets where electricity is available he is struck by the number of small shops that have electric lighting. Not only this, but they appear over rather than under lighted, showing they are liberal consumers. The strong present market lies in the furnishing of apparatus and materials for new stations. This market is being developed faster than one would expect.

While a fair volume of electrical trade is possible now, the great volume of trade with China will come with the greater development of the country; this will increase purchasing power, which will result in a more extended use of electrical service. Combined with earning power, education will also result better living and everything that goes to make up higher standard of living.

Those who wish to meet success in entering this market must bear in mind that first of all they must arrange for proper representation; that, secondly, they must have goods adapted to the needs of the Chinese under existing standards; and that they will find it a great advantage if their representatives in China are able to extend moderate terms of credit to native companies that may buy central station apparatus and materials. American goods have a good name and the United States as a nation stands well with the Chinese. If American electrical manufacturers are willing to cultivate the market in a broadminded, thorough manner, China affords an export market almost as rich in its potentialities as all of South America. It is relatively a small market to-day, but, and this may be advantage, a great one to-morrow.

This information, together with an interesting description of the climate and living conditions; language and educational facilities; postal and transportation facilities, agriculture, mining and timber resources; manufacturing industries and a complete account of the electrical industry is given in a bound illustrated monograph, comprising over one hundred pages, issued by the Bureau of Foreign and Domestic Commerce under the title "Electrical Goods in China, Japan, and Vladivostok," written by R. A. Lundquist, Trade Commissioner of the Bureau, who was sent to those countries by the Government for the purposes of making a thorough investigation at first hand.

From this account we learn the two main amusements of the Chinese appear to be their theatres and teahouses. Attending a Chinese theatre in a large port one hot evening, the writer was struck by the good ventilation, in spite of the fact that both men and women were smoking. The electric lighting also was ample and was disposed so as to have little unfavorable effect on the eyes. Electric fans of both ceilings and walls were in operation. Of interest to engineers is the fact that at Canton a store termed "universal providers" not only has all the usual appurtenances of an American department store, but has recently added a foundry department and a machine shop which is a step ahead of their American contemporaries.

It is impossible in a review of this kind to give a comprehensive analysis of the Chinese market for electrical goods and those interested are therefore directed to Mr. Lundquist's report. It may be said in passing, however, that a complete analysis is given of central station development factors, practice and management of generators, switchboard and switch gear; transmission and distribution equipment; underground cable, bare and weatherproof wire-poles and towers; crossarms, insulators and pins-line hardware; transformers; street lighting fixtures; motors and controlling apparatus; electric-railway equipment; meters and testing instruments; lamps; batteries; electrical vehicles; farm-lighting plants; telephone and telegraph equipment; wiring supplies and lighting fixtures; fans and other domestic and office appliances and other electrical equipment.

It is but possible to make reference in a general way to a few of these. We learn that while a great amount of bare wire is used, the tendency seems to be towards the use of weatherproof rather than uncovered wire for distribution lines and in the past most of this has apparently come from Germany or England. No triple-braid weatherproof wire so far seen comes up to good American wire in quality, and prices are not materially lower than those that could be made by manufacturers in the United States. Insulators are of porcelain, generally white in color, and are usually bought complete, with pin and washer. In the past

Germany, England, and the United States have sold in this market.

Prior to the war the chief competitors in the field for transformers were one of the American companies, a German, and two of the large English companies. American transformers used in China have a very good reputation, only one complaint being made. This was in regard to small-size, three-phase units, of which the general criticism was made that they were not so satisfactory as the best British transformers of the same type. In the past street-lighting fittings have come from England, Germany and the United States, but in future Japan will be a competitor.

The gradual electrical development in China is bringing an immense market for motors. The business will not be in large units as a rule, but rather the reverse, since a great deal of the demand will be for low-horsepower motors for work that has hitherto been done by hand, horses, or by mules, such as small rice or bean-oil mills and machine shops. The development of railroads will bring a large market for motors, since electric drive will be employed in all new railway machine and repair shops, and mining on a large scale will also create a broad field for the sale of electrical power apparatus of all kinds. In addition there will be more cotton mills, silk filatures, cement mills, cold-storage plants, etc., which will mean increased demand for electrical motors. From this development will come the market for larger type motors, but the volume of business during the next few years will likely be in the smaller capacities, motors of 2 to 25 horsepower.

In the past England, Germany, and the United States, with Japan a growing factor, have supplied most of the motors used in China. In direct-current lines, American motors are generally high in price, the British and Germans competing with each other closely in normal times. In alternating current motors the American manufacturers compete well, quality considered, and in single-phase lines they show not only better operating characteristics, but lower prices as well.

In Shanghai, American single-phase motors have not been strongly represented in the past apparently, but if properly pushed there are several makes that can do considerable business there. American single-phase motors are the best in the market, the only strong competition noted coming from England. The British competition can readily be met when American motors are locally represented, and well-known American designs are being sold to British central stations, owing to their marked superiority and better price. This is one of the few instance where higher-quality American apparatus sells at a lower price than its inferior foreign competitor. While American manufacturers will not be likely to do much business in direct-current motors, of which there is not a great amount anyhow, they should sell a considerable number of alternating-current motors in spite of a somewhat higher price.

The market for electric elevators is small, though growing, and is confined to a few of the largest cities. The Chinese are good builders and like to have elevators in buildings where there is any need for them.

At present China presents only a limited market for portable instruments, but in this line American manufacturers may do a little better, since quality is more of a factor in this type of instruments than in panel meters. One field for portable instruments, and switchboard types as well, that American manufacturers can cultivate is the market afforded by the development of the technical school in China. By furnishing instruments to these schools at a small margin of profit at the start not only is there an opportunity to secure such business in the future at better prices, but the student will become accustomed to good instruments and will not be satisfied to use inferior meters when he completes his course and takes a position with a power company.

The meter business is growing rapidly, as new plants are being installed. In 1916 they were imported in the amount of over $40,000. The market is largely for alternating-current types. The American alternating-current meter can compete with foreign makes. Prior to the war one American manufacturer only seemed to be at all active, but since then two or three others have arranged representation and have sold a fair number of meters. Foreign meters do not have the quality of American meters. Not only are they less accurate over a period of time, but they seem to deteriorate more quickly under the climatic conditions.

American exports of batteries have been of fair volume the amount being (for China and Hongkong) in 1918 $34,419. In the dry-cell line American manufacturers are in a better position and there is a good market, the majority of the telephone systems being of the magneto type. The climate is such that cells do not dry out as in some countries and the normal life is longer. There should be an opportunity for American manufacturers to do a fair amount of battery business in connection with the sale of electric vehicles.

Only one item in general domestic and office appliances is selling to any extent in China; that is the electric fan, which is universally used on account of the hot, humid summer weather and which is one of the most important of American electrical exports to that country. In 1918 those exported amounted to $173,520, the American trade having trebled when the war removed European competition. At present a half dozen good American fans are on the market. Fans not only are given severe usage in China, as they are often operated continuously for a whole day or more, but the humidity causes insulation leaks and breakdowns. It was said by one dealer that a certain American fan was the only one than can be run continuously without difficulty, that Japanese fans get hot quickly and also show leakage. In ceiling fans Americans have an excellent hold on the market.

While there will be a small but increasing demand in China for the best in all lines of electrical goods, coming from the wealthy Chinese as well as from foreigners living in the country, importers state China, generally speaking, wants apparatus and similar large equipment to be the best, but that in minor devices, supplies, and accessories the cheapest will be favored.

Merchants' Association Opposes Public Ownership

The Merchants' Association of New York has reaffirmed its opposition to government ownership and operation of public utilities and has declared emphatically in favor of private ownership under government regulation. The following is quoted from the report of a special committee:

"While we are not unmindful of the defects that not frequently characterize the operation by corporations of public utilities, we do not believe that those defects can be cured by substituting another method which in every respect of efficiency is much below the standards that generally prevail under private management. In so far as the evils which are popularly assumed to exist in private management are found to exist in fact, other remedies than the substitution of methods abounding in greater evils should be found.

"We believe that the public can best be served by utilizing the efficiency, enterprise and energy of private corporations for the continued operation of public utilities, under such public control as shall protect the public in its right to efficient service and fair rates; and at the same time assure to private capital invested in public utilities a fair return upon such capital.

"We do not find any change of conditions resulting from the war which warrant or require the previous position of the Association, in opposition to government ownership and operation, to be modified."

National Electric System for Spain

A royal order published in Spain December 31, 1918, provides that as soon as possible a permanent Spanish electric commission shall be formed under the direction of the Ministry of Public Works, writes Consul-General C. B. Hurst, from Barcelona. This commission shall report on the following points:

1. The possibility and practicability of the construction by the State, directly or indirectly, of a national system for the distribution of electric current.
2. The maximum extension possible of such a system.
3. The approximate cost of such a system calculated on a basis of relatively normal prices, or with copper at between 70 and 80 pounds sterling per ton.
4. The possibility of the State supplying the capital to be thus employed, or of guaranteeing its interest, taking tolls on the current transmitted, and how much this toll should be, or any other means of financing the system deemed preferable.
5. The possibility of a uniform tension and the means to secure it.
6. The basis on which a law should be drawn up in connection with the foregoing.

The director general of Spanish commerce, industry, and labor states that it is of transcendental importance to Spanish industry that it avail itself of the electric energy that the country is capable of producing. A great deal has been done to this end, but there are still many problems to be solved in connection therewith. Water power is distributed throughout Spain, but only companies with great capital can confront the expense of producing sufficient current to electrify railways. While there is water power in some parts of Spain supplying force a hundred miles or more, there are again tracts where no such power exists. Climatic conditions vary largely, as does the flow of water in the rivers. For example, the proportion of water in the Guadalquivir in winter as compared with summer is 1 to 1,000, and on the other hand there are rivers on the slopes of the Pyrenees which are dry in the winter and fullest in August when the snows are melting.

Coal production has been brought to a prosperous condition during the war, but the problem of its transportation remains unsettled.

Although general electrification is difficult, the undertaking in Spain is regarded to be well within the realm of possibility.

New York Jovian League Dissolved

Members of the organization known as the New York Jovian League operating under a charter from the national organization, the Jovian Order, with headquarters at St. Louis, met at the Hotel McAlpin the past month and unanimously voted to divorce themselves from the national order and to become from this time on the New York Electrical League. The New York Jovian League was composed of men interested in electrical industries in general and the new organization, as its name indicates, will have the same class of membership and will be devoted to the same purposes and principles. Hereafter it will not be necessary for members to become affiliated with the Jovian Order in order to become a member of the New York Electrical League.

The officers, committees, etc., of the old organization by a unanimous vote become the officers, committees, etc., of the new organization. Plans are being formulated for the organization of a permanent body to be known as the Electrical Board of Trade of the City of New York. The New York Electrical League membership will form the nucleus of the Electrical Board of Trade.

Increase in Electric Railways

THE forthcoming quinquennial report on the electric railways of the various states shows the remarkable growth of this service, according to preliminary figures given out by Director Sam L. Rogers, of the Bureau of the Census, Department of Commerce. They were prepared under the supervision of Eugene F. Hartley, chief statistician for manufactures. The statistics relate to the years ending December 31, 1917, 1912, and 1907. The totals include electric light plants operated in connection with electric railways and not separable therefrom, but do not include mixed steam and electric railroads nor railways under construction.

The figures for Mississippi show substantial gains in the industry during the decade 1907-1917, but the growth was chiefly confined to the first half of the period, the railway revenues in 1917 being slightly less than in 1912 and the operating expenses materially greater. There were 11 companies in 1917, as compared with 12 in 1912 and 8 in 1907. The track mileage increased from 86.40 in 1907 to 117.14 in 1912 and to 122.79 in 1917, exclusive of 4 miles not operated. The number of persons employed was 627 in 1917, as compared with 507 in 1912, an increase of 23.7 per cent; and there was paid in salaries and wages $392,600 in 1917, as compared with $302,509 in 1912, an increase of 29.8 per cent.

The revenue passengers carried numbered 10,730,801 in 1917, as compared with 10,883,077 in 1912, a decrease of 1.4 per cent, though the number in 1917 is an increase of 18.1 per cent over 1907. The income from all sources was $1,225,712 in 1917, as compared with $910.390 in 1912, or an increase of 34.6 per cent, but the increase was entirely due to growth in the light and power business of the railway companies. The revenues from auxiliary operations increased from $273,217 in 1912 to $583,515 in 1917, an increase of 113.6 per cent, while the revenues from railway operations were $617,527 in 1917 as compared with $626,307 in 1912, a decrease of 1.4 per cent.

The operating expenses were $890,006 in 1917, as compared with $651,866 in 1912, or an increase of 36.5 per cent; and deductions from income, comprising taxes, interest, and fixed charges, amounted to $455,148 in 1917, as compared with $296,833 in 1912, or an increase of 53.3 per cent. As a result there was a deficit in 1917 of $119,442, as compared with a deficit of $38,309 in 1912 and a net surplus of $123,914 in 1907.

The power consumption was 23,301,621 kilowatt hours in 1917, of which 20,022,367 was generated and 3,279,254 purchased, as compared with 13,650,069 kilowatt hours in 1912, of which 9,954,975 was generated and 3,695,094 was purchased.

The figures for Arizona and New Mexico show general increases at each successive census. The number of companies has not changed, Arizona having 4 and New Mexico 2, but they operated 57.49 miles of line in 1917 ,as compared with 54.19 in 1912 and 37.82 in 1907. The number of passengers carried increased from 3,135,459 in 1907 to 5,802,885 in 1912 and to 9,488,467 in 1917.

The income of the roads from all sources increased from $225,630 in 1907 to $360,288 in 1912 and to $613,333 in 1917; and the operating expenses from $160,335 in 1907 to $292,987 in 1912 and to $456,542 in 1917, the increases for the period 1907-1917 being 172 per cent in gross income and 185 per cent in operating expenses. Deductions from gross income, comprising taxes, interest, and fixed charges, amounted to $123,947 in 1917, as compared with $94,551 in 1912, resulting in a net income in 1917 of $32,844, as compared with a net deficit of $27,250 in 1912.

The power consumption was 5,537,348 kilowatt hours in 1917, of which 1,526,960 was generated by the companies and 4,010,388 was purchased, as compared with 3,435,207 kilowatt hours in 1912, comprising 685,400 generated and 2,749,807 purchased.

Colorado showed marked losses in the industry for 1917 as compared with 1912, although there were pronounced gains during the period 1907 to 1912. The number of operating companies was 15 in 1917, as compared with 16 in 1912 and 11 in 1907. There were 499.87 miles of single track operated in 1917, as compared with 467.97 miles in 1912 and 317.37 miles in 1907, but the number of revenue passengers carried in 1917, 84,623,896, was 2.3 per cent less than in 1912 (86,597,205), though 15.2 per cent greater than in 1907 (73,458,468).

The income from all sources decreased from $6,630,480 in 1912 to $5,826,512 in 1917, the decline amounting to 12.1 per cent, though as compared with 1907, when this income was $4,483,254, there is shown an increase of 30 per cent for the ten-year period. The decrease in income for 1917 as compared with 1912 applies to income from railway operations and to non-operating income. On the other hand, there was an increase in operating expenses from $3,264,753 in 1912 to $3,404,817 in 1917, or of 4.3 per cent, and in deductions from income, comprising taxes, interest, and fixed charges, from $2,106,967 in 1912 to $2,211,329 in 1917, or of 5 per cent. As a result the net income, which was $1,110,809 in 1907 and $1,258,760 in 1912, was but $210,366 in 1917, making a decrease of 83.3 per cent as compared with 1912 and of 81.1 per cent as compared with 1907.

The power consumption waws 111,508,542 kilowatt hours in 1917, of which 98,227,472 was generated by the companies and 13,281,070 was purchased, as compared with 106,373,451 kilowatt hours in 1912, comprising 97,915,436 generated and 8,458,015 purchased.

The figures as presented for Vermont show that during the decade 1907-1917 and the five-year period 1912-1917 there were substantial gains in number of passengers carried and in revenues from railway operations, but the marked increase in operating expenses for 1917 as compared with 1912 has resulted in a decrease in net income. The companies credited to the state—9 in 1917 and 1912 and 10 in 1907—operated 107.95 miles of track in 1917, 102.85 miles in 1912,. and 124.31 miles in 1907, the figures for 1907 include track operated by outside companies in the later years. The mileage of single track in the state was 125.47 in 1917, in comparison with 120.83 in 1912 and 113.38 in 1907, an increase of 10.7 per cent for the decade. The number of revenue passengers carried increased from 7,103,082 in 1907 to 8,135,725 in 1912 and to 8,738,378 in 1917, the rate of increase for the decade being 23 per cent.

The income from all sources increased from $454,-252 in 1907 to $631,241 in 1912 and to $875,058 in 1917, the rate of increase being 92.6 per cent for the decade and 38.6 per cent for the five-year period 1912-1917. The operating expenses, however, increased from $313,845 in 1907 to $345,268 in 1912 and to $599,446 in 1917, or at the rate of 91 per cent for the decade and 73.6 per cent for the last five-year period. Deductions from gross income, comprising taxes, interest, and fixed charges, amounted to $239,724 in 1917, as compared with $169,912 in 1912 and $117,601 in 1907. As a result the net income which was $22,-806 in 1907 and $116,061 in 1912, decreased to $35,-888 in 1917.

The electric power consumption amounted to 21,-754,488 kilowatt hours in 1917, of which 11,601,930 was generated and 10,152,558 purchased, as compared with 8,989,344 kilowatt hours in 1912, comprising 6,867,675 generated and 2,121,669 purchased. These figures show an increase of 142 per cent in electric power consumption for 1917 as compared with 1912.

The figures as presented for the states of Idaho and Wyoming show small gains in trackage, equipment, and income for the semi-decade 1912-1917, but they are far below the gains made during the period 1907-1912. The operating companies in these two states numbered 6 in 1917, 5 in 1912, and 2 in 1907. There were 127.7 miles of single track in 1917 (Idaho 104.65 and Wyoming 23.05), as compared with 111.84 miles in 1912 (Idaho 88.93 and Wyoming 22.91) and 44.24 miles in 1907, the latter being all in Idaho. The number of persons employed was 204 in 1917 and 224 in 1912, and there was paid in salaries and wages $186,209 in 1917 and $195,630 in 1912.

The revenue passengers carried in 1917 numbered 4,736,414, with a passenger revenue of $423,940, as compared with 5,568,781 revenue passengers in 1912 with a passenger revenue of $450,913, showing decreases of 14.9 per cent in number of revenue passengers and 6 per cent in passenger revenue.

The total income was $524,182 in 1917, as compared with $519,153 in 1912, an increase of but 1 per cent. Operating expenses increased from $368,697 in 1912 to $375,858 in 1917, or by 1.9 per cent, while deductions from income, comprising taxes, interest, and fixed charges, which amounted to $154,302 in 1912, were $132,786 in 1917, a reduction of 13.9 per cent. As a result the roads show a net income of $15,538 in 1917, whereas in 1912 there was a deficit of $3,846. The companies all operated with purchased power, the consumption of electric current amounting to 6,587,-229 kilowatt hours in 1917 and 6,144,296 kilowatt hours in 1912.

The Mica Industry of India

The annual report of the Chief Inspector of Mines in India says that the mica output for 1917 was practically stationary, being 35,896 hundredweight, as compared with 35,978 hundredweight in 1916. This was the result of an increase of nearly 10,000 hundredweight in the Bihar and Orissa field being balanced by an equal decrease in the Madras field. In the first-named field conditions in the earlier part of the year were much the same as in 1916, with prices ruling firm and supplies considerably short of the demand, particularly for the better qualities, though stained mica was in considerable request. In the latter half of the year an increasing demand for the smaller sizes, chiefly from America, for wireless-telegraphy apparatus resulted in an abnormal rise in their value. The work in this field is now being carried on with greater energy and improved methods. New roads are under construction, and in other ways the local government has assisted the mine owners to improve conditions generally. In the Madras field, in spite of the encouraging features of the market, there was a marked decrease in the output. A considerable number of new plots were prospected, but very few turned out well.

Hydroelectric Development in England

In the electrical field in Great Britain, the past year was occupied with meeting immediate needs for power rather than in embarking upon new developments, writes Commercial Attaché Philip B. Kennedy. These, however, are destined for attention in the near future, when effort must be focused on the problem of cheap electrical power as an essential to increased industrial output. Both at home and abroad hydroelectric developments have been freely discussed as a preliminary to something being done when normal conditions are restored. Authorization is already being sought for large developments of Scottish water power, and estimates of the available power from the Highlands place the figure between 375,000 and 650,000 horsepower. In any case, water power is not to be overlooked in the program of reconstruction. Interest, however, will first center upon the scheme for the large increase in electrical-power production at the much-talked-of super-power stations.

Small Investors Important Factors in Building

Economists investigating present financial conditions for the Department of Labor agree with Mr. Walter Stabler, Comptroller of the Metropolitan Life, in the conclusion that more than ever before in financial history the small investor in the United States is to be an important factor in financing business and building. Mr. Stabler is quoted to the effect that large mortgage lenders are not plentiful in the market and borrowers must look to small investors, whose participations may be pooled under the trusteeship plan.

Mr. Stabler's statement, advertised by the Title & Guaranty Trust Company, of New York City, was limited to the New York district, but investigations made by the Department of Labor, through its Division of Public Works and Construction Development, suggest the conditions to which Mr. Stabler directed attention is pretty general the country over.

Replies to a comprehensive questionnaire, recently distributed to a selected list of representative institutions throughout the country, indicate an absolute decrease during 1918 of funds available for investment in real estate mortgages and indicate also a relative decrease since 1914 of funds so invested compared with the total resources of the institutions considered.

It is essential, in the opinion of the Department of Labor, to devise ways and means of availing of the small investors' capital and for that reason the American Bankers' Association's plan, advocating the adoption of amortization schedules for real estate loans, together with the Building and Loan Associations' agitation for a federal system of "Home Loan Banks," have challenged the sympathetic interest of the Labor Department.

Just how to gather the comparatively small amounts of capital held by the small investors, and marshal them in amounts necessary to financing extensive building projects, is a problem which must be met by local initiative where the problem arises. The Division of Public Works and Construction Development points out that the small investors were the balance of power necessary to the success of the government's war finance program, and they may now be made the balance of power in the reconstruction work of the nation.

The home builder—he who builds for his immediate use rather than for rental purposes—appears to be getting under way with his building plans. This especially is noted in the central west. The home building program will be facilitated and augmented if small investment money is made available for building loans. In one or two communities this is being attempted by private organizations, brought together for this sole purpose. In other and more numerous cases the regular banks are giving thought to the problem. The building and loan interests already have formulated a plan under which a system of Federal Home Loan Banks would enable them to rediscount their first real estate mortgages, and make available for further loans more than a billion dollars of their assets.

While the Department of Labor is endeavoring to cooperate with state and municipal authorities in getting under way road building and public improvements, and with private interests in their more extensive building operations, it is convinced that home building, for the use of the builder rather than for rental, must be looked to as an important factor in providing better employment for labor during the transition from war to peace production, and for the stimulation of business. For this reason the Department of Labor is making a determined drive for a nation-wide "Own Your Home" campaign.

Foreign Trade Convention

The Sixth National Foreign Trade Convention will be held in the Congress Hall, Chicago, on April 24, 25 and 26, 1919. James A. Farrell, chairman of the National Foreign Trade Council, who issued the call for the convention, and will call the meeting to order, says: "Now, as never before, the United States must rely upon foreign trade to make certain the full employment of labor and to provide investment for capital; to stabilize industry and prevent disturbance of domestic conditions; to insure the permanent retention and operation of our new merchant vessels under the American flag; to maintain prosperity among American producers and to forestall any retrogression from the high standards that have been achieved."

This year the convention has assembled a large amount of valuable technical information, which is available to all delegates who wish to use it. This information will be furnished by the volunteer trade advisors of some of the most experienced business houses and by the representatives of the Government trade agencies. A number of prominent business men of long experience in every branch of foreign trade have offered their services as volunteer advisors. The information they can give is based on personal experience, and as such is doubly valuable. In addition, the Department of State will co-operate by assigning to the convention some members of the Consular Service, who will just have returned from Europe, Latin America and the Far East. The Department of Commerce will send a number of its experts from the Bureau of Foreign and Domestic Commerce. The Shipping Board will be represented. The Pan-American Union will be present to give information on Latin-American relations. These men are thoroughly familiar with their respective fields and can supply a great fund of valuable information if called upon.

ELECTRICAL ENGINEERING

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THE business interests of the country are complaining of the loss of trade and the delays resulting from the censorship of foreign cables and mail. The Merchants' Association of New York is using every effort to obtain an abatement of the restrictions, especially to neutral countries such as South America and the Far East, where the enforcement of censorship regulations seems unnecessary now that the war is over. While some of the Federal officials express sympathy with these efforts, so far they have been without result. Permission to use codes in commercial messages is also being sought. It is pointed out that the employment of codes would greatly relieve the pressure upon the cables, thus facilitating the sending of messages, and that it would reduce materially the expense of doing business abroad.

THE fight against the continued Government operations of public utilities is going steadily on. The sentiment throughout the country among business men in crystalizing against a policy that could be justified only by the emergencies of a great war. Senator Joseph I. France, of Maryland, in a letter to the Merchants' Association, says: "I feel it will be better for the country if the wire systems are returned as promptly as possible to the people. I have always feared the effects upon our Government of a policy of Government ownership until there has been developed among our people more of the community and co-operative spirit. These fears have been justified by my observation of the effect of Government ownership and operation during the last few months. I find that many of the progressives who formerly favored Government ownership have awakened to the realization that bureaucracy may become oppressive and that more power lodged with the Government by its assumption of non-governmental functions means less power reserved to the people for the protection of their rights and the preservation of their liberties. Viewing the subject from the standpoint of the common welfare, I feel obliged to advocate the earliest possible abandonment of the Government ownership policy and the prompt return of the wire systems to the people." During the war one could patriotically make allowances for the many sins of omission and commission of the Post Office Department, but conditions have improved very slightly since the coming of peace. America certainly does not want its unsurpassed cable, telegraph and telephone systems brought down to the level of the post office administration.

AN experiment that will be watched with a great deal of interest is the opening by the U. S. Employment Service, Department of Labor, of a practical demonstrating office in New York, the first of its kind in the country. Skilled mechanics and their helpers only are registered for placement, the function of the office being to determine the fitness of applicants for the positions they seek, for reference to opportunities for employment may depend upon other elements than trade ability such as education, age, experience, physique and the like, and the technical interview is relied upon only to determine the degree of trade ability and skill actually possessed, which enables the Service to refer only suitable applicants to the employer and from which the latter may make his selections. If government officials can conduct such an enterprise as this without becoming the slave to red tape and bureaucratic methods, the business world will be more hopeful about the many other enterprises which the Government is endeavoring to manage.

IN discussing conditions confronting the country, Secretary Wilson, of the Department of Labor, says: "The present period of readjustment is the critical time. If we can pass through it safely, we have before us from eight to ten years of industrial activity equal to any wave of prosperity we ever have had. But if there is any serious unemployment, there will be a period of industrial unrest which may lead us to a repetition of the French or the Russian revolution." Secretary Lane, of the Department of the Interior, refers to this prediction and declares that he can do much to stem the tide of industrial unrest if Congress will appropriate the sum he asks in order to enable him to establish soldier-settlements in every state in the union. This scheme would enable him to offer jobs to 100,000 of the returning fighting men and provide farm homes for 25,000 of these men. Without any attempt to belittle Secretary Lane's plan, it would seem to the ordinary business man that the best way to obviate industrial unrest would be to improve general business conditions and thus do away with unemployment in the natural and logical way. A conference of governors and mayors was called at Washington for a discussion of business and labor problems growing out of the ending of the war. But this is not a matter to be settled by politicians or state and city officials. It is the concern, mainly, of those who direct great industries. And yet business was not directly represented. In order to find out the views and attitude of business, the journal *Industry* sent out a questionnaire to the most important corporations and manufacturing firms in twenty-six states, all of them large employers of labor. The answers that were returned attribute the growing unemployment to various causes. Labor itself was blamed for decreased production and prohibitive costs, enforced by strikes for shorter hours and higher wages. But many of the manufacturers were frank in putting much of the trouble up to the Government itself, which, it is charged, has had no fixed policy, has inclined toward paternalism in many fields, and has coquetted with price fixing and Government regulation. The paper says editorially that there is a hesitancy throughout the country which is due, in part at least, to suspicion of the Government's efficiency in handling the economic and financial problems which have followed the war. This suspicion is based on the fact that this Government has done practically nothing since the armistice was signed to stabilize conditions: while, on the other hand, there has been a persistent campaign to concentrate in the hands of the Government a power of interference which inevitably disturbs business throughout the country.

Public Opinion on Government Control

The interim report of the Public Policy Committee of the National Electric Light Association has the following to say on public ownership:

"Public opinion will be divided as to the influence of war experiences upon the question of public ownership of utilities. The former advocates of public ownership will try to see in the extension of public control exercised during the war a trend which is likely to continue. On the other hand, the general public will be likely to judge the merits of the question by its opinions as to economic and service results achieved under direct government control in comparison with the results of previous operations under corporate management.

"Government control of the railroad systems of the country during the war has been universally recognized as a wise procedure, because of the necessity of subordinating the individual interests of the various railroads to the all-important idea of securing the maximum of transportation service throughout the country for the movement of troops and essential commodities. The serious curtailment of the usual passenger and freight service coincident with the greatly increased charges for both classes of service, has been accepted by the public as necessary to the quickest possible success of the war program.

"Now that hostilities have ceased, the railroad administration will be judged by other standards than those of war necessities, and already the editorial columns of prominent papers are extremely critical of the operating and financial results of government control. In the opinion of your committee, there is nothing in the experience of the Government thus far to justify or encourage permanent public operation of the railroads either from the standpoint of economics or of service, and while doubtless the ardent advocates of public ownership will seek to capitalize recent experiences of the Government in favor of their theories, it is indisputable that those who travel on the railroads and those using them regularly for shipping are anxious for the termination of direct government operation as soon as may be practicable."

Popular vs. Government Ownership

Carl D. Jackson, Chairman of the Wisconsin Railroad Commission says: "The actual ownership of most public utilities is by the people themselves. The first liens on most public utilities are very often owned by Trust companies, banks, and largely by insurance companies thoroughout the United States. Nearly every man carries an insurance policy. The average citizen has a bank account, yet not one citizen out of a hundred realizes that in one form or another his actual savings and insurance and his wife's and children's welfare depend upon the solvency and continued operation of public utilities. There is probably not one man in fifty whom we meet on the street who does not own a part of a public utility, whether he knows it or not. So the question relating to public utilities are not confined to the consumers on one side and the public utilities as such on the other, but the whole question is one involving financially nine-tenths of the entire population. Furthermore, public utilities should not only be solvent in themselves, but there should still remain a reasonable incentive to reasonable development along the lines to be demanded by future generations. Nothing should take place in this country to discourage individual and collective efforts along progressive lines."

Colonel H. M. Byllesby, in a telegram to the Oklahoma Utilities Association in convention at Oklahoma City, said:

"The trend of events in the utility situation is one which should command our most earnest, thoughtful and active attention. It seems to me that only two courses are open to the utility business; first, that the laws be so adjusted as to enable these companies to make such a fair return upon their investment as will enable them to find capital continuously for the further extension of their enterprises which the growth of the community served and the improvements in the art render increasingly necessary. These laws and regulations at the hands of Commissions or other properly authorized bodies should encourage in every proper way the spirit of enterprise and provide some profitable return beyond the mere bare interest on the cost of the properties in order to bring to bear the very best inventive and enterprising capacities of all those engaged in this business.

"If the laws and regulations cannot provide for this situation then the only alternative it seems to me is that the various communities should take over the properties at a fair and suitable compensation to the owners, as I am confident that at bottom no real American wishes to rob anyone or to take possession of any property without making due, proper and fair payment therefore. This latter course is one which I sincerely trust will not be adopted as it involves all the evils which years of experience have shown always attach to governmental operation of enterprises of this nature.

"The very best results to the community, to those who pay for the service rendered, will be found as always in private ownership, where this ownership, while being regulated along proper lines, is still allowed full scope for the exercise of ingenuity and enterprise; and in order to do this they must be allowed, as I have previously stated, not only a standard return for the capital invested in other enterprises of a similar nature, but in addition to this some fair, reasonable allowance to compensate for the exercise of painstaking, continuous industry, ingenuity and enterprise."

Italian Specifications for Electrical Machinery

The Italian Gazetta *Ufficialle* for December 12, 1918, publishes a decree announcing that the standards of the Italian Electrotechnical Association for 1916 (Norme per l'ordinazione e il collauda delle machine elettriche, edite dall' Associazione Elettrotecnica Italiana nel 1916) will be followed in the specifications of electrical machinery for the Government. The regulations are printed in detail and include conventional signs, terms, and definitions and instructions for bidding on Government work.

Government Telegraph Rates Raised

The Ceylon telegraph lines are owned by the Government, and the rate has now been increased from a unit charge of 25 rupee cents to 40 cents for 10 words, including the address, writes Consul Walter A. Leonard, from Colombo. This means an increase of 60 per cent on the minimum charge, but the rate for additional words remains the same, viz, 5 rupee cents for each additional 2 words or less.

Organization Conference of Railroad Engineers

Questions of immediate concern to all railroad engineers will be discussed at a conference in the Gold Room of the Congress Hotel, Chicago, March 17, beginning at 2 P. M. and extending through the afternoon and evening. The conference will be held under the auspices of the Railroad Committee of the American Association of Engineers, of which Mr. W. H. Finley is president and chairman of the Railroad Committee. Some of the subjects on the program are: The need of an association including all railroad engineers to look after their economic welfare; Methods of organization; Aplication to order 27 and supplements of the U. S. Railroad Administration, especially with reference to overtime and classification of engineers; Rates of pay.

The session will be held on the Monday of the week of the annual convention of the American Railway Engineering Association in order that those planning to attend the A. R. E. A. convention can come a day earlier and attend the organization conference. The conference is thoroughly democratic in character. Every railroad engineer is invited, whether a member of any engineering organization or not, and whether mechanical, civil, electrical or in any special field. Detail of program will be announced later.

The Railroad Committee of the American Association of Engineers announces the employment of an Assistant Secretary to give attention to the railroad field. A sub-committee will be appointed to study wages paid technical engineers on the railroads and elsewhere. A tentative report will be represented at the March 17 conference.

Exhibition Committee Plans

The Exhibition Committee of the National Electric Light Association held a meeting at the headquarters in New York on February 15th, under the chairmanship of Mr. J. W. Perry. It was formally decided to approve the proposition to hold the next annual convention at Atlantic City, the week of May 19th, and to resume all the proposed plans and activities that had been so carefully worked out in 1917, with additional features of interest to the operating member companies. These will be given in full for publication as soon as possible. In the meantime the committee desires to announce to the Class D exhibiting members that all reservations made in 1917 as to exhibition space will be given priority and be carried out by the Exhibition Committee, which is communicating immediately with all the pledged and prospective exhibitors, upon whom it is impressing the fact that this is the reconstruction convention after the great war, the most notable and historic in the life of the N. E. L. A. Mr. H. G. McConnaughy, secretary of the Exhibition Committee, can be addressed on all such matters at the association offices, and it is suggested that all exhibitors get in touch with him at once.

Obituary Notes

E. H. Jacobs, construction engineer and superintendent of all distribution lines of the Western States Gas & Electric Company at Stockton, Cal., died of pneumonia recently, after having been ill with influenza for about ten days. Mr. Jacobs has been connected with the Western States Company for ten years, and for the last seven years had been located at Stockton.

A. O. Dicker, Illinois manager for the Luminous Unit Company and St. Louis Brass Company, died at his home in Oak Park, Ill., the past month, at the age of 30 years. He had taken a prominent part in illuminating engineering in Chicago.

Will Join the Westinghouse Forces

William A. Sumner, Rockville, Conn., recently discharged from the Army, with the rank of second lieutenant, has entered the employ of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, where he will specialize on electrical machine designing.

Care, Spacing, Setting and Grinding of Brushes

By T. Schutter

THE brushes of any direct current motor or generator must be set so that they are in the neutral position in order to obtain sparkless operation.

On most of the larger machines a rocker ring is provided on which the brush holders are to be mounted and this is drilled or bored at proper intervals to receive the studs on which the brush holders are to be fastened; as for example, on a four-pole machine the rocker ring will be drilled or bored at four places, equally spaced, or

$$\frac{360^\circ}{4} = 90^\circ$$

apart. On a six-pole machine the rocker ring would be drilled or bored at six places or

$$\frac{360^\circ}{6} = 60^\circ$$

apart. This will, of course, insure that the distance from one brush stud to the next will be the same distance.

But this does not insure the distance from one brush to the next to be the same all the way around the commutator, for if the brush holders are not properly set on the studs it will be impossible to obtain proper commutation on any machine. All brush holders should be gauged so that they will be set the same distance from the commutator surface so that all brushes will have the same angular pitch and the distance from brush to brush will be the same all the way around the commutator.

Fig. 1 shows a commutator with six brushes placed, as above explained, 60° apart. Assuming that brush A is set in its proper position. The distance from point a to point b on the commutator equals one-sixth of the entire circumference or 60°, which would be the proper position for the toe of brush B. But as will be seen, brush B has its toe set back of that point and is less than 60° from brush A. This is caused by the brush holder of brush B being set closer to the surface of the commutator than the holder of brush A, and this gives the brush B a different angular pitch.

The distance from point a to point f on the commutator is exactly one-sixth of the circumference or 60°, and as the toe of brush F is set on that point f it will be in its proper position. Brush C is also in its proper position, the brush holder having the same angular pitch as those of brushes A, E, and F. But the distance from the toe of brush C to the toe of brush D (points c and d on the commutator) is more than one-sixth of the circumference, or 60°. This shows that the brush holder is set higher or further from the surface of the commutator. This will give the brush a greater angular pitch and causes the distance from point c to d on the commutator to be more than 60°.

Under these existing conditions brushes B and D would

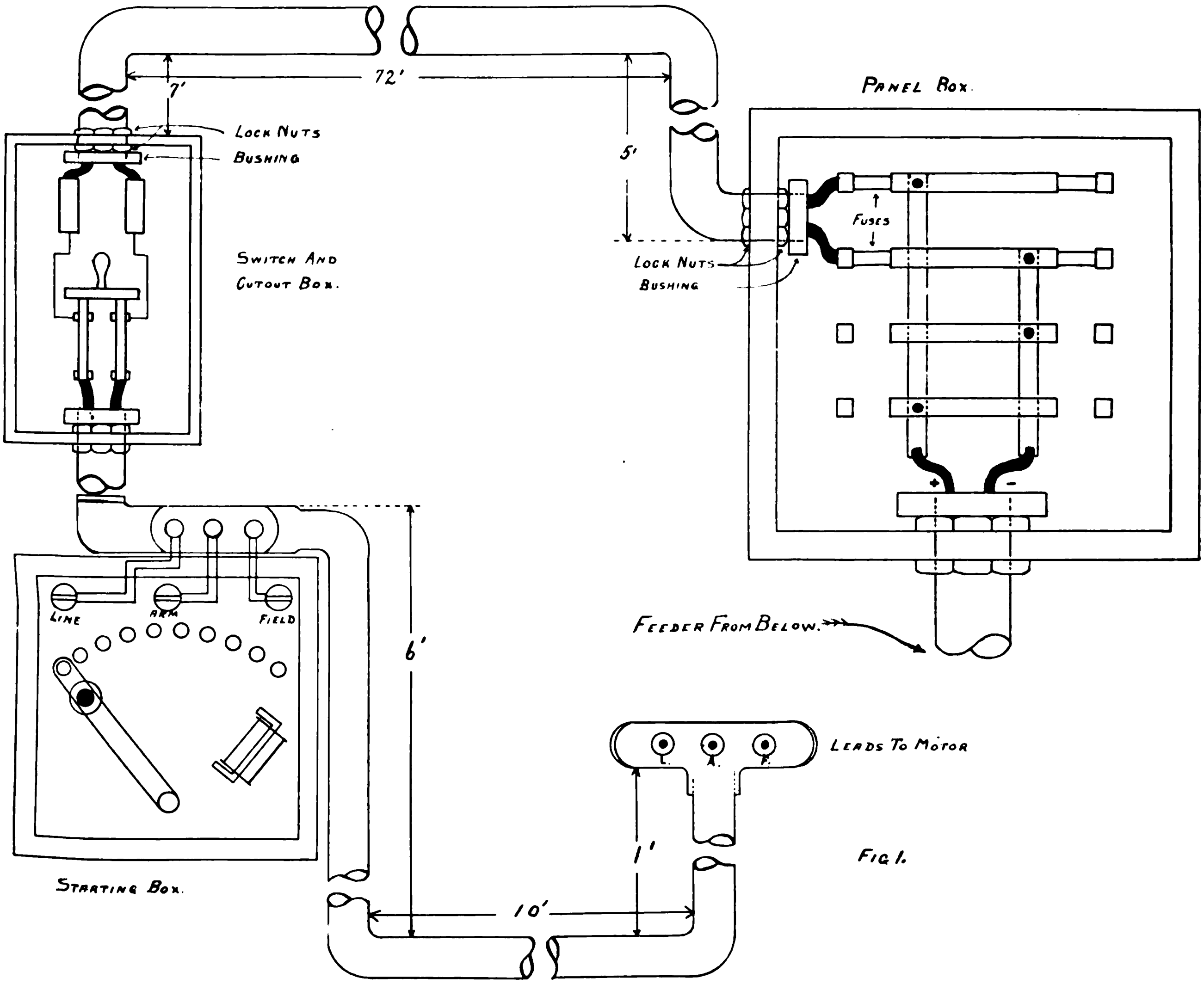

Fig. 1.

show signs of sparking; this, however, can be remedied by raising brush holder B and lowering brush holder D to the same level as holders A, C, E and F. This would also mean that brushes B and D would have to be reground so as to have a full contact surface, since brush B now requires a larger surface and brush D a smaller surface than before.

Another fault setting was recently demonstrated to the writer when called in to see what caused the brushes on a

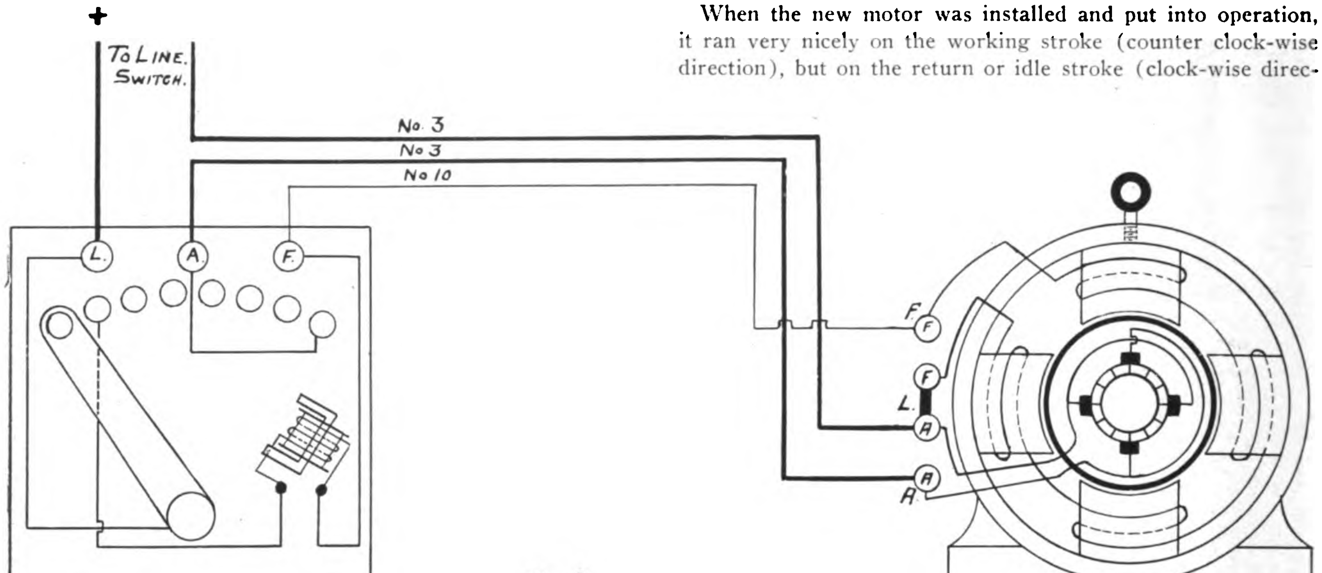

FIG 2.

5-hp. direct current motor to rattle, spark and brake up in a short time.

This 5-hp. motor was belted to a piece of machinery which ran in one direction for a given period of time, then was

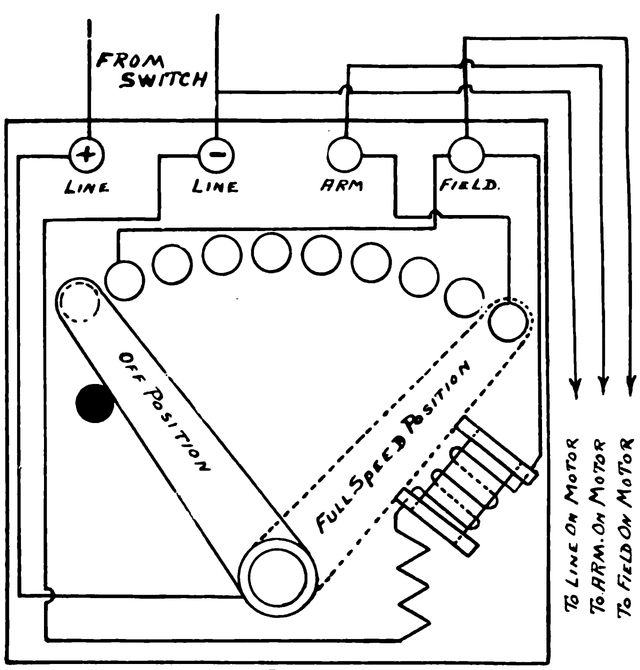

FIG 3.

stopped and started again in the opposite direction for the same period. For some reason or other the armature of this motor developed a short circuit in the winding and some of the coils burned out. This, of course, meant that the armature had to be rewound, and as there was no spare armature for the same motor another motor had to be installed in the meantime, so as to keep the machine in operation.

As above mentioned, the machine driven by this motor had to operate in both clock-wise and counter clock-wise directions; the counter clock-wise direction is the working stroke, that is, in this direction the machine is working under load, and the clock-wise direction is the return or idle stroke. On this stroke there is practically no load on the motor and the current consumed is very small.

When the new motor was installed and put into operation, it ran very nicely on the working stroke (counter clock-wise direction), but on the return or idle stroke (clock-wise direction) the flashing and chattering of the brushes made it impossible to use the motor. As both motors were of the same size (5 hp.) it was certain that there was no overload to cause such sparking since the sparking only occurred on the idle or return stroke when the motor consumed the least amount of current. But to make sure of conditions and ammeter was connected into the circuit and the machine was started once more and on the working stroke the motor consumed 31 amperes, which was about 75 per cent. of its full load rating; and on the return or idle stroke it was impossible to get any reading at all, since the sparking and flashing at the brushes caused the ammeter needle to fluctuate so that at one instant it would read full scale, and 5 or 10 amperes at the next.

The machine was shut down again and a careful examination made of both the machine and the motor and no apparent defect or trouble could be found until the brushes were taken out of the holders. Then it was seen that the toe of each of the four brushes was badly chipped and one brush was cracked. This made it apparent that the trouble was caused by the setting of the brushes, and on inspection it was found that the brushes were set so that the angular pitch made it possible only to run the machine in the counter clock-wise direction, and when the machine ran clock-wise the speed was against the brushes, which then had a tendency to lift the brushes.

Fig. 2 shows the position in which the brushes were set in the old machine. This is known as the radial position. This makes it possible to run the machine in either direction without tending to throw the brushes out of the holders.

In Fig. 3 the solid lines show the position in which the brushes were set on the new motor. Brushes set in this position will only permit the motor to run in a counter clock-wise direction, which was the working stroke of the machine; and when this motor is reversed the running direction is against the brushes and they are then raised off the commutator surface, which was the cause of the flashing mentioned above. In order to run the motor clock-wise the brushes should have been set as shown by the dotted lines in Fig. 3.

The trouble was overcome by changing the position of the brush holders to the radial position, and the brushes reground to suit the commutator surface.

When the brushes are not making full contact on the surface of the commutator, sparking and burning results, which in turn causes heating of the machine, and this is known to be very injurious if continued for any length of time. When brushes are removed from their holders for cleaning great care should be taken to see that they are put back in the same position that they formerly had. Fig. 4 shows a brush which is properly ground and fitted to the commutator surface, and Fig. 5 shows the same brush after it has been taken out and cleaned and replaced in the wrong way. When a brush is replaced as shown in Fig. 5 only a very thin edge is making contact on the commutator bars, and the slightest irregularity in the commutator surface, or in case that the mica between the commutator bars is undercut, would cause the brushes to chatter and chip off. At the same time the commutation of the coils in the armature would be so affected that when they passed from one polarity to the other there would be continual sparking.

When the brushes are worn down and it is necessary to replace them by new ones, if they are not ground and fitted to the commutator surface they would fit or set as shown in Fig. 6. When a new brush is put into the holder it should be ground so that it will have a full surface contact as shown in Fig. 4. This is done by placing a strip of coarse sand paper (sand side facing the brush) between the brush and the commutator and pulling it backward and forward until full surface is obtained. Then use a strip of fine sand paper to produce a smooth surface on the brush. When this fitting process is completed all brushes should be removed and cleaned as well as the brush holders, to remove all carbon dust and particles of sand.

It sometimes happens that when brushes are to be replaced, new ones of the proper thickness are not at hand and a brush which is thinner will be substituted and used as a relief in the emergency. When this brush is put into the holder it would set as shown in Fig. 7 (armature would be rotating as shown by the arrow). To trim a brush under these conditions so that it would have full contact surface, the sand paper cannot be pulled backward and forward as explained above as this would also cause the brush to move back and forth in the holder, and instead of grinding a convex surface so as to have a full contact surface, a concaved surface would result which would give very poor results. In order to grind a brush under these conditions it is only possible to pull the strip of sand paper in one direction, that is in the same direction as that in which the armature rotates. When the paper is drawn in the reverse direction the brush should be raised clear of the sand paper. This will grind and fit the brush as shown in Fig. 8.

Installing and Wiring a Motor

By J. Adamson

In many instances when an electrician is sent on a job to instal a motor, all the necessary material is shipped to the job and all he has to do is put the motor in position and run the wires and make connections as per instructions he has received.

The object of this article is to show how all this necessary information can be obtained from the name plate of the motor, and for a practical example, assume that on the name plate the following data is found: Maker's name, serial number, type, horsepower 15, volts 220, amps. 60, speed 900 R.P.M.

The first step to determine is what size of wire is to be used to run from the feed or service box to the motor cutout. (In most of our modern buildings an outlet or panel board, one for lighting circuits and one for power circuits, is located on each floor.)

In choosing a size of wire a certain per cent. must be allowed

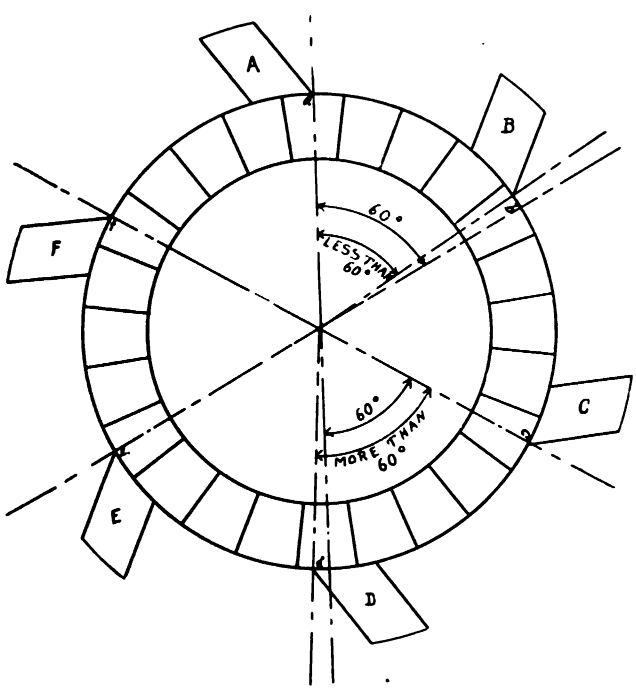

Fig. 1

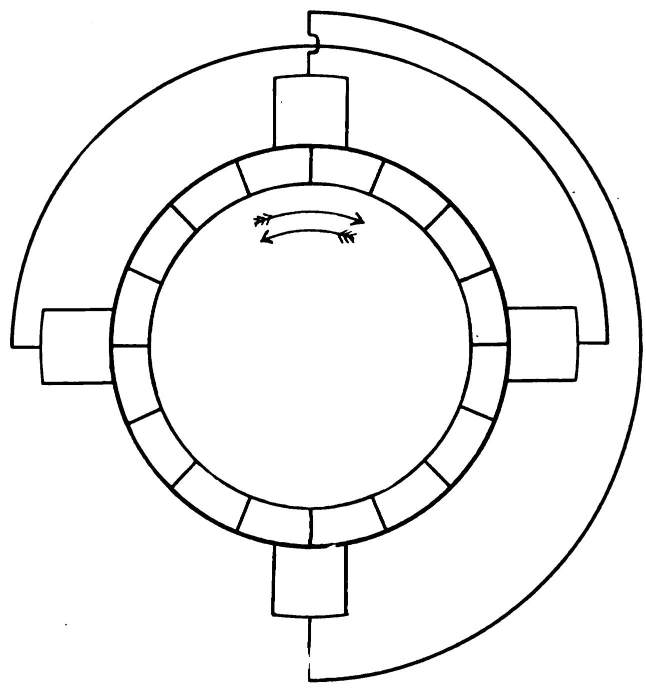

Fig 2.

for an over load. A 25 per cent. allowance is what is required by the insurance companies, so that the wire would have to be capable of carrying 60 x 1.25 = 75 amps., and from table No. 1 the size of wire may then be selected from the column headed "Rubber covered wires."

Size of wire B. & .S. Gauge	Dia. Solid Wires Cir. Mils.	Area Cir. Mils	Rubber Covered Wires	Wires not Rubber Covered
18	40.3	1,624	3 Amps.	5 Amps.
16	50.8	2,583	6 "	10 "
14	64.1	4,107	15 "	20 "
12	80.8	6,530	20 "	25 "
10	101.9	10,380	25 "	30 "
8	128.5	16,510	35 "	50 "
6	162.0	26,250	50 "	70 "
5	181.9	33,100	55 "	80 "
4	204.3	41,740	70 "	90 "
3	229.4	52,630	80 "	100 "
2	257.6	66,370	90 "	125 "
1	289.3	83,690	100 "	150 "
0	325.0	105,500	125 "	200 "
00	364.8	133,100	150 "	225 "
000	409.6	167,800	175 "	275 "
——	447.2	200,000	200 "	300 "
0000	460.0	211,600	225 "	325 "
——	——	300,000	275 "	400 "
——	——	400,000	325 "	500 "
——	——	500,000	400 "	600 "
——	——	600,000	450 "	680 "
——	——	700,000	500 "	760 "
——	——	800,000	550 "	840 "
——	——	900,000	600 "	920 "
——	——	1,000,000	650 "	1,000 "

Under heading of "Rubber covered wire" it will be found that a No. 3 wire has a capacity of 80 amperes, which is the nearest to the desired size to carry 75 amperes safely.

These feeders are to be run in conduit and from table No. 2 the size of pipe required can be determined.

Size of wire B. & S. Gauge	1 Conductor in a conduit conduit size in inches	2 Conductors in a conduit conduit size in inches	3 Conductors in a conduit conduit size in inches	4 Conductors in a conduit conduit size in inches
14	½	½	½	¾
12	½	¾	¾	¾
10	½	¾	¾	1
8	½	1	1	1
6	½	1	1¼	1¼
5	¾	1¼	1¼	1¼
4	¾	1¼	1¼	1½
3	¾	1¼	1¼	1½
2	¾	1¼	1½	1½
1	¾	1½	1½	2
0	1	1½	2	2
00	1	2	2	2½
000	1	2	2	2½
0000	1¼	2	2½	2½
200000	1¼	2	2½	2½
250000	1¼	2½	2½	3
300000	1¼	2½	2½	3
400000	1¼	3	3	3½
500000	1½	3	3	3½
600000	1½	3	3½	——
700000	2	3½	3½	——
800000	2	3½	4	——
900000	2	3½	4	——
1000000	2	4	4	——

Since the feeders are both run in the same pipe or conduit, under the heading "2 conductors in a conduit, size of conduit in inches," it will be found that for two No. 3 wires a 1¼-in. conduit will be required.

The next to be determined is the size of the cutout and switch. The cutouts and switches are made in 30 amp., 60 amp., 100 amp,. etc. sizes. For this reason the 100 ampere size of each must be used; the fuses will be of the cartridge type with knife contact ends. An iron box should be supplied to protect the fuse block and switch.

The list of material required to run the feeders from the panel box to the switch box (a distance of 85 feet) is as follows:

90 feet of 1¼-in. conduit.
2—1¼-in. bushings.
2—1¼-in. lock nuts.
1 iron box for switch and cutout.
180 feet No. 3 D.B.R.C. (stranded) B. & S. gauge.
4 copper lugs.
15—1¼-in. pipe straps.
Nails, screws, solder, etc.

The switch and cutout should be located as near to the motor as convenient, and the starting box or speed regulator is usually placed below the switch. If the motor is set some distance away from the wall it must be wired in conduit as follows:

From the lower side of the switch and cutout box run a short nipple (1¼-in.) into a tpye LL44 condulet, and at the other end of the conduit, where the wires leave to be connected to the motor terminals, use a type B4 condulet with a 3-hole composition cover.

Assume the distance from the starting box to the motor is 10 feet and from the floor to the starting box is 6 feet, then the list of material required is as follows:

20 feet 1¼-in. conduit.
50 feet No. 3 D.B.R.C. (stranded) B. & S. gauge.
20 feet No. 10 S.B.R.C. (solid) B. & S. gauge.
1 foot LL44 condulet.
1 foot B4 condulet.
1 foot 1¼-in. bushing.
1 foot 1¼-in. lock nut.
2 feet copper lugs.
5 feet 1¼-in. pipe straps.
Screws, nails, solder, etc.

Fig. 1 shows the diagram of the pipe line how it should be fastened to the panel box, switch box, and also from there to the starting box and motor.

The starting box should be installed directly below the switch and must be mounted on a piece of slate or soap stone; porcelain knobs are used to keep the starting apparatus free from the wall or partition, as shown in Fig. 2.

In running the wires from the starting to the motor, two No. 3 and one No. 10 wire will be run; the No. 10 wire is for the field, as it only carries a small part of the current that the motor consumes.

There is another style of starting box as shown in Fig. 3, which has four binding posts instead of three as the one shown in Fig. 2. The connections to this style of starting box are made the same as shown in Fig. 2, except that a tap is taken from the line marked L on the motor and connected to one of the line terminals on the starting box. If this connection were omitted the motor could be started all right, but when the last point of the starting box is reached the handle would not be held by the retaining magnet.

Before starting a motor a general inspection and examination

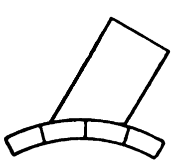
Fig. 4

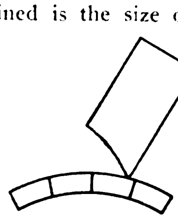
Fig 5

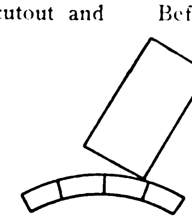
Fig 6

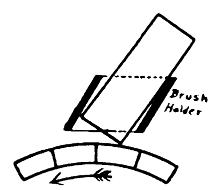

Fig 7

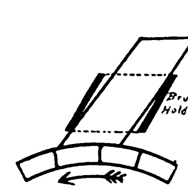

Fig 8.

of the entire installation should be made to see if the proper fuses are placed, all connections tight, oil in motor bearings, brushes set in proper position (most manufacturers put a mark on the rocker rung on which the brush holders are mounted and a corresponding mark on the frame, so by having these two marks set together the brushes must be set properly), and be sure and have the brushes properly ground to fit commutator surface. If all the above mentioned are found to be correct the motor may be now started light (no load).

When the starting box handle is brought up to the first point the armature of the motor should begin to revolve slowly and gradually increase its speed as the handle is gradually brought up to the last point, when the motor will run full speed. The reason for the motor speeding up as the starting box handle is brought from the first to the last point is as follows:

On the first point all the resistance of the starting box is cut into the armature circuit and the field windings are directly

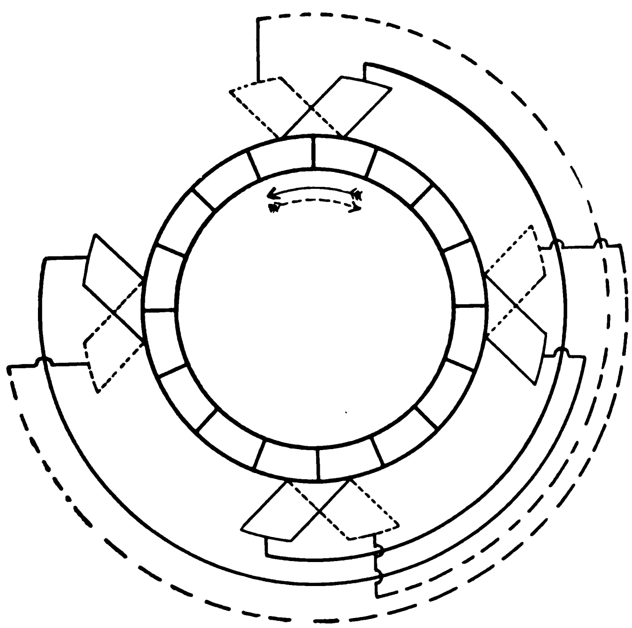

Fig 3.

connected across the line; this produces a very strong field and a weak armature torque, which results in a slow speed; as the handle is moved from point to point, the resistance is being cut out of the armature circuit and into the field circuit, consequently the field is weakened and the armature strengthened and this causes the armature to increase its speed; and when the last point is reached all the starting box resistance is in the field circuit and the armature is directly connected across the line.

When a motor is being started light (no load) it should take from 15 to 20 seconds to bring it up to full speed, and under loaded conditions from 30 to 40 seconds.

If the retaining magnet, or no voltage release coil, as it is sometimes called, should heat up and smoke the first time the motor is being started, the connections between the starting box and the motor should be examined and it will be found that the wire from the armature terminal on the starting box has been connected to the field terminal on the motor, and the field wire to the armature. This will send the armature current through the no voltage release coil and cause it to heat. To correct this trouble, simply transpose the armature and field wires on the motor and start motor again.

Personal

Captain Harry C. Turnock, late of Coast Artillery Corps of the 59th Regiment, Heavy Artillery, delivered an address at a recent meeting of the Cleveland Electrical League. Captain Turnock is a charter member of the Electrical League and veteran of the Spanish war and Philippine insurrection. He volunteered his services in May, 1917, and after a course of intensive training at Fort Ben Harrison and Fortress Monroe, Va., was commissioned a 1st Lieut. of Heavy Artillery and sailed for France, September 14, 1917. After serving as instructor of radio telegraph, he asked for active service and was at the front in the St. Mihiel sector. After the wiping out of this salient, Captain Turnock went with his regiment to the Argonne Forest, where he was on duty at the time of the signing of the armistice.

J. F. McGuire, manager of the Minot, N. D., division of Northern States Power Company, has been made a member of a committee, appointed by the board of directors of the Association of Commerce, to investigate the feasibility of building an electric line from Minot to Roseglen and Elbwoods, in which many farmers along the route are greatly interested.

George Dielman has been made manager of the Olympia Gas Company, succeeding J. G. Bourus, now manager of the Puget Sound Gas Company, at Everett, Wash.

A. L. Martin, manager of the Marshfield, Ore., division of the Mountain States Power Company, has been elected president of the Marshfield Chamber of Commerce.

Mr. Lester E. Armstrong has accepted a position as advisory engineer with the Powdered Coal Engineering & Equipment Company, of Chicago. Prior to his service in the Air Branch of the Army, Mr. Armstrong was associated with Babcock & Wilcox.

Col. C. H. Crawford, of Philadelphia, has been elected director of the American Association of Engineers to succeed Mr. T. M. Chapman, deceased. Col. Crawford served in the Purchase, Storage and Traffic division of the general staff of the War Department during the war, and has recently taken employment with the Baldwin Locomotive Works, at Philadelphia. Prior to the war he was assistant to the President of the N. C. & St. L., at Nashville, Tenn. He has been interested for a number of years in the unity of the engineering profession, and was an active member of the Committee on Co-operation, representing the Engineering Association, at Nashville, Tenn.

Mr. John F. Nealis, who recently received his discharge from the Aero Observers branch of the service, is now associated with the Powdered Coal Engineering & Equipment Company, of Chicago, as advisory engineer. Mr. Nealis formerly had charge of research work for the U. S. Steel Corporation.

W. G. Lord, formerly chief electrician of the Arkansas Valley Railway Light & Power Company, Pueblo, Colo., has been appointed superintendent of the Pueblo division, succeeding C. A. Orr, resigned.

Here and There in the Electrical Field

Barrington, N. S., is planning the installation of an electric light system and power plant.

The town council of Cobri, Sask., is planning the installation of an electric light system.

The North Shore Power Company, of Three Rivers, Que., will instal an electric lighting system at St. Louis de Champlain.

During 1917 the Government telegraph lines in Brazil showed increases in operation and equipment. In that year 1,314 kilometers of telegraph lines were constructed and 2,218 kilometers of additional wires strung, bringing the total length of lines up to 39,646 kilometers and the length of the wires to 72,658 kilometers.

B. W. Cowperthwait, manager of the Faribault, Minn., division of the Northern States Power Company, and president of the Minnesota Electrical Association, has issued the call for the association's 1919 convention. It will be held in St. Paul, March 18, 19, 20.

The transmission line between Boscobel and Prairie du Chien, Wis., has been completed, connecting the last named town with the transmission system of the Interstate Light & Power Company (subsidiary of Northern States Power Company). This adds approximately 300 kw. to the electric load of the Interstate company.

The Superior Court of Fairfield County, Conn., has fixed a limit of four months for the presentation of all claims against the Bridgeport Electric Manufacturing Company, Inc. The receiver is Max Cohen, 96 Bank Street, Bridgeport.

According to statistics compiled by the American Electric Railway Association, of the 277 cities in the United States with a population of more than 25,000, 176 are already paying an increased rate of fare. Of the remaining 101 cities, 53 are now endeavoring to obtain advances in rates. The majority of rate increases granted are from five to six cents. Twenty-seven cities are now paying a ten-cent fare.

Swift & Co. are adding 229 horsepower to their power installation at the South St. Paul stockyards, which is served electrically by the Northern States Power Company. The growth of population due to the new Armour packing plant at South St. Paul has been such that the community is suffering from a scarcity of dwellings. One concern plans the construction of 200 new houses this year.

Contract has been closed with the Missouri-Arkansas Oxygen Company whereby the Fort Smith Light & Traction Company will furnish current for 200 horsepower in motors to operate the oxygen plant.

Prize Essay Contest in Industrial Economics

The National Industrial Conference Board offers a prize of $1,000 for the best monograph on any one of the following subjects:

1—A practicable plan for representation of workers in determining conditions of work and for prevention of industrial disputes.

2—The major causes of unemployment and how to minimize them.

3—How can efficiency of workers be so increased as to make high wage rates economically practicable?

4—Should the State interfere in the determination of wage rates?

5—Should rates of wages be definitely based on the cost of living?

6—How can present systems of wage payments be so perfected and supplemented as to be most conducive to individual efficiency and to the contentment of workers?

7—The closed union shop versus the open shop: their social and economic value compared.

8—Should trade unions and employers' associations be made legally responsible?

Essays must be sent over an assumed name, with the real name of the contestant in a sealed envelope, to the board at 15 Beacon Street, Boston, on or before July 1, 1919.

Trade Notes

"Dixon's Graphite Products" is the title of a new pocket catalog issued by the Joseph Dixon Crucible Company, of Jersey City. While not so complete as the large general catalog, it furnishes a good idea of the variety of products made by this old concern. Pages have been devoted to list of articles, especially for mills, railroads, automobiles, etc. The descriptions are brief but the company will gladly send pamphlets dealing in detail with any of the individual members of the line. This new catalog should be in the file of every purchasing agent, engineer, superintendent and others who have occasion to use lubricants, paint or pencils. Ask for booklet No. 129-KP.

The Robbins & Myers Company, Springfield, O., issue their 1919 catalog of Electric Fans as a most attractive little booklet of 36 pages in a colored cover. This describes and illustrates non-oscillating, oscillating, ceiling and ventilating fans, and hat cleaning motors for alternating and direct current circuits. The company also issues two most attractive folders for advertising purposes, beautifully illustrated in colors, one devoted to ceiling fans, and the other to oscillating and non-oscillating fans.

A. F. Danm, 1157 Hodgkiss Street, Pittsburgh, Pa., has just put out a bulletin illustrating and describing the various forms of refillable fuses for electric light and power that he manufactures. Danm fuses have been on the market for over eight years, and during that time they have steadily grown in favor. The Danm plant has been enlarged three times since starting the renewable fuse business, and larger additions are now being considered, showing a steady and healthy growth.

The Appleton Electric Company, of Chicago, has issued Catalog Eight, describing and illustrating "Unilets," and other conduit fittings they manufacture. This is a compact, little handbook of 160 pages.

The Bureau of Commerce, Washington, reports that a firm in Denmark desires to purchase and also secure an agency for the sale of electric motors of 220 and 110 volts, direct and alternating current; electric bulbs; accessories for automobiles and motorcycles; ball bearings; tires for motor cars and motor lorries; files and belting. Quotations should be made f.o.b. New York. Terms cash. Correspondence may be in English. Address No. 28,320, care of the Bureau. An agency is desired by a man in Australia for the sale of magnetos, self-starters and other electrical appliances for motor cars. References. Address No. 28,557.

A wiring chart for determining the proper wire size for use on circuits of 110-125 volt country home lighting systems has just been prepared by the Engineering Department, National Lamp Works of General Electric Company. The steady demand for the low voltage (28-32 volts) wiring chart for country homes, distributed in July of last year, shows that the information contained therein is valuable and conveniently arranged. For this reason the chart on 110-125 volt systems is designed along the same lines. However, to aid in distinguishing the two charts, the new one is salmon colored and is contained in an envelope on which the printing is done in dark red. In connection with the high and low voltage systems, it should be noted that there is a fundamental difference between the two designations, 28-32 volt lamps and 110-125 volt lamps. In the first instance, a single class of lamps, any one of which is designed to operate on any voltage within the range indicated is referred to; but, in the latter case there is a different lamp for each individual voltage between 110 and 125 volts. While the characteristics of all the lamps in this range are such as to allow of their being grouped together for many purposes, as in the wiring chart just prepared, it should be remembered that a 110-volt lamp is to be burned only on a 110-volt circuit; a 115-volt lamp on a 115-volt circuit; or, in general, each lamp only on a circuit of the voltage for which that lamp was designed. As indicated above, the information on the chart for 110-125 volt systems may be used for all voltages within the range. Either chart may be obtained on request from the Engineering Department, National Lamp Works, Nela Park, Cleveland, Ohio.

ELECTRICAL ENGINEERING

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Perfecting the Submarine Detector

THE United States Navy Department, after nearly two years of the closest censorship, has given approval to the publication of certain data relating to the development in the United States during the war of submarine detecting devices, which were used to signal advantage by this country and the Allies in prosecuting and bringing to a successful conclusion the campaign against the German U-boat. The apparatus may be termed the composite work of the General Electric Company, Submarine Signal Company, Western Electric Company, the National Research Council, assisted and advised by many eminent scientists, engineers and research men, chief among whom were Drs. W. R. Whitney, Irving Langmuir and W. D. Coolidge, Prof. R. A. Milikan, Prof. Max Mason, etc.

Realizing that the prompt solution of the submarine problem was the key to a successful termination of hostilities, Secretary Daniels, immediately upon our entrance into the conflict, appointed a special board to devise ways and means to overcome it. At the suggestion of Dr. Whitney, director of General Electric Company's research laboratories, a group of scientists was formed at Nahant, Mass., under Dr. Irving Langmuir, where the results of extensive research activity were put to practical tests under actual conditions as nearly as possible approaching those in European waters. Another group under Prof. Milikan, head of the Physics Department of the University of Chicago, was organized at New London, Conn., where and the work of both bodies was later co-ordinated.

Out of the efforts of these two groups and the work carried on in Schenectady, assisted by Allied commissions of scientific men, there grew the American Submarine Detector—a development of the old principles of sound wave transmission in water in an altogether new and startling manner. The apparatus, finally perfected and put to immediate use, was first designed to hang overhead from naval craft amidship below the water line and it depended for its direction getting qualities on the peculiar and heretofore little understood faculty of the human ear to detect the direction of sound by the shifting of that sound from one ear to the other.

Owing to the interference of sounds made by the listening ship's own motors, it was found more practical to stop the engines when about to take observations and this added greatly to the effective range of the instrument. To overcome this obstacle, another device was developed which could be trailed off the stern a hundred or so feet away where the engine noises of the ship were out of range and the sound was then brought into the operator in the ship's hold. A third adaptation of the listening principle was an instrument which protruded through the hull and was a stationery part of the vessel's equipment. A somewhat circular device was constructed for use on submarines, but all of them were used to advantage.

While demonstrating the device to the British Admiralty, our American engineers were asked to study the question of fitting submarine detection units to airplanes, balloons and dirigibles. After some experimentation, followed by more practical tests and conferences with the Lancashire Group of scientists at Harwich, apparatus was developed which met these needs and many aircraft were equipped with sound detectors which rendered it possible for them to follow the course of the enemy after they had seen her submerge, a valuable faculty which such craft did not possess until the introduction of the American detector.

Permission has not yet been obtained to enter into a detailed description of the devices invented during this period. The Government, having spent large sums of money on the apparatus, desires the intricacies of its manufacture still kept secret, while other matters involving several American concerns, makes discretion the better part of valor in attempting to tell the inner secrets of its development. However, when the devices had proved themselves eminently satisfactory after exhaustive experimentation here, the Navy Department organized a special Service Party under Captain R. H. Leigh of the Bureau of Steam Engineering to demonstrate the detectors to the British Admiralty. Shortly after the arrival of this party abroad, the

American submarine detectors were universally adopted by all the Allied navies. It was found to be much superior in many ways than any of previous development, and came to be considered one of the most effective offensive weapons ever used against the submarine.

To sum up, the results achieved by these American listening devices, it is only necessary to recount a few pertinent points to illustrate the device's practicability. Under ideal conditions with extraneous noises reduced to a minimum or entirely eliminated, the device was effective at a range of from 15 to 25 miles. Trained operators could clearly and invariably distinguish between the sounds made by approaching surface craft and under-water vessels (submarines). Under average circumstances, the device was good for a range of between 3 and 8 miles. Within five miles the engine characteristics of different vessels was clearly marked even to the point of identifying by name certain (unseen) vessels after they had been observed previously for more than one time. (This test was substantiated by a series of night time experiments at the entrance to Boston harbor in September and October, 1917.)

It was found practical to tell when a submarine changed from her oil engines to electrical drive which was necessary every time she submerged. The direction of sound could usually be computed within a very few degrees of its actual location and a good judgment of the distance could generally be made. This was proved to the satisfaction of all concerned following a number of practical tests off Cape Cod, Mass., in the late summer of 1917, in waters adjacent to Boston and in Long Island Sound.

While in fairness to all of the sound-detecting devices developed during the war period, it must be said that the American device was inferior in certain respects when it came to the application of these devices under actual battle conditions and in heavy sea and weather they stood up remarkably well. This factor was of especial value during operations in the English Channel and the North Sea, which has been termed the roughest body of water for its size in the world.

The addition of these listening devices to submarines added the heretofore lacking sense of hearing to all the underwater craft and made them at once a much more effective weapon of offense. An Allied submarine on one occasion chased a German U-boat for four hours, while both craft were submerged, without once losing sound contact with the enemy.

The engagement occurred one early morning in the English Channel. A small squadron of sub-chasers discovered an enemy craft moving slowly up the channel submerged. Forming for the attack they rushed over the spot where the listeners indicated the U-boat to be, dropped a pattern of depth bombs and then withdrew to take observations. Feverish activity and the sound of hammers ringing against the ship's side was heard. The submarine engines would then start up and stop, start and stop again. Further attacks were delivered and more noise came to the listeners from the hold of the submarine. Evidently the first depth charge had taken good effect and the enemy's crew was making a last desperate effort to reach the surface. Then there was a dead silence broken at last by twenty-five sharp reports like revolver shots. The crew, giving up in despair, had committed suicide. The loss of this submarine was later substantiated by the British Intelligence Department.

When Captain Leigh and his party went abroad in November, 1917, he requested the Admiralty to loan him two high-speed chasers in which operations could be begun in English waters, but was finally obliged to accept three trawlers of 9 to 10 knots speed, because of the then scarcity of higher speed craft. Equipping these vessels with all of the anti-submarine detecting apparatus they went out in the English Channel on New Year's Day, 1918. Shortly afterwards a wireless message was picked up from an airship giving the position of a submarine which had just been seen to submerge. The channel had been laid out in numbered squares to facilitate the immediate location of enemy craft and the little squadron steamed over, got their devices out and picked up the submarine course. When believing themselves about over the enemy, depth bombs were discharged and later a trawling instrument was used which indicated that the submarine had been destroyed. Great quantities of oil rising to the surface also substantiated the success of the attack.

Remaining in English and French waters for several months, where the American devices proved of great value and were highly complimented both by Admiral Sims and British naval officers, another squadron was equipped and sent into the Mediterranean and Adriatic where at this time submarine activity was at its height. Because of the deeper water and less interference from surface traffic, listening conditions were unusually good. A barrage line of boats was organized across Otranto Straits between the main land and the Island of Corfu to effectively put a stop to the enemy's free entrance to the Mediterranean.

Three of the chasers patrolling in formation abreast one dark night heard a sub approaching. The bearings obtained by the two beam vessels pointed directly toward the center boat. The middle boat now heard the submarine approaching from a position dead astern. The enemy came nearer and nearer and finally passed right under the sub-chaser so close to the surface that those on board felt a wave of water along the keel of their ship. When the German had passed on and out in front, the attack was made in unison, a pattern of depth bombs was "let go" and the little fleet halted for further observations. Pretty soon the whirl of the submarine's electric motors was heard evidently in an effort to reach the surface. When came a crunching noise not unlike the popping in of a blown-up paper bag. It was apparent that the submarine had been damaged, put out of control and sunk and that she had collapsed from the tremendous water pressure at these depths.

Many incidents of this kind occurred during the subsequent operations in foreign waters and several submarines were accounted for through the direct aid of the American listening devices. In fact, naval experts who were closely in touch with submarine detection development during the war period, state with conviction that if the conflict had continued through another summer, the submarine would literally have been driven from the ocean, the promise of a condition due in a large measure to the perfection of submarine detecting apparatus.

It has also been stated that the noticeable change in naval tactics—from defensive to offensive—which marked this country's entrance into the war was largely caused by the application of American principles to the pursuit and attack of the U-boat, something made possible by the practical use to which it was found the American submarine detector could be pupt.

Electric Railways in Porto Rico and Hawaii

Preliminary figures of the forthcoming quinquennial report on the electric railways of Porto Rico and Hawaii have been given out by Director Sam. L. Rogers, of the Bureau of Census, Department of Commerce. They were prepared under the supervision of Eugene F. Hartley, Chief Statistician for Manufactures. The statistics, which relate to the years ending December 31, 1917 and 1907, show substantial gains in the electric railway industry in both Porto Rico and Hawaii for the ten-year period covered.

There were three operating companies in Porto Rico in both 1917 and 1907. The mileage of track totaled 22 in 1917, as against 18 in 1907. The number of revenue passengers carried was 6,724,051 in 1917, or 32.2 per cent more than in 1907. The revenue car mileage amounted to 1,378,322, an increase of 67.4 per cent. for the decade. The electric power consumed amounted to 7,445,563 kilowatt hours, of which 2,390,601 was generated by the companies, and 5,054,962 was purchased.

There was only one operating company in Hawaii in 1917, as in 1907, with 32 miles of track in the later year, as compared with 26 in the earlier. The number of revenue passengers carried was 14,378,092 in 1917, or 95.4 per cent more than in 1907. The revenue car mileage amounted to 2,039,235, an increase of 29.4 per cent for the decade. The electric power consumed—all generated by the operating company—amounted to 4,734,000 kilowatt hours, an increase of 104.1 per cent, as compared with 1907.

In order not to disclose the operations of individual companies, the financial statistics for Porto Rico and Hawaii were combined in 1917, as in 1907. The comparative statistics for the two districts combined are as follows.

The companies employed 582 persons in 1917, an increase of 46.6 per cent, as compared with 1907. The salaries and wages paid to these employees aggregated $472,356, an increase of 93.6 per cent for the decade. The income from all sources was $1,186,418, of which sum $1,167,714 represented operating revenues. The rate of increase in the total income for the period 1907-1917 was 57.4 per cent. The operating expenses aggregated $684,054, an increase of 63.5 per cent. over 1907; and the deductions from income, comprising taxes, interest, and fixed charges, amounted to $139,876, a decrease of 24.1 per cent as compared with 1907. The net income was thus $362,488, as compared with $151,025 in 1907, the rate of increase being 140 per cent.

The Electric Light and Power Industry

According to a report about to be issued by Director Sam. L. Rogers, of the Bureau of the Census, Department of Commerce, the electric light and power stations in the United States during the year 1917 generated more than 25 billion kilowatt hours of electric energy, producing an income of more than a half billion dollars, and gave employment to more than 100,000 persons, whose salaries and wages aggregated nearly $100,000,000. The output in 1917 was more than double that for 1912, and more than quadruple the output for 1907.

This report, which was prepared under the supervision of Eugene F. Hartley, Chief Statistician for Manufactures, covers both commercial and municipal plants, but does not cover electric plants operated by factories, hotels, etc., which generate current for their own consumption; plants operated by the Federal government and state institutions; nor plants that were idle or in course of construction.

The figures show great strides in the industry during both of the five-year periods 1907-12 and 1912-17. The output of electric energy by the light and power stations increased at a considerably greater rate, and their expenses at a slightly greater rate, than their income; and the rate of increase in the number of persons employed was much smaller, particularly during the later five-year period, than that in the amount of business done.

The total number of establishments increased from 5,221 in 1912 to 6,541 in 1917, the latter comprising 4,224 commercial, and 2,317 municipal, establishments. The increase indicated by these figures is somewhat misleading, since 2,295 new establishments came into existence between 1912 and 1917, but as a result of combinations in the commercial systems and various other changes, the net increase was only 1,320, comprising 565 commercial and 755 municipal stations.

The total income of the stations in 1917, of which 95.3 per cent represented electric service, amounted to $526,886,408, an increase of 74.3 per cent, as compared with 1912 and of 200 per cent as compared with 1907. The total expenses were $427,136,136,049, or 82.1 per cent more than in 1912 and 218.3 per cent more than in 1907. The employees of the light and power stations numbered 105,546, an increase of 33 per cent over 1912, and of 121.6 per cent over 1907; and their salaries and wages aggregated $95,239,954, an increase of 55.7 per cent, as compared with 1912 and of 168.9 per cent over 1907.

The total primary power in 1917 amounted to 12,857,998 horsepower, an increase of 70.8 per cent, as compared with 1912 and of 213.7 per cent over 1907. Of this power nearly two-thirds—8,389,389 horsepower—was derived from steam; almost one-third—4,251,423 horsepower—from water; and the remainder—217,186 horsepower, or less than 2 per cent—from internal-combustion engines. The corresponding proportions for 1912 and 1907 differed but slightly from those just stated. The average horsepower per steam engine shows a very great increase—from 334 in 1907 to 631 in 1912 and to 1,124 in 1917. The average horsepower of the water wheels also shows a marked increase from census to census, but in the case of the internal-combustion engines there has been a decline.

The total dynamo capacity, 9,001,872 kilowatts in 1917, represents an increase of 74.3 per cent as compared with 1912 and 232.2 per cent over 1907, these rates of increase being slightly greater than the corresponding ones for total primary power. The output of electrical energy aggregated 25,438,611,417 kilowatt hours, an increase of 119.9 per cent for the period 1912-17 and of 333.9 per cent for the decade. Of the 6,541 establishments reported for 1917, those which purchased all their electric energy from other establishments numbered 1,422, as against 507 in 1912 and 227 in 1907.

The horsepower of stationary motors served amounted to 9,216,323 in 1917, or 123.1 per cent more than in 1912 and 458.9 per cent more than in 1907. The figures indicate that the arc lamp for street lighting is being fast superseded by the incandescent of various types. The former class of lamps decreased in number from 348,643 in 1912 to 256,838 in 1917, the reduction amounting to more than one-fourth, while during the same period the number of incandescent lamps more than doubled, increasing from 681,957 to 1,389,382.

A Big Turbine-Generator Equipment

By J. P. Rigsby

THE 45,000 K. W. Turbo-Generator unit recently put into operation in the power station of the Narragansett Electric Light Company at Providence, R. I., is of the now well-known Westinghouse cross-compound double unit type, consisting of a high and low pressure turbine, each connected through a flexible coupling to its own generator, having a capacity of 22,500 kw. and mounted on separate bedplates supported on foundations lying parallel to each other. The generators are arranged to feed separately or together to the main bus.

This type of turbine is very successfully exemplified by the three 30,000 kw. units installed a few years ago in the Seventy-fourth Street Station of the Interborough Rapid Transit Company, New York. Steam enters the high-pressure turbine through suitable governor-controlled valves, passes through this single flow element, and out through an exhaust on the top, and is conducted by means of a receiver pipe overhead to the middle of the double flow low-pressure turbine alongside, where it divides, flowing in opposite directions through low-pressure blading, then down through the exhaust chambers into two Westinghouse Leblanc jet condensers of the latest type.

The energy given up by the steam at full load is equally divided between the high and low-pressure turbines, the generators dividing the load in half; at lower loads a greater proportion is carried by the high-pressure element. The unit was designed to operate with a steam pressure at the throttle of 200 pounds with 100 deg. superheat and a vacuum of 29 inches in the exhaust, while the generators have a capacity of 23,750 kva., 11,000 volts, 3 phase, 60 cycles at 0.95 factor, the high-pressure elements having a speed of 1,800 r. p. m., and the low-pressure 1,200 r. p. m. There are four bearings to each unit, a flexible pin type coupling being used to connect the turbine and generator.

The high pressure turbine is of the single-flow reaction type throughout, of a very simple, rugged construction, designed for efficiency and dependability, all parts coming in contact with high-pressure steam being made of cast steel, while the exhaust chamber and other parts not subjected to high temperature or stresses are of cast iron. The pressure in the high-pressure cylinder varies from a maximum of about 200 lbs. at the inlet to atmospheric pressure in the receiver pipe at full load.

With reaction type machine, high-pressure steam is admitted, of course, direct to the cylinder casing instead of into nozzle chambers, as is the case with an impulse type. This presents the problem of perfecting a horizontal joint on a cylinder of considerable diameter that will be tight, and stay tight, against 200 to 300 lbs. steam pressure, or any tendency to open, due to distortions from the high temperature.

The high-pressure end, or steel part of the cylinder, is composed of two steel castings, 5 ft. 10 in. inside diameter and 1¾ in. thick, while at the joint thickness gradually increases until it merges into a flange eight inches wide, tapering to the outer edge. These bolts, or studs, as they really are, 2¼ in. in diameter, are tapped alternately into upper and lower flanges registering with suitable bosses on the companion flange.

This method permits of a closer spacing of bolts, removing less metal, and produces a stronger flange than by any other means. No gasket is used, the joint being scraped to a surface.

The four rings containing the blades are not an integral part of the main cylinder, but are made of separate castings joined in the middle, resulting in simplicity of construction, freedom from strains, and the absence of those difficulties inherent in a complicated steel casting, besides being a distinct aid in manufacturing, as the machine work is not all done on one piece, but can be divided among different machines, and finally assembled when each piece is completed. These rings are clamped in place, again saving expensive work on the main castings.

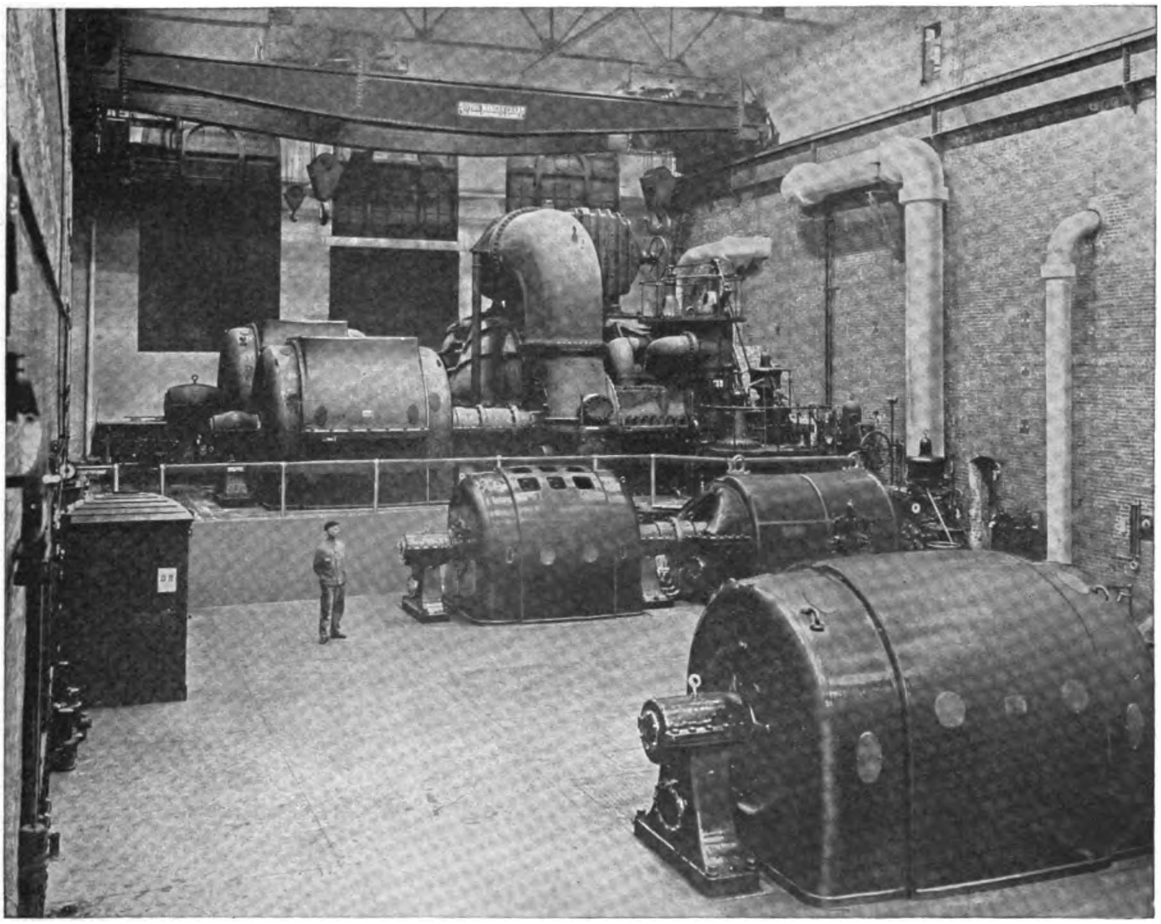
The high-pressure cylinder is supported on three points, as usual, one under the governor, or thrust end, and one on each side of the exhaust, near the center line, thus insuring against distortions, or a possibility of misalignment, due to differential expansions between the turbine and generator supports from unequal temperatures.

The high-pressure spindle consists of a hollow steel drum about three feet in diameter, carrying most of the blading, there being two blade rings of larger diameter on the one end, and corresponding dummy rings, or balance pistons, on the other. The spindle ends are pressed into the drum and are secured with tee-headed shrink links, which are themselves held in place by the blade and dummy rings. The stresses in the spindle parts are quite low, these parts being made from ordinary carbon steel. However, strict care is taken in making the castings in order to insure homogeneity, the precautions necessary to secure this uniformity having been learned by long experience.

There are 24 rows of blades in the high-pressure turbine, ranging in size from 1 in. blades, 4 in. long, to 1¼ in. blades, 9½ in. long. These blades are unusually strong and rugged, and they insure the highest efficiency and durability. The maximum mean blade speed is 470 feet per second.

The steam passes out through an exhaust at the top of the cylinder into a 66-inch receiver pipe leading over to the low-pressure turbine. A similar exhaust is provided directly below, which connects through an automatic relief valve to the atmosphere. A gate valve is placed in the receiver pipe, in case it is necessary to operate either turbine alone, the high-pressure turbine running non-condensing, under control of its own governor, or the low-pressure turbine, on steam admitted through a 14-inch throttle from the high-pressure line, it being connected in step electrically with some other unit in the system.

Steam is supplied to the unit through a 24-inch



A 45,000 K. W TURBO-GENERATOR UNIT FOR A PROVIDENCE LIGHTING COMPANY header, every care being taken to provide adequate flexibility to the line. A standard Westinghouse type throttle valve with the regular automatic stop features controls the admission. The throttle valve steam strainer and primary steam chest, which are located adjacent to the bedplate alongside the turbine, are spring-supported, so as not to impose a dead load on the cylinder.

The low-pressure element is of the straight, double-flow reaction type. The steam entering at the top through the above-mentioned receiver pipe, passes around the spindle in an annular chamber of ample proportions, and enters the low-pressure blading, there being eight rows in each end, ranging from ¾-inch blades 6 in. long, to 1¼-in. blades 18 in. long. The low-pressure cylinder rests on four supports applied near the center line on each side of the exhaust chambers. It is free to expand axially sliding on these supports, the turbine being anchored to the inboard generator pedestal. A system of radial and axial stays in the exhaust chamber produces extreme rigidity, minimizing the possibility of distortion or sympathetic vibrations.

The low-pressure spindle is composed of a central hollow drum, rigidly secured to the spindle ends. Upon each of these ends are mounted two discs carrying the low-pressure blades, the maximum mean velocity of which is only 515 feet per second, which precludes the necessity of using other than a reasonably good grade of cast steel in the blade rings. However, owing to the double-flow feature, ample blade area is provided to make the best use of a high vacuum and still maintain a conservative blade length in the last rows. Phosphor bronze blades are used throughout, except the last three rows in the low-pressure, which are forged steel. The low-pressure cylinder is entirely of cast iron, composed of a center section and two end sections, bolted and spigoted together, and all split horizontally. The three upper pieces are handled as one, the vertical points never being disturbed.

The high-pressure steam admission is controlled much the same as on all other Westinghouse machines, by means of a powerful, though sensitive, governor, which operates the plunger of an oil relay attached to a floating lever, this relay controlling the admission of oil to an operating cylinder mounted on the side of the first, or primary valve. This cylinder, by means of levers, controls the primary, secondary and tertiary admission valves. The primary valve, located on the side, admits steam to the bottom of the high-pressure cylinder, while the secondary and tertiary valves, being located on the top symmetrically about the center line, admit steam to the second, or third stage, as the case may be. Loads of 30,000, 40,000 and 50,000 kw. respectively, can actually be carried on these valves.

Both turbines are equipped with double Kingsbury thrust bearings capable of taking the load in either direction, though when running under load the thrust is toward the generator. The shafts are sealed with the usual well-known water gland with the addition of an annular steam chamber for the admission of steam so that a vacuum can be established before starting up. Each turbine is provided with an oil pump sufficient for its own needs, though both feed into the same oiling system. They are double plunger pumps, running at 165 strokes a minutes, with a common suction, but separate discharge.

The high-pressure oil necessary to operate the steam inlet valves is taken from one side of the pump on the high-pressure turbine, pressure being maintained by a spring-loaded relief valve. The total amount of oil used is approximately 175 gallons a minute. The bearing oil pressure is from five to eight pounds.

This unit, although it does consist of two separate elements, is started the same as any other machine. Field excitation is supplied to the generators, the throttle on the high-pressure element is opened, and slowly brought up to speed, the low-pressure generator operating as a motor, and coming to speed in step with the other. The two machines as a unit can then be synchronized, and placed on the line, remaining in step and properly dividing their load.

The condenser equipment for the above turbine consists of the largest condensing apparatus in the world. The condenser unit is composed of two separate and distinct low-level jet condensers, which can be operated together, or separately, if necessary. If the temperature of the injection water is low enough to warrant it, the operation of only one condenser is necessary to maintain a workable vacuum. These condensers are connected to form a single condensing apparatus by means of an exhaust connection, ample in area to permit operating either condenser alone, when necessary.

The same water level is maintained in each condenser by the use of a water equalizing connection between one pump body and the other. This is an absolutely necessary feature, and it is provided in order to maintain a constant submergence over the center line of each pump, to provide sufficient head to force water into the runner under vacuum. This water-equalizing connection is so constructed that no surges occur between the condensers, it being made in the form of a toe, the bottom of which forms a reservoir. A baffle running almost to the bottom prevents surging. An air equalizing connection is provided to maintain the same air pressure in each condenser. If both are in operation, the valve may be either open or closed, but it has been found by trial that if one condenser only is in operation, the valve must be open in order to have the same air pressure in each.

The condensers are equipped with geared turbine-driven pumps, running at 500 r. p. m. instead of 700 r. p. m., which latter is standard. This was found necessary, owing to the limited headroom in the basements. These pumps are able to operate with a submergence of 50 in. above the center line of the pump shaft, while 72 in. is necessary with a 700 r. p. m. pump. This resulted in a saving in headroom of 22 in. Considering capacity, this unit requires less floor space than any other condenser unit now in operation.

In starting up this condenser it is necessary to use a priming pump. The main turbine is operated non-condensing, or with a slight vacuum, until sufficient vacuum is obtained for the condenser to lift its own water. The operating company has found it convenient in winter time, when the temperature of the injection water is very low, to operate only one condenser of the twin outfit, and still maintain the vacuum desired, thereby cutting the cost of operation in half. In cutting the condensers out, it is only necessary to close the discharge and injection valves to the condenser not in operation and to operate the other independently.

As a matter of interest, it may be well to note that the above concern uses nothing but jet condensers. Its experience has been that while boiler feed water is expensive, nevertheless, surface condensers do not stand up under the extremely bad water conditions existing at Providence, and it is necessary to employ jet condensers. The twin condensers used with the above 45,000 kw. turbine require 18,000,000 lbs. of condensing water per hour, 9,000,000 lbs. in each condenser. In addition to this 15 per cent. more is required for the operation of air pumps.

Use of Electric Furnace Products

Important steps were taken to promote the use of various electric furnace products, at a meeting called by Mr. Acheson Smith, Vice-President and General Manager of the Acheson Graphite Company, held at Niagara Falls on Friday and Saturday, March 21 and 22. Mr. Smith called the meeting to order and made a general statement of the importance of getting before the consumers of electric furnace products, and the public generally, the many great advantages of the use of electric furnaces, and the uniformly high grade products which are made by them. He asserted that it was his belief that all interested in the matter could join together on a common basis to extend the use of electric furnaces and their quality products. A special emphasis was laid on electric steel, the tonnage of which during the past four years has shown a remarkable increase not only in the United States but throughout the world. This has been brought about for two important reasons, (1) the higher quality which can be made by use of the electric furnace, (2) and the lower cost of operation shown in most cases as compared with the previous method of manufacture.

The meeting passed resolutions inviting all manufacturers of electric furnaces, electrical apparatus, electric furnace supplies and accessories, public utility corporations, designers and inventors of electric furnace equipment, and the users of electric furnaces to become members and to join in making an aggressive and thorough campaign to disseminate to Engineers and to the public accurate data as to the quality of electric furnace products of all kinds.

A splendid start was made in an organized way to carry out these plans. The meeting was attended by representatives of a large number of companies representing manufacturers of electric furnace equipment, accessories, utilities, supplies, designers and inventors, and manufacturers of electric steel. Among those present were the following: Mr. L. S. Thurston, Mr. C. A. Winder, Mr. G. Campbell and Mr. J. A. Seede, of the General Electric Company; Mr. C. J. Schluederberg, Mr. J. L. McK. Yardley, Mr. C. B. Gibson, and Mr. R. P. Chase, of the Westinghouse Electric & Manufacturing Company; Mr. F. J. Ryan, of the American Metallurgical Corp., Philadelphia; Mr. F. T. Snyder and Mr. F. von Schlegell, of the Industrial Electric Furnace Co., Chicago; Mr. C. A. Vom Baur, of the T. W. Price Engineering Co., New York; Mr. C. H. Booth, of the Booth-Hall Co., Chicago; Mr. H. A. DeFries, of Hamilton & Hansell, New York; Mr. R. J. Paulson, of the Ludlum Electric Furnace Co., New York; Mr. W. E. Moore, of the Pittsburgh Electric Furnace Co., Pittsburgh; Mr. F. A. Fitzgerald, of the Fitzgerald Laboratories, Niagara Falls; Mr. F. J. Tone, of the Carborundum Co., Niagara Falls; Mr. Acheson Smith, Mr. E. G. Acheson, Jr., Mr. W. H. Arison, Mr. H. P. Martin, Mr. S. L. Walworth, Mr. A. M. Williamson, Mr. P. D. Steuber, Mr. J. F. Callahan, Mr. E. B. Drake, Mr. L. C. Judson, and Mr. A. B. Oatman, of Niagara Falls.

The organization formed is to be called the Electric Furnace Association. A permanent organization was created, as follows:

President—Mr. Acheson Smith, of the Acheson Graphite Co., Niagara Falls.

First Vice-President — Mr. C. H. Booth, of the Booth-Hall Company, Chicago.

Second Vice-President—Mr. W. E. Moore, of the Pittsburgh Electric Furnace Co., Pittsburgh.

Secretary—Mr. C. G. Schluederberg, of the Westinghouse Electric Mfg. Co., Pittsburgh.

Treasurer—Mr. F. J. Ryan, of the American Metallurgical Corp., Philadelphia.

Directors—The Officers and Mr. C. A. Winder, of the General Electric Co., Schenectady, and Mr. F. J. Tone, of the Carborundum Co., Niagara Falls.

Important committees were created to begin work without further delay. These are as follows:

Publicity—Mr. C. H. Booth, Chairman; Mr. C. A. Winder, Mr. C. G. Schluederberg, Mr. A. B. Oatman.

Data—Mr. W. E. Moore, Chairman; Mr. J. A. Seede, Mr. A. M. Williamson, Mr. F. J. Ryan, Mr. F. A. Fitzgerald, and Mr. C. A. Vom Baur.

Fields—Mr. F. T. Snyder, Chairman; Mr. F. J. Tone, Mr. H. A. DeFries, Mr. S. L. Walworth.

The President was authorized to get in touch with all companies and persons who should be interested in joining the organization, and was requested to arrange an early meeting when completed publicity plans could be presented and thoroughly discussed. In the meantime, the different committees were instructed to make every effort to rapidly perfect reports which could serve as a basis for constructive work.

It is quite likely that the next meeting will be held in New York City the early part of April, at the same time as the Spring meeting of the American Electro-Chemical Society.

Meeting of the Electrical League

Mr. Arthur E. Reinke, European Engineer of the Western Electric Co., Inc., was the principal speaker at the New Electric League luncheon held at the Hotel McAlpin "Winter Garden," on March 27. Mr. Reinke said that "the term Bolshevism is used very loosely and, as a rule, is confused with anarchism. Bolshevism, pure and simple, is radical socialism carried through to its local conclusion by brute force against any opposition. Everyone is asking how Russia can survive and this to me is easy to understand. The country is agricultural, factory industry is little developed. The people will simply return to the agricultural life. They will raise what they need, they will know how to weave cloth, make sheepskin coats and felt boots. The structure of the country will cause Russia to break up into one-half million self-sustaining agricultural communities. Many of the city workers will return to their relatives on the farm. The lack of national instinct will avoid counter-revolutionary efforts, with its attendant bloodshed. The change in Russian affairs will be slow in coming, it may take years, but when it comes the revival of Russia will be startling. The people want order. It is bred in the bones of the Slavs. Lenine and Trotsky are not a pair of crooks or scoundrels, but clear-headed, sincere, enthusiastic radical socialists, whose power in Europe has steadily grown and who have started a campaign for Bolshevizing Europe. It is as clear-sighted leaders of a movement that we must look at that so that we can wake up and fight this menace."

M. H. Roughton, Australian Commissioner on Investigation of Exports and Imports, spoke briefly on existing business relations between Australia and America. He made an earnest appeal for the affection of Americans for Australians and said he hoped that eventually there would be a better understanding bteween the peoples of the two countries. David A. L'Esprance, Major 369th N. Y. Colored Regiment, who was awarded the Croix de Guerre for meritorious service in France, also spoke briefly. Mr. J. M. Wakeman, President, presided.

Electricity and the Housing Problem

"There's more than one bite to a snake" and there are many results of the war that, despite their individual and even local application, are regarded as vital issues. Not the least important of these is the housing problem. Because of the Government restrictions placed on building materials during the war, there have been practically no dwellings erected in the past two years. The consequent situation is startling. The average number of buildings erected yearly before this country entered the war was between 300,000 and 350,000. Building contractors base their calculations for the next twelve months on the erection of not less than 700,000 new homes, just double the number of former years. The Government, somewhat more optimistic, or pessimistic, according to the point of view, sets the estimate at 1,000,000. According to officials in real estate circles and in the metropolitan public utilities who are in a position to know, there are, in the city of New York alone, 30,000 families searching almost hopelessly for homes. And New York reflects the situation in other large cities.

With these conditions existent and the Government restrictions on all building materials lifted it was believed my many that there would be a surplus of labor, hence one bugaboo of the building question would be dispelled. It was furthermore believed that with restrictions off the prices of building materials would decline.

On the contrary, it is a fact that labor wage is almost certain to remain at its old scale—if it does not climb still further. In fact, in the New York papers of March 20 appeared the notice of an increase of one dollar per day to all classes of labor in the building trades. This was the decision of Supreme Court Justice P. Henry Dugro, umpire, selected by the Building Trades Association and the United Brotherhood of Carpenters and Joiners to consider their dispute over wages.

Uncle Sam says the best time to build is now. The prevailing conditions of labor and material costs should be taken advantage of, because it is certain that prices, in the main, will be at even a higher level.

In addition to the proposed construction of new houses, thousands of homes, more than the annual average number are slated for remodelling, re-decorating and other renovating. In most of the larger cities the shortage of suitable houses had driven Mr. Average American to become a home owner, and realty companies report many sales transactions and many more pending the final breaking of winter.

Some of the great cement manufacturers, whose ears, figuratively speaking, are always close to the ground, report an increasing number of calls for estimates of building construction, which is a most hopeful condition.

The Society for Electrical Development of New York City has inaugurated a national campaign, scheduled for April 1st to May 15th, called "Electrify Your Home," which is destined to stimulate trade activities. This dovetails into several other spirited national movements to hasten prosperity by the Government and various trades and mercantile associations in which the publishers of the country are actively co-operating.

Electric Drive for U. S. S. "New Mexico"

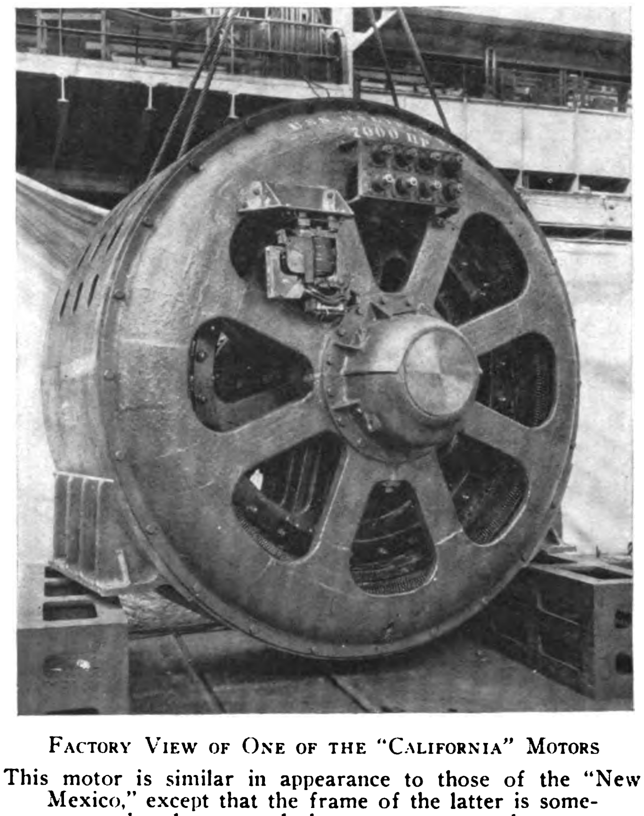
SOME years ago experts in the building and equipment of ships became convinced that one of the most important fields for improvement was in the application of the electric drive to the propulsion of vessels. Electrical science had brought to a high degree of perfection turbine generators that gave great efficiency and high speed, with minimum size and weight. As long ago as 1912 the United States collier *Jupiter* was equipped with two electric motors, directly connected to the propeller shafts. This vessel was a twin-screw boat of 20,000 tons displacement, having a speed of 14.5 knots. So favorable were the results obtained after exhaustive tests that no one doubted that electric-driven battleships would be a feature in our future navy.

The *New Mexico,* a 32,000-ton ship and one of the most powerful battleships afloat, was chosen by the officials of the United States Navy as the first of the electrically driven fighters. This vessel was to have a great cruising radius, and a maximum speed of 21 knots. In the April number of the "General Electric Review," advance sheets of which have kindly been placed at our disposal, a full account is given of this interesting installation. Mr. A. D. Badgley, of the General Electric Induction Motor Engineering Department, says that it was evident that for the most economical operation a changeable-pole motor giving a speed ratio of 2:3 was desirable on each shaft, the four motors at full speed taking power from two generators and when cruising from one generator. By changing the poles on the motor, the proper speeds of the screw are obtained with a maximum speed of the generator thus giving low steam consumption on the turbine in both cases.

Previous to the time of designing the motors for the *New Mexico,* a 2:1 speed ratio had been extensively used with single windings in stator and rotor. All other ratios of speed had been secured by using two windings in the stator, one for each speed, rather than a single winding with a large number of stator leads, which would cause too great a complication of the control. The double winding has the disadvantage of requiring a larger motor, as only half of the copper is in active use at either speed.

Since the motors and generators of the *New Mexico* were to be especially built to operate together, more liberty in design was allowed. A new type of winding was designed, the coils of which were so grouped that a change in the connection at the motor terminals would give a balanced quarter-phase distribution for either 24 or 36 poles. This gives a simpler control than if the motor were wound three-phase. In addition, since the four motors receive power from two generators at full speed and one generator at cruising speed, the best combined operation is obtained with a decreased voltage on the 36-pole combination. This also works out best for a quarter-phase winding; by connecting the generators in square connection for high speed and parallel connection for low speed, the correct ratio of operating voltage is obtained. By this scheme of connection, eight terminals were brought out of the motor though only four-line leads were required.

The torque requirements derived from actual experiments on the *Jupiter,* supplemented by tank trials, showed that a resistance inserted in the rotor winding would be required only for a few seconds at a time, that is, during starting or upon reversal in order to obtain quick possession of the screw and bring it up to speed. With this in mind, a double-squirrel-cage type of motor was adopted thus eliminating the rheostat. The outer high-resistance low-reactance winding takes the place of the rheostat when starting and reversing. The inner low-resistance higher-reactance winding is the running winding when the motor is up to speed. The inductive action between these two cages is such that when the frequency in the rotor is high, as at starting or reversing, the current is choked back in the low-resistance winding thus forcing a large percentage of the current through the high-resistance and producing adequate torque. As the motor speeds up, the rotor frequency drops off and the inductive effect on the inner winding decreases, allowing the current to in-



FACTORY VIEW OF ONE OF THE "CALIFORNIA" MOTORS
This motor is similar in appearance to those of the "New Mexico," except that the frame of the latter is somewhat longer and the contractor on the shield end is not used

crease with a corresponding decrease in the outer winding until at slip frequency practically all of the current passes through the low-resistance cage. By this construction, the torque advantage of a high-resistance rotor is obtained with the low slip and high efficiency of the low-resistance type of rotor when at full speed.

The specified requirements for driving the *New Mexico* propellers called for 26,500 h. p. at 161 revolutions per minute, corresponding to 21 knots ship speed, and 8,350 h. p. at 112 revolutions per minute for cruising at 15 knots.

The motors were wound to operate with either 24 or 36 poles with an output of 6,700 h. p. at 4,000 volts on the 24-pole connection and 2,050 h. p. at 2,800 volts on the 36-pole connection with an overload capacity of 8,375 h. p. at 173 r. p. m.

At speeds from 8 to 15 knots, the four motors are operated on the 36-pole connection from one generator with its winding connected in parallel, the switching being so arranged that either generator can be used. The variation of speed is obtained by steam control on the turbine-generator.

From 15 to 17 knots, the motors are thrown over to the 24-pole connection still using one generator only. Above 17 knots, two generators are used connected in two squares. The two motors and generator on the starboard side and the two motors and generator on the port side are connected together and each set operated as separate units.

For reversing, the 36-pole connection only is used. If the motor is running on the 36-pole connection one phase is reversed. If operating on 24-pole, the connections are changed over to 36 poles and reversed.

During the trial run a test of this reversal was made with the boat running at a speed of 21.25 knots. At this speed the motors were reversed and the screw was brought up to full-speed astern on the 36-pole connection (two-thirds of the forward speed) in 20 seconds; 12 seconds of this time being used in switching.

Mr. C. S. Raymond, in the same magazine, describes the turbine-generators. There are two main turbine-generator units, each generator designed to develop 10,500 kw. at 78 per cent. power-factor, and 13,500 kv-a. at full speed of the ship, and to carry a 25 per cent. overload (16,850 kv-a. at 78 per cent. power-factor) for four hours. The rotors have two poles and a maximum rotative speed of 2,100 r. p. m., which corresponds to a frequency of 35 cycles. The stators are wound two-phase with leads brought out from the beginnings and endings of each phase to an 8-pole, double-throw, disconnecting switch placed in the main circuit between the generators and the motors. By manipulating this switch two generator connections are available: first, diametrical, two-circuit, low-voltage (3,000 volts); and, second, square, one-circuit, high-voltage (4,240 volts). With a constant flux, the voltage will vary directly or inversely as the $\sqrt{2}$ depending on the connection involved. Suitable interlocks have been installed, making it impossible to operate the two generators in parallel.

All speeds of the ship up to 17 knots inclusive are obtained by the use of one generator having the low-voltage connections, the generator furnishing power for driving the four motors. Above 17 knots, two generators having the high-voltage connection are used, each generator furnishing power for driving two motors. The main turbine-generators are used only for propelling the ship, and are in no way connected to the lighting or other auxiliary power circuits. Therefore, it is possible under the varying conditions of load to adjust the voltage and current to obtain good efficiency.

The induction motors, direct connected to the ship's propeller shafts, are two-speed motor with connections for 24 and 36 poles. The speed reduction between the generators and the motors when using the 24-pole motor connection is 12 to 1, and with the 36-pole connection, 18 to 1. Hence, the extreme range of generator r. p. m. for the specified operating speeds of the ship, 10 to 21 knots, is approximately 1,440 r. p. m. to 2,100 r. p. m. In order to calculate the generator efficiency with accuracy, the windage loss must be carefully determined at various speeds for this is the largest single loss. Tests were made at the factory to determine the windage of the rotor. The windage loss varies approximately as the cube of the speed.

The *New Mexico* generators are conservatively designed. Compared with the maximum rated machines for land practice, the relative armature reaction is considerably lower and the densities in the magnetic section are slightly higher. Sufficient excitation current is applied to the generator fields to insure keeping the motors and generators in step. In other words, the generators are not working at the peak of the kilowatt curve, but at a safe distance down where there is sufficient margin in power to take care of the rudder swings and heavy seas. Based on the maximum power-factor of the motors, 79 per cent., the generators have a margin in power of 24 per cent. with the excitation given.

Another very important feature in regard to the generator design is the condition of over excitation required for starting and reversing the motors. The turbine-generators have a fixed mechanical rotation, but the motors may be run in a clockwise or counter-clockwise direction by changing the phase rotation by suitable switching. A very important feature inherent with electrical propulsion is that full power is always available for either direction of propeller rotation. From actual reversal tests, at maximum speed of the ship, the observed excess excitation current required for reversal was approximately 60 per cent. above that for the steady running condition. The line current increased to approximately three times the steady running value. That these high values of current are not injurious to the generator is due to the extremely short time required for reversal and the large heat storage capacity in the generator. The observed time for reversal from maximum speed ahead to full reversing speed astern, with the motors in the 36-pole or low-speed connection, was approximately 20 seconds. To pull the motors into step in the reversed direction of rotation required holding the over excitation on the generator fields approximately eight seconds, the balance of reversal time being consumed in the release of the interlocks and in the switching operation.

Mr. Eskil Berg says that the contract for the electric propelling equipment of the U. S. S. *New Mexico* included the following machinery:

Two main turbine-generator units, complete with throttle and governing valves.

Four main propelling motors.

Switches, panels, instruments, controllers, cables, insulators, etc., complete.

Two main motor-driven circulating pumps.

Two main motor-driven air pumps.

Two main motor-driven hot-well pumps.

Four motor-driven lubricating oil pumps.

Two motor-driven oil coolers and tanks.

Motor-driven blowers for ventilating the main motors.

Spare parts for the above apparatus.

The total weight of the apparatus and material above mentioned, complete in all respects with spare parts, was guaranteed not to exceed 700 tons. In case this weight was exceeded, a penalty of $500 per ton was to be imposed; and if it was exceeded by 5 per cent. or more, an additional penalty of $10,000 was to be deducted from the contract price. The actual weight of all the apparatus furnished, with spare parts, was 590 tons.

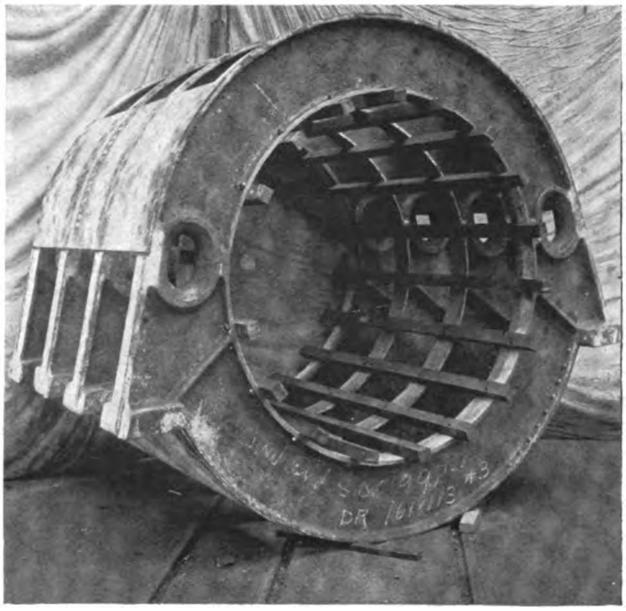
The steam consumption guarantees were all based upon 250-lb. gauge steam pressure at the throttle and dry saturated steam, with the following corrections: Should superheat be used, the guaranteed steam consumption will be reduced at the rate of one per cent. for each 13 deg. F. of superheat observed at the turbine. Should the steam contain moisture, the guaranteed steam consumption will be increased at the rate of 2¼ per cent. for each per cent. of moisture present in the steam at the turbine. The steam consumption guarantees as made to the Government cover the total amount of steam used both by the main generating units and the auxiliaries mentioned above, and were as follows:

Steam pressure 250 lb. at throttle, dry steam.

10 knots, 15.38 lb. per shaft h. p.-hr.
15 knots, 11.57 lb. per shaft h. p.-hr.
19 knots, 11.32 lb. per shaft h. p.-hr.
21 knots, 11.53 lb. per shaft h. p.-hr.

Very heavy penalties were attached to these guarantees in case they were not met; namely, $25,000 per lb. for 10 and 15 knots and $20,000 per lb. for 19 and 21 knots.

The contract price for the *New Mexico* equipment, including all auxiliaries and apparatus mentioned in the beginning of this article, was $431,000.



THE SECTIONALIZED I-BEAM TYPE OF GENERATOR FRAME
This construction, embodying light weight without sacrifice of strength and rigidity, is used in the "New Mexico" Generators

New Electrical Plant for Nottingham

Arrangements have been made by the municipal authorities of the city of Nottingham for the construction of an additional electrical plant at a cost of $379,000, writes Consul C. M. Hitch. The electricity department in a recent report to the Nottingham City Council stated that, owing to the removal of the lighting restrictions and to the fact that many inquiries are being made for power and light, it is absolutely necessary that an additional plant should be installed to meet the public demands.

It was the intention of the city to erect a modern power station on the Trent River, and with that object in view an electrical engineer was instructed to report early in 1915. Before definite action was taken upon the report, however, the Government placed restrictions on capital expenditure and new schemes, and no further action could then be taken. Recently the Coal Conservation Committee of the Ministry of Reconstruction and the Committee on Electrical Supply appointed by the British Board of Trade have presented reports, with the result that the whole question of electric power supply for the country is under consideration by the Government, and it is expected that some definite action will shortly be taken.

In anticipation of the Government scheme, certain action has been taken by the city council of Nottingham and by the local authorities in the surrounding district, and experts have been engaged to report upon the question of an ample and cheap supply of electricity for this area. Pending the decision of the Government and the settlement of the course to be taken locally, it is deemed essential that some provision should be made to meet the demands which may be expected during the coming year. The electricity committee has therefore, after careful consideration of a report prepared by the city electrical engineer, decided to extend the turbine bay at St. Ann's power station and install at 3,000-kilowatt alternator, with the necessary auxiliary plant, transformers, switch gear, and rotary converters, and also extend the underground mains from time to time as the necessity arises.

An estimate of the capital required for the above purposes placed the sum required for extension of plant at $279,000, and that needed for extension of mains at $100,000. The city engineer estimates that the annual saving of coal at the present prices will amount to $60,000, but that the extension agreed upon will only meet the demands for the coming year.

When Our Natural Gas is Gone

A news item published recently in a Philadelphia paper stated that the Pennsylvania Fuel Commission will have finished their duties as soon as the question of the serious natural gas shortage in three northern tier counties has been settled. The situation in this particular quarter calls to mind numerous others that we have been reading of. The time is not far distant when our supply of natural gas will be entirely gone. How are we to supplement its service for heating, lighting, cooking and power uses? With the establishment of central stations, the nation-wide spread of electrical transmission systems, and the development of our waterpower, electricity is undoubtedly going to become the dominant factor. Industrial plants, farmers and householders as well, have already stepped forward, economically, by the use of electric motors. Electric lighting is, in fact, today more common than gas lighting. Is the housewife now using gas for cooking, going to change over to a coal range, or is she considering the good points in favor of electric cooking? The advantages of an electric range are worth reviewing:

1. They require no kindling or coal handling.
2. There is no early rising to start fires.
3. There are no ashes to carry out and no consequent sweeping from such a cause.
4. Not a cent's worth more heat is required than is actually needed.
5. There are no stove pipes.
6. It is not necessary to cook during the hot months in the summer in an overheated kitchen.
7. The price of electric current will drop, as the supply of current increases due to a relief from the extra demand during the war.

The fact that modern school systems are equipping their domestic science departments with electric cooking appliances is a strong indication that the young women of today who are being taught to cook by electricity, and thus appreciating its value, will demand it in their future homes. At any rate, in several sections of this country where there has been an absolute dependence on natural gas, which is now becoming exhausted, the question of coal or electricity is a forced issue and worth serious consideration.

Extension of Big British Electric Plant

The Borough of Rotherham, with a population of 62,500, is only 6 miles distant from Sheffield, with which it is joined by street railway connections, as well as by two lines of railroads, writes Consul John M. Savage, from Sheffield. It is largely engaged in the steel industry, and several important works are situated there. In order to meet manufacturing requirements the first electric super-power station has been erected by the Rotherham Corporation and will be available for distributing its output early in 1919. The war undoubtedly influenced the extensions, and the municipality in its enterprise has the support of the Government. The new works are an extension of the former electrical department inaugurated by the corporation in 1891.

The first two turbo-alternators will have a capacity of 12,500 kilowatts each, or 16,800 horsepower per set. By midsummer next a 30,000 kilowatt set, representing 40,200 horsepower, will be completed. With the existing generating machinery of the power station, the capacity will then be brought to 70,500 kilowatts. This figure, it is believed, constitutes a record for any municipality in England. There are special advantages in respect of railway and water connection, and an abundance of fuel is within easy reach. The arrangements are such that it is computed that fuel can be brought from the pithead to the overhead bunkers in the boiler house at about 14 cents per ton.

The installation includes 12 of the largest water-tube boilers, each equipped with special coal-feed arrangements, and a suction ash plant. With the class of coal now being used, it is computed that the consumption per unit delivered on consumer's premises will be less than 2 pounds per kilowatt, or to 1½ pounds per horsepower. An achievement of this sort is considered remarkable.

The Rotherham Electricity Department has during the past year greatly extended its sphere of influence by taking over the electrical area of the Mexborough (6 miles) and Swinton (5 miles) Tramways Co. The necessity for the new developments was in a measure due to some 15,000 horsepower being required for a new rolling mill plant. At present there are applications from existing works for between 40,000 and 50,000 kilowatts. As to cost, the old and new works total approximately $5,000,000, and sanction has been obtained for the expenditure of a further $4,000,000. Cheap power for industry is the primary object and there is every probability that the enterprise of the Rotherham Corporation will be profitable.

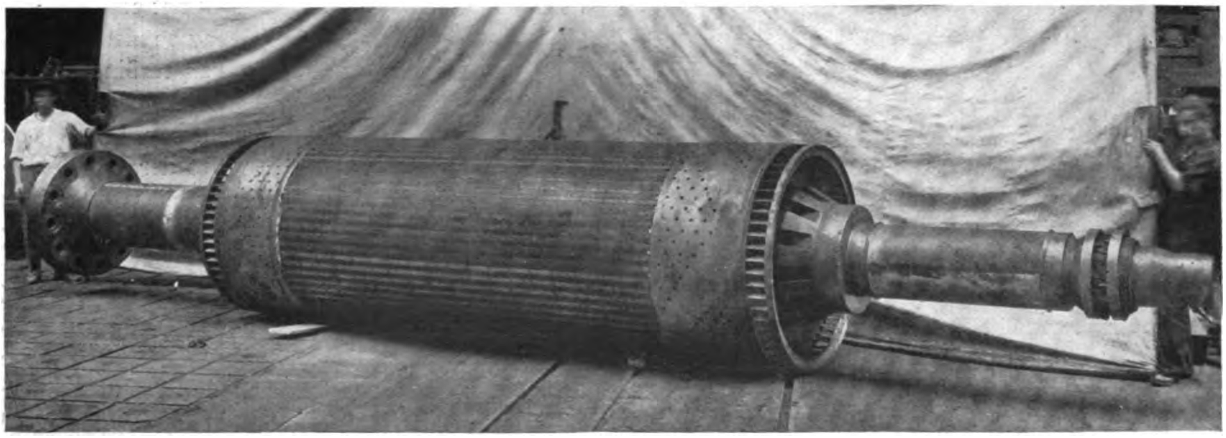
Advantages of Electric Drive

ANY type of propelling machinery, to be acceptable for a capital ship, must be entirely satisfactory in the following particulars:

(1) Reliability.
(2) Weight and space occupied.
(3) Economy.
(4) Flexibility of installation.

Needless to say, the most important of these is reliability; and no machinery should be considered at all which has not proved itself satisfactory in this respect. The performance of the *Jupiter* during the past five years has thoroughly proved the reliability of electric machinery on board ship. For demonstrating this quality, the *Jupiter* was a good type of ship to select, as a collier ordinarily does a great deal more cruising than a capital ship, writes Commander S. M. Robinson, Bureau of Steam Engineering, Navy Department, in the "General Electric Review." During the past five years the *Jupiter* has been held up only once on account of trouble with her electric equipment, and in this case the delay was for only two or three hours and the repairs were effected by the ship's force with the facilities available on board ship. The trials of the *New Mexico*, just completed, indicate that she should duplicate the performance of the *Jupiter* in this respect. In fact, there are inherent reasons why electric propelling equipment is more reliable than other types of machinery. As direct-connected or geared turbines are usually arranged, it is seldom the case that damage to one turbine does not affect more than one shaft; with electric machinery, each shaft can be absolutely isolated from the others by merely opening a disconnecting switch to the motor on that shaft. Furthermore, in case of damage to a turbine with straight steam drive, the ship is left to drag one or more propellers while driving with the others; with electric drive, the failure of one turbine will still allow the ship to be propelled by all four screws in perfectly normal manner. The latter will be seen to be no small advantage when it is considered that the effect of one dragging screw may be as high as 15 per cent. of the total effective horsepower required to drive the ship, and to this may be added the fact that the maneuvering qualities of the ship are not nearly so good when it becomes necessary to drag one screw. It sometimes happens that the damage to a turbine is such that the shaft cannot be allowed to revolve; in this case, it becomes necessary to limit the speed of the ship as the "jacking gear," or other locking device, is not sufficiently strong to hold the shaft at high speeds of the ship. There is still another advantage of electric propulsion that is brought out very strongly when the ship is maneuvering in shallow or muddy water, such as obtains in harbors and their entrances; the ordinary ship uses all of her main engines and therefore all of her main condensers and auxiliaries all the time, but an electrically driven ship need use only one turbine, condenser and set of auxiliaries and the other can be kept as a standby. If the steamdriven ship runs into mud, she will probably plug up all her condensers at the same time, or even if she only plugs one she will temporarily be deprived of the use of one or more shafts and this may be fatal for maneuvering in restricted waters. As an actual experience the *New Mexico* while entering New York Harbor had to shift main generators twice owing to the plugging of her condenser with mud, and these shifts were made so quickly that they did not affect the operation of the ship at all. There is one other point that adds to the reliability of electric drive, and that is that the direction of rotation of the steam turbine is never changed; reversal of direction of rotation is the most severe of all conditions imposed upon any form of steam machinery, and its entire elimination in electric drive adds very much to the reliability of the latter.

When comparing different types of propulsion in regard to the other three points given at the beginning



ROTOR DEVELOPMENT FOR HIGH-SPEED TURBINE GENERATORS
This type of construction is used in the propulsion generators that are a part of the electric drive equipment of the U. S. S. "New Mexico"

of this article, it is difficult to say that anyone of the three is of more importance than the others, inasmuch as the machinery must be satisfactory in all three respects; it is only where two types of machinery are nearly equally satisfactory in some of these respects that they can be directly compared in regard to the remaining points. For example, no type of machinery could be considered which was vastly heavier or occupied twice the space of other types of machinery, no matter how economical it might be, and, vice versa, the economy must be reasonably good or any question of weight saving could not be considered. Therefore, the electric drive will first be compared with other types of machinery in these two respects before proceeding to a consideration of its relative advantage as to installation. It is difficult to arrive at exact comparisons with other types of machinery in regard to weight as, so far, we have built no capital ship with geared turbines arranged on four shafts and therefore are unable to get a direct comparison of the two types of machinery; but, from the data at hand, it is not believed that there is any very great or important difference between the electric drive and general turbines in regard to weight, although it seems to be fairly certain that the geared turbine has a slight advantage in this respect. In regard to the question of floor space occupied, it is not believed there is any great difference, and what difference there is is probably in favor of the electric drive. It is at least safe to say that so far as weight and space occupied are concerned, the difference is not great enough to be of much importance.

As to the relative economy of electric and geared drives, we are able to make a little more definite statement than in the case of the weight comparisons. It seems fairly certain that in the case of large horsepower installations with large speed reductions, such as are found on battleships and battle cruisers, the geared turbine will have a slight advantage at full power, but at the lower speeds of the ship the electric drive will have a very material advantage over the geared installation. Just how great this advantage will be will depend to some extent upon the arrangement of the machinery. For example, on a battle cruiser developing enormous horsepower at full speed, and where it would be necessary to use all of this transmission gearing at the cruising speeds of the ship, the saving by the use of electric drive would be very much greater than in the case of a battleship where the percentage of reduction of power would not be so great. In connection with the subject of economy, it is interesting to compare the trial results of the *Pennsylvania* and the *New Mexico*. The *Pennsylvania* is fitted with direct-connected turbines and small geared cruising turbines which can be run up to speeds slightly above 15 knots. The trial results of the two vessels show that in total fuel consumption the *New Mexico* saves more than 20 per cent. over the *Pennsylvania* at speeds from 19 knots to full power. At a speed of about 15 knots, which is about the limit of the geared cruising turbine and also of the low-speed connection of the electric drive, there is a very much greater saving, it being something in the neighborhood of 30 per cent. At ten knots, the fuel saving is apparently very small, although at both 10 and 15 knots the trial results were not directly comparable on account of the different conditions under which the trials of the two ships were run. Ships fitted with small geared cruising turbines, however, showed remarkable good economy at very low speeds of the ship, such as 10 knots.

It therefore appears that electric drive, generally speaking, is quite satisfactory in regards to points (1), (2) and (3), and compares very favorably with other types of propulsion in these respects. It may, therefore, be compared directly with other types of machinery in regard to point (4), the "Flexibility of installation." The tendency in building modern capital ships is to provide for more and more torpedo protection and it becomes necessary to crowd the machinery away from the sides of the ship as much as possible. This arrangement is also desirable from the point of protection against gunfire for a similar reason. In this respect, electric drive has an enormous advantage over any other type of machinery in which the prime mover is mechanically connected to the propelling shaft. The main turbine-generators may be placed in any part of the ship that is most desirable; they may be placed in compartments forward of each other and they may be raised up enough to place the main condenser underneath them—in fact, there is practically no limit, other than the head room, as to the position of the main turbine-generator in the ship. This gives an enormous advantage to electric drive over all other types of machinery and enables the Naval Constructor to give far more adequate protection to the ship and machinery against damage by torpedo and gunfire. Those parts of the machinery—the main motors—which it is necessary to connect mechanically to the shafts, are comparatively small and take up only a small space so that they can be placed in small isolated compartments which will not menace the ship in case of flooding; since no main auxiliaries are required for the motors, the flooding of a motor room will not entail any loss in that respect. Also the motors may be placed very much farther aft than can steam-driven turbines and therefore the length of the main shafting can be very materially reduced. This constitutes a big advantage; both on account of less liability to derangement of the shafting itself, due to injury to the ship, and also of less danger to the ship itself because of the shafting not having to pierce a number of watertight bulkheads. These advantages of installation constitute the real and main reason for the adoption of electric drive for capital ships and any other advantages are minor compared with them. Utilizing these advantages to the fullest extent makes it possible to build capital ships which are far superior to any others fitted with any other form of machinery. In addition to advantages from the point of view of protection, there are also the advantages from an engineering standpoint. The shorter lengths of shafting make it easier to keep the shafts in line; the grouping of boilers around the machinery makes short and direct steam pipes with a consequent reduction in weight and complication and a smaller drop in steam pressure. The same may be said of practically all the other piping systems of the ship, such as feed lines, oil lines, exhaust lines, etc.

"Electrify Your Home" Campaign

Harry A. Wheeler, President of the United States Chamber of Commerce, in a letter to J. M. Wakeman, General Manager of the Society for Electrical Development, has manifested his approval of the Society's nation-wide house-wiring campaign. The greater use of electric service, Mr. Wheeler agrees, is a benefit to the community and should be fostered everywhere.

It is Mr. Wheeler's opinion that the nation is on the road to great prosperity, but that the driving must be done carefully. People and industries, he says, need time to readjust themselves, and a too rapid or forced stimulation will be dangerous. The electrical campaign, however, he feels is a necessary one for public and private good, and should be backed throughout the country.

Mr. Wheeler's letter reads in part: "Obviously I must approve the nation-wide campaign of your Society for urging greater use of electric service, not from the standpoint of stimulation which it might supply to your business and others related, but rather because the greater use of electric service improves the standards and convenience of living, and as such is to be encouraged everywhere.

"Prosperity is just around the corner, but if we try to make the turn too quickly we may suffer a spill. An effort to stimulate public work whether necessary or not, just for the sake of starting things, is economically unsound and will bring about serious reaction. A legitimate campaign to do whatever is necessary in private or public work at the present time is a campaign of common sense."

Electricity in Oxygen-Making

The commercial importance of oxygen in medicine and to aid in the generation of heat is well known. When it is made from water by electrolysis, double its volume of hydrogen is given off. Within the past few years this hydrogen has found a large market for the hydrogenating of vegetable oils, converting them into stearine. This is hard at ordinary temperatures, and is used as the basis for margarine, cooking fats, etc.

An interesting plant for the manufacture of oxygen and hydrogen is that of the Bettendorf Oxygen-Hydrogen Company, near Davenport, Iowa. It contains 100 I. O. C. type electrolytic cells and 200 Levin type cells. An electrolyte of caustic potash is used. Water is supplied to replace that broken up, so that the level of the liquid remains constant. An asbestos barrier is placed between the electrodes so that the two gases cannot mix. It is very important for the safety of the plant and of users of gas that it should be practically pure, since even a small percentage of one gas in the other will form an explosive mixture, causing a flame to "flash back" from a torch to the storage tank and a serious explosion. Hence the manufacturer maintains a purity standard above 99 per cent. for each gas.

Electrical power is purchased at 440 volts, 3-phase alternating current and converted to direct current at 125 volts by means of four motor-generator sets, of which three are of Westinghouse make. Current is passed through a suitable number of cells in a series to give the proper current. The gas is collected by a piping system and taken to outdoor steel gas holders. From here oxygen is delivered by a pump driven by a Westinghouse 15 h. p. motor to the adjoining factory of the Bettendorf Steel Car Company, and hydrogen to the hydrogenating plant of Wilson & Company. Surplus gases are compressed into steel cylinders for shipment, the compressors being each driven by 10 h. p. Westinghouse motors.

Ventilating System in Rural School

The "district school," where so many famous men learned the "three R's" needed no ventilating system, the cracks round the windows and between the weatherboards let in plenty of air—more than the big stove could keep warm. But the modern consolidated school, serving a whole township, must have the best of heating and ventilating equipment, including, of course, forced draft. The Orange Township School, in Blackhawk County, Iowa, six miles south of Waterloo, has two low-pressure boilers, a temperature control system and a ventilating system through which a 24-inch fan, driven by a Westinghouse 5 h. p. single-phase motor, forces air to every room. The building has now 230 pupils, and serves 38 square miles of rich farming country. Electricity for power and lighting is secured from a transmission line passing the door. The pupils are hauled free of charge in 12 busses furnished by the school board. J. C. Ralston, of Waterloo, was architect for the building.

High Voltage Generators for Radio Communication

For use in continuous-wave radio work the Westinghouse Electric and Manufacturing Company has manufactured a number of types of small direct-current machines, which have been used by the Signal Corps for communication in France and by the Navy. One of these is a two-commutator generator, giving direct current at 27 volts, 2.5 amp., to light the filaments of three-element vacuum tubes, and at 280 volts, 80 milli-amp., for the output circuit of vacuum tubes used to generate continuous high-frequency oscillations. This generator is mounted on the landing-gear of an airplane, so that the back-wash of the propeller drives the generator by means of a small two-blade wooden fan. Thus the generator runs whenever the plane is in motion, and also when it is on the ground with the engine running. Constant voltage with variable speed is secured by an ingenious arrangement of differential fields controlled by a two-element vacuum tube mounted in the streamline housing at the rear of the machine. This generator furnishes power for sending and receiving radio-telephone messages between airplanes and between airplanes and the ground.

For use at ground stations, a Westinghouse dynamotor was developed to operate from batteries. It has an input of 10 volts, 9.3 amp., and output of 80 milli-amp. at 350 volts or 166 milli-amp. at 300 volts. Originally it was mounted on a light metal framework with a panel carrying a voltmeter, fuses and terminals, but recently a metal carrying case has been designed, which has a top-plate mounting a switch, fuses, and terminals, to which leads are permanently attached. When not in use, these are folded inside the lid. A rubber gasket makes the box watertight when closed. This dynamotor is used with continuous-wave sets for both telegraph and telephone communication.

A similar dynamotor was furnished to the Navy for use on submarine chasers, the voltages being 27.5 and 300. These machines were mounted in pairs, one serving as a spare, in a spring cradle. This was done to minimize noise, which might be heard by the sensitive listening devices of an enemy submarine in the immediate vicinity.

Water-power Resources of Norway

NORWAY and Sweden are said to possess the most abundant water power of any European countries. The power available for development in Norway is estimated to be about 15,000,000 horsepower and in Sweden more than 6,000,000 horsepower.

The development and utilization of this water power on a large scale started about 10 or 15 years ago, and by this time it is estimated that 1,300,000 horsepower is developed in Norway and 950,000 horsepower in Sweden. This is of interest to note at this this time when special attention is being given by the United States, England, France, and Germany to utilizing the maximum amount of hydraulic power obtainable.

Large developments are in progress in all parts of Norway and also in Sweden, and even the tarnsmittal of power from Norway to Denmark has been considered. (*See Commerce Reports* for June 12 and July 9, 1918.) Denmark is practically without any possibility of hydraulic power development; the only place where power can be developed is at Gudenaaen, where the total possible development is not more than 800 horsepower, and only 200 horsepower has already been developed. Exportation to Denmark will take place through a submarine cable from southern Norway direct to the northern part of Jutland or to the southeastern part of Sweden, whence in turn power will be transmitted to Denmark.

The scarcity of fuel in recent years has made the people aware of the advisability of developing hydro-electro power for light, for electrifying railroads, for power for all sorts of industries, and even for heating. The production of carbide in the electrochemical industry has been of great help in overcoming the difficulties in the fuel situation.

The total water power available in the eastern part of the country is estimated to be about 2,500,000 horsepower. Some of the greater sources are the waterfalls in Glommen, 350,000 horsepower; waterfalls in Drammenselv and Hallingdal, 225,000 horsepower; Norefaldene, 200,000 horsepower; and other falls in Numedal, 125,000 horsepower.

The total water power available in southern Norway is also estimated at 2,500,000 horsepower. Some of the larger waterfalls are Rjukan, 290,000 horsepower; Toke, 240,000 horsepower; other waterfalls in Telemarken, 400,000 horsepower; waterfalls in Arendal district, 120,000 horsepower; and waterfalls in Saetesdal, 200,000 horsepower.

Western Norway is considered the district where the water power is most favorably located for development and for use in the electrochemical and electrometallurgical industry. It is estimated that about 5,000,000 horsepower is available in this part of the country. This amount of power is distributed thus: Waterfalls at Ryfylke, 550,000 horsepower; Tyssefaldene, 190,000 horsepower; Kinso, 120,000 horsepower; other waterfalls in Sondhordland and Hardanger, 900,000 horsepower; waterfalls in Bergen and Voss district, 475,000 horsepower; Aurlandsvasdraget, 250,000 horsepower; other waterfalls in Sogn, 500,000 horsepower; Aura, 190,000 horsepower; and other waterfalls in Romsdal and neighboring districts, 250,000 horsepower.

It is assumed that also northern Norway possesses water power amounting to about 5,000,000 horsepower, although the investigation of this part of the country has not been as thorough as that of other parts of the country. A number of waterfalls in this district is owned by the State. These are Glomfjord, 125,000 horsepower; waterfalls in Rosaaen, 230,000 horsepower; waterfalls in Bjerkelven, 45,000 horsepower; and other waterfalls belonging to the State in northern Norway, 190,000 horsepower.

In the past few years the Norwegian State has bought a great number of waterfalls in all parts of the country and is now owner of more than 1,500,000 horsepower. A great part of this power has been bought with the intention of electrifying the State's railways, from 200,000 to 300,000 horsepower being reserved for this purpose. The State's largest sources of power are the waterfalls in Hallingdalselv, 75,000 horsepower; Norefaldene, 200,000 horsepower; Toke, 240,000 horsepower; Kvina, 55,000 horsepower; Ulla, 150,000 horsepower; Rauma, 70,000 horsepower, and those in northern Norway mentioned above. Only a very small part of the State's water power has been developed. The first large development to be finished will be the Glomfjord plant, recently purchased by the State, where 50,000 horsepower will soon be available for use. Of the 1,300,000 horsepower already developed in Norway, 1,100,000 horsepower is in private ownership and 200,000 horsepower belongs to different communities.

The saltpeter industry is carried out in the Telemarken district of southern Norway. More than 300,000 horsepower is being used in the plants at Notodden and Rjukan for making nitric acid, Norwegian saltpeter, and other nitrates and nitrites. The company Norsk Hydroelektrisk Kvaelstofkompani (Norsk Hydro) is also the owner of several waterfalls in other parts of the country.

The manufacture of calcium carbide is the oldest electrochemic industry of the country, and there are now many large plants making this product, which has became highly important to all industrial life in recent years, particularly to the steel industry. A large plant in operation at Hafslund, near Sarpsborg, is making more than 30,000 tons of carbide a year. Another plant is located at Notodden and a third at Kragero, all in the southeastern part of Norway.

The largest carbide factory at present operating in the country is the Odda plant of the Alby United Carbide Factories (Ltd.), which in 1915 produced at least 60,000 tons. Of this production about 20,000 tons were used for manufacturing cynamide at the North Western Cyanamide Co.'s plant, which is also located in Odda. Another carbide factory closely connected with the Odda factory is located at Meraker, near Trondhjem. This is a comparatively small plant, with a production of only a few thousand tons a year. The total production of calcium carbide in Norway in 1915 was more than 100,000 tons, but it is probably not that high now.

Several large plants for manufacturing calcium carbide and other electrochemical products are now under construction at different places in the country. At Saude, in the district of Stavanger, an American company has a concession to use 84,000 horsepower, and a large plant for utilizing this power is now being built. Another company has just finished the construction of a plant in Aalvik, in Hardanger, and has started operations with a load of 34,000 horsepower. A plant at Hoyangen, in Sogn, has recently finished its power development and has started operations.

There are several ferrosilicon plants in Norway; these are located at Sarpsborg, Notodden, Arendal, Tyssedal, and Meraker. The production is now about 30,000 tons per year. Other metallurgical plants for production of ferroalloys, aluminum, zinc, and similar products are located at Sannesund, Porsgrund, Atendal, Kristianssand, Flekkefjord, Stavanger, Florli, Haugesund, Tysse, Vadheim, Stagfjord, and Trondhjem. Large plants are being built at Kvina, Bremanger, Aura, in Sundalen, and Glomfjord.

Norway possesses more water power in proportion to its population than probably any other country. It is also interesting to note that the developed horsepower per capita is larger than in any other country. The population of Norway is 2,500,000 and the developed power is about 1,300,000 horsepower, which gives more than 0.5 horsepower for every person in the country. The corresponding figure for Sweden is 0.17.

One-Man Electric Cars

Pine Bluff, a thriving city of 30,000 inhabitants, situated in the richest cotton and rice-growing section of the State of Arkansas, can boast of an up-to-date and efficient street railway system. The Pine Bluff Company have had in operation for more than a year one-man cars with decided success. During the entire period of operation these cars have not had one failure or caused one detention in service. These cars, four in number, were rebuilt and changed from two-man to one-man type. The seating arrangement consists of cross seats for twenty-eight passengers and with this number of one-man cars a regular city schedule under ten minutes headway is maintained over a three-mile city line. The original equipment, consisting of heavy obsolete motors, was replaced with double Westinghouse No. 506-C-2 motors, employing the original type K-10 control with only slight alteration in the car wiring. With these modern lightweight motors and equipped for one-man operation, the car weighs complete 18,500 pounds.

Electrical Industries of Japan

In respect of funds invested, the electrical industry in Japan has a lead on several even of the greatest industries, says a report issued by the Department of

Communications on January 7, 1919, on the achievement of the industry last year. The investment increased by as much as 64,515,000 yen ($32,160,727) during the last twelvemonth.

The electrical industry has been given a developing incentive by the boom in fuels and the wonderful industrial expansion of Japan occasioned by the great world war, says the official report. At the end of last year the use of electrical power was thought to be economizing petroleum to the amount of 3,700,000 koku (176,319,800 gallons) and coal to the extent of 4,000,000 tons.

In light and power plants 368,482,823 yen ($183,-688,687) had been invested by the end of 1918, 43,-717,969 yen ($21,793,408) in electric tramways, and 332,997,483 yen ($165,998,245) in plants both for suppyling power and light and operating tramways. The total amount of capital invested amounted to 745,198,275 yen ($371,480,340), this figure being a gain of 64,515,000 yen ($32,160,727) over the close of 1917. The investment in this comparatively new line is, says the official report, bigger than that in mining, which stood at 240,000,000 yen ($119,640,000) at the end of last year. It even threatens to rival the investment in railways, which is 1,100,000,000 yen ($548,350,000).

Steam Railroad Electrification

By Calvert Townley

ELECTRICITY fills every requirement of railroad service, but as it involves a large investment, electrification has proceeded slowly. Electrification has also been retarded because the problem has been largely considered one of replacing the steam locomotive by the electric locomotive, whereas in reality the problem is much broader. It really offers a fundamentally different method of train propulsion because the limitations of the steam locomotive disappear and the strictly limited motive power is replaced by one that is practically unlimited, thereby opening up many possibilities in the methods of railroad operation. While there are a number of different systems of electric traction all of the systems have many features in common and the possibility of unlimited power is a characteristic of them all. A brief review is given of electrified sections of railways showing the advantages which have been realized in both the freight and passenger service. Existing electrifications have been operated for a sufficient length of time so that operating statistics are now available, and any proposed undertaking may, therefore, be predicated on established facts. While electrification will greatly increase track capacity, there is a large railroad mileage which already has more than sufficient capacity, in which case electrification would not be justified. On the other hand, there are so many cases where its advantages are clear and conclusive that when the railroads are able to finance their required electrification it will test the capacity of the electric factories of the country to serve them.

Electricity now performs every railroad service previously rendered exclusively by steam locomotives and in every case does it better than it was done before. But in order to use electricity a large investment in equipment and installation must be made and electrification has proceeded slowly because railroad executives were not convinced that the advantages to be gained are always worth the cost.

The progress of electrification has also been impeded, first, before the war by the difficulty in financing, due to conditions other than the merits of electrification, and second, since the war began, because every one has been too busy to consider any work that could be deferred and because the government's taking over the railroads has created an unsettled situation not conducive to the investment of new capital for future returns. Now, however, there seems to be ground for hoping that these bars to progress will be removed in the not distant future so that electrification can be again studied on its merits; therefore, our consideration of the subject is timely.

In reviewing the past twenty years' history of this question, I cannot escape the conclusion that we electrical men, and not our steam road colleagues, are responsible for the slow progress made. We have not known enough about either the science or the art of railroading. Our belief in and our zeal for our own profession has led us, albeit with entire honesty of purpose, to make more or less extravagant claims as to what we could do and to underestimate the cost of doing it. The inevitable reaction of mind which followed an accurate determination of facts, of course, disturbed confidence in our judgment. But if at times we have injured the cause of electrification by claiming too much, strange as it may sound, we have injured it a great deal more by not claiming enough. Electrical engineers not having always been railroad men, have been unable to study railroad problems as they should have been studied, that is to say with only real and not with any arbitrary limitations before them. It has been natural for the electrical man to ask the railroad man for a statement of the conditions he was expected to meet. It was equally natural for the railroad man to prescribe the conditions upon which his steam service was predicated. Under these circumstances the problem became largely one of replacing one sort of locomotive with another, and of balancing hoped-for economies in operation and maintenance on the one hand, against fixed charges for the additional investment required, on the other. Right there comes the mistake. A perfectly natural, but yet a fundamental mistake, for which no individual or class should be censured, but for which the unusual development of the art is responsible. We cannot blame railroad men for not being electrical engineers nor electrical engineers because they are not railroad men, but the progress of electrification has to lag until both should be able to see, each with the eyes of both. It is only by combining the railroad man's knowledge of the fundamental requirements of his service with the electrical man's skill in applying electricity to perform that service that all the possibilities of any specific problem may be developed.

The electrification of a railroad is not simply the substitution of one kind of locomotive for another. It is far more than that. It is the adoption of a fundamentally different method of train propulsion. It is conservative to say that, within the bounds of ordinary practice, electricity can furnish every train with all the pulling power that can be used. The limitations of the steam locomotive in this respect disappear and ruling grades rule no longer. A strictly motive power is replaced by one that is practically unlimited.

There are a number of so-called "systems" of electric traction and heavy emphasis has been laid by the advocates of each upon its points of difference from every other. So much has been said about these differences and so little about the points of similarity as to create an entirely misleading impression. It is a fact that there are more kinds and types of steam locomotives in use many times over than there are electric systems. It is a fact that except for the storage battery locomotive, which has but a limited field of application, all electric systems have many more common features than differences. It is a fact that they agree on fundamentals and differ in detail only. Their costs may not be the same, their efficiencies may vary, but they all do their work and do it successfully and well. The possibility of unlimited electric power is a characteristic not of any one system but of all. It is due to basic differences between steam and electric equipment. A steam locomotive is a complete independent unit which not only generates but also utilizes its power. The electric locomotive generates no power at all. It is only a translating device receiving energy from an outside and a remote source. The electric power house always having much greater capacity than any one locomotive, can supply ample power for the heaviest train on the steepest grade. The steam locomotive which carries its own power house with it is limited to the capacity of its one boiler. By the multiple unit principle as many electric locomotives as may be needed can be coupled together and operated in synchronism by one crew from any cab. Any required tractive effort can thus be exerted without slipping the wheels, without imposing undue strains on the rails or bridges and without increasing the number of engine crews.

The business of a railroad is to transport freight and passengers. I put freight first because on the average it produces 73 per cent of the revenue. Unlimited motive power permits longer trains and higher schedule speeds. On the Elkhorn grade of the Norfolk & Western the schedule speed was doubled. It cuts the operating cost by hauling more cars with the same or a smaller crew. The Norfolk & Western uses two electrics to do the work of three Mallets. These new opportunities at one fell swoop banish many of the railroad's time honored traditions. The traffic possibilities must be studied from a new angle and advantage taken of every facility. It is a new thought to realize that train length is limited not by motive power but by the yard tracks and length of sidings, or that all the trailing tonnage that the draw bars will stand can be hauled. Nor are these new limits fundamental. Sidings can be extended, draw bars can be made stronger, if it pays to do it. In a word electrification opens up tremendous possibilities of increasing the freight capacity of a road and without it being necessary to build additional tracks.

While not as important as freight, passenger traffic likewise comes in for its share in the widened horizon and the vanishing tradition. Unlimited power, of course, is available, but the absence of combustion is another basic advantage. Smoke and cinders disappear. Tunnel operation loses its terrors. Unobscured signals permit normal speeds with undiminished safety. Projects like the Pennsylvania terminal in New York, depending entirely on submarine tunnel operation and previously impracticable, become immediately possible. Railroads owning valuable realty in cities can erect buildings thereon, where before smoky locomotives made any structure above the ground level impracticable. The aerial rights are now valuable. Multiple unit operation has in fact made suburban traffic. The rapid acceleration made possible by electric traction has directed attention to the equal value of rapid retardation and has quickened the study of braking acordingly; also of modified coach design to bring about the more efficient loading and discharge of passengers. These combined possibilities secure increased schedule speeds and attract patronage. The people not only get over the line in a shorter time, but as a corollary more people get over it in the same time. Again it is seen, therefore, that in passenger as in freight traffic the ability to do something that could not be done before rather than to do the same thing at a lower cost is the most valuable attribute of electrification, and again we find a greatly augmented capacity without the need of additional tracks.

It is not my purpose to make an exhaustive comparison of the relative advantages of steam and electric operation. That has been done often and well by others. What I have said about the expanding opportunities for electrified service is by way of illustration to emphasize my plea that the question should always be viewed in its broader aspect and not hampered and restricted within any narrower limitations than properly belong to it.

I am going to assume, then, the broadest possible treatment and to suppose that every electrification project is to have its pros and cons most fully examined. The real and vital question then is, "How far will this lead us?" "To what extent may we expect complete electrification of all our roads?" Parts of a number of them have already been equipped. Many of these are numbered among our prominent roads, successful corporations which have had the advice of the most highly skilled executives and engineers, and which are progressive. The service performed on the electrified sections comprised practically every kind of railroad transportation. The Bluefield division of the Norfolk & Western Railroad in West Virginia is an example of an important coal road operating through the mountains. The Chicago, Milwaukee & St. Paul 440-mile main line, through Idaho and Montana, demonstrates what can be done by a trans-continental carrier on a large scale with through traffic, both freight and passenger. The New York, New Haven & Hartford Railroad 73-mile stretch between New York and New Haven shows how through freight and a heavy passenger traffic can be taken care of on the most congested four-track section of an important eastern carrier and what is possible for complicated freight yard operation, while the New York Central and the Pennsylvania out of New York City are splendid examples of our greatest modern passenger terminal electrifications. There are, of course, many other electrifications, but even if there were not, those named are of a character to command the respect and attention of the railroad world. Now, every one of these projects has been successful. Every one has justified itself. Nearly every one in its present scope represents an extension of the zone initially electrified, the most convincing evidence possible as to what views the operating companies hold regarding these several projects. Railroad officials are generally glad to give others the benefit of their experience, so it is reasonably safe to say that operating statistics are available covering long enough periods so that the results to be expected from any proposed undertakings may be predicated on established facts and not upon theories. In the light of present day knowledge, therefore, what answer can we make to the question "Should all railroads be electrified?"

Taken together in 1910 there were in the United States 240.000 miles of railroad main line regardless of the number of tracks. Of this mileage approximately 1,250 or one-half of one per cent has been electrified or is today in process. The remaining 99½ per cent comprises, of course, roads performing every variety of service. They range from the back country branch line built by some over enthusiastic promoter and now perhaps, operated as part of a large system, only because operation cannot be avoided and regularly contributing its annual deficit, up to the most important through arteries of travel upon which the commerce and industry of the nation depend. Every sort of community is served; every kind of railroading has its place in this vast aggregation of effort, and the variables in the problem are so multitudinous and their nature often so profound as to well daunt the courage of one who seeks to formulate them for incorporation in a general statement. Fortunately or unfortunately, depending on the point of view, it has been my lot to have to deal with this electrification problem from both sides. At one period from the standpoint of an intimate affiliation with the development and manufacture of electric apparatus and at another from that of one charged with official responsibility on the railroad's behalf. I am a thorough believer in the virtues of electrification and an enthusiast about the wonders which it can accomplish, but I also have a keen appreciation of the almost infinite variations in the railroad problem and a very wholesome respect for the dollar. I do not believe that all railroads will ever be electrified. I am not sanguine even that all the tracks of any one really big system will be so equipped in our time. It is a question of economics, and the results will not justify the expenditures even when considered with such broad vision as that which guided the Pennsylvania in spending millions to put their passenger terminal in New York City without the prospect of a direct return. Electrification will increase the track capacity. But there are thousands of miles of railroad that have sufficient capacity now, frequently several times over, and where the wildest stretch of imagination fails to picture a future need of this kind. Electrification works wonders in suburban and interurban passenger service. I have ridden for hours across the western prairies without seeing a single town, much less a city where these advantages would count. Electrification effects marked economies in fuel, in maintenance, in labor and otherwise through a long list; but electrification calls for a heavy investment and unless these economies bulk large enough, the interest on such investment will wipe them out and turn the enterprise into a losing venture. I do not believe the cause of electrification is helped by undue optimism on the part of its advocates. Rather should there be an enlightened partisanship, enthusiastic where enthusiasm is justified but tinged with the sober conservatism of the man who has to put his own dollars to work.

Mr. Townley says that electrification is now firmly entrenched and successful, and is recognized as an effective agency with great possibilities.

Pre-War and Present Prices

REDUCTIONS in steel prices, as announced by the Industrial Board of the Department of Commerce, are held to be no more important to the general business situation, especially in the building and construction industries, than are the Board's statements that present wage levels should not be disturbed and pre-war prices are out of the question.

Since January there have been received in the Department of Labor thousands of letters from architects, building contractors, prospective investors in buildings, and from State and municipal authorities in which it was represented that uncertainty as to prices and wages, rather than the present high level of prices and wages, were the stubborn obstacles to be eliminated before a general revival of building and construction work would be had.

Recently the Information and Education Service, in the Department of Labor, has been putting out the results of investigations by trained economists, in the price and wage fields. The conclusion has been, and in this conclusion so eminent an authority as Prof. Irving Fisher of Yale University has concurred, that the popular expectation of a re-establishment of pre-war prices is not justified. It was aserted that wages had not advanced in proportion to living costs, and that while minor price changes might be expected in some fields, to use the language of Prof. Fisher, "we are on a permanently higher price level and the sooner business men of the country take this view and adjust themselves to it, the sooner will they save themselves and the nation from the misfortune which will come if we persist in our present false hope."

Since the steel industry is one which most profited from the demands of the war, it probably can afford to make a greater reduction in present prices than may be expected in other industries. Building and construction authorities are not, therefore, disposed to believe that subsequent price negotions by the Industrial Board of the Department of Commerce will develop reductions proportionately as marked as those announced for steel. They assert that the Board's statement, "in view of the higher costs developed throughout the world as a result of the war, a return to anything like pre-war prices is regarded as out of the question," is a sound conclusion and timely corroboration of the statements made by the Department of Labor in its campaign to stimulate building and construction work.

Two departments of the Government—the Department of Labor and the Department of Commerce—working independently, have arrived at the same conviction, namely, that the country is on a new price level and to delay business projects in the hope that pre-war prices again are to prevail is to jeopardize the business structure of the country, delay the return of prosperity, and in the end discover, as Prof. Fisher puts it, "to talk reverently of 1913-14 prices is to speak a dead language today."

Investigation of contracts on building and construction projects, let in February, 1919, made by the Department of Labor, produced convincing evidence that a majority of the contractors and builders in the country have come to understand the situation. When the contracts let in February of 1913 and 1914 are revised to the basis of present construction prices and these figures are compared with the contracts let in February, 1919, the comparison shows that February, 1919, was better than 90 per cent of normal. Now that the Industrial Board of the Department of Commerce adds its testimony on the futility of delaying business in the hope of availing of pre-war prices a reasonable expectation is that building and construction work will show a further approximation of normal.

Through all the economic studies recently issued by the Information and Education Service of the Department of Labor has been such evidence as clearly indicated the imprudence of any policy contemplating radical changes in existing wage scales. In the recent conference of Governors and Mayors in Washington it was clearly the consensus of opinion that readjustment should not and could not mean an immediate pressing down of wages. This because wages have not gone up in the same proportion as living costs and, further, because it is generally believed prudent to do everything possible to maintain the higher living standards which have been evolved during the war.

Notwithstanding these developments, there are many in industry who have been urging wage reductions. There has been enough of this agitation to create an uneasiness in the ranks of labor, and uncertainty as to the future labor conditions in the minds of prospective builders and contractors. For this reason the precedent established by the Industrial Board of the Department of Commerce in the steel case should have a very beneficial effect. On the wage matter, in the statement announcing the new prices on steel, the Board says:

"It is fully understood and expected that the present wage rates or agreements will not be interfered with, the approved prices having this in view."

All economists and practical business men agree currency conditions are an important factor in present prices. This can not be admitted without admitting also that present currency conditions are an important factor in present wages. Money is just as cheap when it buys labor as when it buys steel, and those who talk of pre-war wage scales under present currency conditions ignore entirely the fact that we do not have pre-war dollars and we will not have them for many years to come.

ELECTRICAL ENGINEERING

With Which is Incorporated the

SOUTHERN ELECTRICIAN and the ELECTRICAL AGE

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DURING the past few weeks the Bureau of Foreign and Domestic Commerce, which is the agency of the United States Government for promoting trade between this and other countries, has sent more than thirty commercial representatives, with others to be sent from time to time, to investigate foreign trade opportunities and obtain the latest, most complete information for American business men and manufacturers. The changed position of the United States in the business world demonstrates most conclusively the vast importance of foreign trade and the possibility of its expansion. This country is now a creditor instead of a debtor Nation. During the past year the United States did an export business of about $6,150,000,000, as against an import business of $3,031,000,000. The month of January, 1919, showed the largest exports of any single month in American history, and every effort should be put forth to sustain and develop this great commerce with the buyers overseas.

THE Treasury Department, through its newly created Division on Savings, has issued a call to retail men throughout the nation to aid in the 1919 campaign for the continued sale of War Savings and Thrift Stamps and the promotion of the idea of national and personal thrift as a happy permanent American characteristic, by establishing War Savings Societies in all retail establishments. Information reaching the national War Savings headquarters at Washington indicates that the retail trade has responded to the Government's call in a most gratifying way, and already many large retail associations, some of which have as many as 2,000 and 3,000 branches scattered throughout the country, have set about establishing these savings societies in each of their branches. Retail men are asked to align themselves with the Government in its campaign on the grounds that public thrift is of untold value as a stabilizer of business. Thrift, it is pointed out, is a much broader matter than one of mere saving. It is shown to the business man as care and prudence in the management of one's business affairs and as the foundation upon which is based every successful and enduring enterprise. Here is the doctrine which the Government, through the hundreds of War Savings workers, is preaching to the business man: A nation the citizens of which measure up to the standard of making the most of one's resources, tangible and intangible, is a stable, dependable nation. Hence the 1919 thrift campaign. It is shown that in the present period of flux and change, of unrest and intrigue and revolution, America can only perform her duty to her people and the people of the world if she holds steady, and she can only hold steady through industry and the foresight of her citizenry. Waste, it is pointed out, is the enemy of good business. Why, it is asked, should the farmer leave the plow to rust away outside the barn all winter? Why should the housewife overheat the house and the factory worker throw good material on the scrap heap? Because of these things, statistics show that there are in America today 1,250,000 people who are dependent upon charity, because in their earning days they cultivated habits of waste rather than of thrift. The merchants of America, it is further shown, must carry much of the burden of support of these wasteful dependents on their shoulders. Education in thrift will make the present generation of workers reduce this burden. Because the retail merchant has for years been carrying on an education in values, the present campaign of the Government parallels and extends certain lessons already promulgated.

The Payment of Engineers

AT the Railroad Confeernce held in Chicago last month, Mr. J. L. Jacobs, a consulting industrial engineer, read a paper on "Principles and Procedure in Classification and Standardization of Salaries of Railroad Professional Engineering Positions." After telling of the activities of the American Association of Engineers along this line, Mr. Jacobs said:

"Inequalities in salary rates for positions having similar duties and responsibilities. interpretation and readjustment of salaries and working conditions without definite and sound bases; lack of standards of duties, responsibilities and qualification requirements; multiplicity of misleading and unnecessary titles; inequitable and unsystematic practices concerning selection, assignment, promotion and other employment conditions—all these have a demoralizing and stagnating effect on employes, employers, and the community.

"This constructive program contemplates not only the elimination of inequities and inequalities in the compensations and opportunities of employment but has for its objects the formation of sound and definite bases for the determination and regulation of salaries and employment conditions; the development of practical standards of service, duties and qualification requirements; the establishment of clear and uniform understanding of the obligations and advantages of employments; the introduction of definite procedures governing selection, advancement, promotion and retirement on the basis of merit and seniority; and detailed fact bases and organization necessary for effective administration of all matters of employment."

Among the essential points in any programme to carry out this plan, Mr. Jacobs gives definite wage differentials for different positions based on special work and qualification requirements, location and other special employment conditions, and classification of positions into functional classes, all positions being played into classes according to general character of duties and into grades according to responsibility and difficulty of work.

At the same conference, Mr. Halbert P. Gillette, the well-known writer and editor, presented a paper on "Shall Engineers Be Paid Overtime?" Among other things, Mr. Gillette said: "Between the extremes of purely muscular and purely mental work, there is a great intermediate class of work that calls for both muscular and mental activity, such, for example, as ordinary drafting or operating an instrument like a transit. The men who do this intermediate class of work frequently aspire to advance to a higher grade wherein nearly all their work will be mental and of a designing or supervisory character. Yet so long as they hold positions of a semi-mental, semi-muscular nature, is it just to require them to be oblivious to the length of the working day in the hope that eventually they will be rewarded by advancement to the supervisory class? I doubt it. It seems to me that there has been altogether too much feeding of young engineers on hopes of future incomes from higher positions. There has been too much appeal to their professional aspirations while asking them to accept less than skilled mechanics' pay.

"A man able to run a steam shovel, a locomotive or a lathe efficiently—a skilled mechanic—is really in about the same class as a good leveler or a transitman, so far as purely manipulative skill is concerned, but in a lower class so far as mental training is concerned. Hence for wage purposes, it would surely be reasonable for instrument men in surveying parties to receive at least as favorable wage considerations as skilled mechanics receive. I am, therefore, inclined to believe that technical engineers in subordinate positions should be paid overtime wherever practicable."

The question of the payment of engineers of standing and reputation takes care of itself. No claim is ever made that such service is underpaid. But the matter is far different with those holding subordinate positions. Unionized labor has fixed a standard to wages and hours that has never before been equalled. It is time that something should be done for those who have no organization back of them, and who may be young and struggling to establish themselves.

The convention of the National Electric Light Association at Atlantic City in May will be a "Victory" celebration in every sense of the term. During the war the entire electrical industry of the country gave full support and co-operation to the Government by every means in its power. All that it was enabled to accomplish will never be fully recorded, although it is gratefully acknowledged. Now that the contest is over, the industry will organize and direct its best energies towards meeting the problems of peace. An elaborate and interesting program is being prepared for the May convention and the indications are that the attendance will reach record-breaking proportions. Plans for the exhibition are virtually completed, and it is certain that there will be a display of electrical devices that has rarely, if ever, been equalled.

Electric Plant for a Stone Quarry

The Blue Mountain Stone Company, R. J. Funkhouser, vice-president and general manager, First National Bank Building, Hagerstown, Md., has just started the construction of a grinding mill for reducing into granules for roofing purposes a green stone commonly known as basic rock for copper deposits. The quarry is located on Jack's Mountain, one of the South Mountains, a part of the Blue Ridge system. The mill and quarry property are at Charmian, Pa. The new mill will be three stories in height, 35 by 155 feet. The company will use electric motor drives, with current from the power company at Hagerstown. Part of the machinery will be in groups, with shaft connections, and part with individual drives.

Orders have been placed for two 100 h. p. motors, one 40 h. p., one 30 h. p., one 15 h. p. and one 5 h. p. motor. These are of Allis-Chalmers make, purchased through the Standard Electric Elevator Company, of Baltimore. The crushing machinery consists of one No. 6K Gates gyratory crushers, from the Allis-Chalmers Company, followed by one 24 by 13 Farrel jaw crusher, from the Farrel Foundry and Machine Company, one set of 36 by 16 Superior crushing rolls, three sets of 36 by 16 Sturdevant rolls and steel elevators and conveyors, also Sturdevant equipment. The air compressors and drills are from the Sullivan Machinery Company, Chicago. The air compressor and hoist are in a detached building, 30 by 30 feet. Both are motor driven, 40 h. p., on the conveyor and 30 h. p. on the hoist. The transmission line for the power is 5½ miles in length, from the company's property to the power company's line connection near Waynesboro, Pa.

The company is opening new quarries. Construction work on the mills has already been started and a spur track has been completed into the quarries from the Western Maryland Railroad. It is hoped that the work can be completed and production begun by May 15.

British Electric Companies Amalgamate

According to reports received by the Bureau of Commerce, arrangements have been completed for the amalgamation of certain electrical plants. Dick, Kerr & Co. announced at their annual meeting that the English Electric Co. had acquired the shares of the Conventry Ordnance Works and the Phoenix Dynamo Manufacturing Co. and had made them a similar offer to exchange their shares for an equal number of English Electric shares. The English Electric Co. has a capital of £5,000,000 ($24,332,500), of which only about £2,000,000 ($9,733,000) had been issued at the time of amalgamating with Dick, Kerr & Co., which latter firm has been given the right to subscribe at par for one £1 ordinary share in the English Electric Co. for every three shares, ordinary or preferred, that it has exchanged. The English Electric Co. will now be one of the three principal electrical manufacturing concerns in the United Kingdom and its board of directors, which includes several representative railway men, contemplates a considerable expansion of its activities.

It is considered that the future success of electrical companies will depend on their capacity to undertake large schemes, such as the electrification of railways, the construction of large power stations, and the development of hydroelectric installation. For this reason the present amalgamation will play a very important part in the future of the English electrical industry.

Personal

Mr. John Henry Schafer, president of the Schafer Construction Material Company of New York, on April 1, sent out an announcement of the fortieth anniversary of his entrance into the business of pole line hardware, and thanking his business friends for their patronage and consideration.

R. E. Brown, manager of the Northern States Power Company, Mankato, Minn., division, has been elected vice-president of the Minnesota Electric Association for the ensuing year.

H. A. Joslin, manager of the Dallas, Ore., division of the Mountain States Power Company, has been re-elected vice-president of the Dallas Chamber of Commerce.

Mr. Calvert Townley, assistant to the president of the Westinghouse Electric and Manufacturing Company, read a paper entitled "Some Possibilities of Steam Railroad Electrification as Affecting Future Policies," before a meeting of the American Institute of Electrical Engineers held at Boston, on March 14. At the annual meeting of Engineering Council Mr. Calvert Townley was reappointed chairman of the Water Conservation Committee for the year terminating at the annual meeting in February, 1920.

General Guy E. Tripp was recently decorated with the United States Government distinguished war service medal, which was awarded him for his excellent work in systematizing methods and practice, resulting in the hearty co-operation of industries producing ordnance material for the army. Mr. Tripp's army career has been marked by a series of successes. Entering the army with the rank of colonel as Chief of the Production Division of the Ordnance Department, he was later promoted to the rank of brigadier-general as assistant chief of ordnance. General Tripp has proven himself to be a man of wonderful executive and organization ability. It was he who conceived the idea that production work of the Ordnance Department should be handled from different points throughout the United States instead of through one big head in Washington. This scheme worked out to perfection and was the means of speedy and efficient production. It is to men like Tripp that our country is indebted for the great part they played in assisting in the speedy and victorious end of the world war. Before going into service, General Guy E. Tripp was president of the Board of Directors of the Westinghouse Electric and Manufacturing Company, to which position he returned after the signing of the armistice, and the cessation of hostilities.

B. W. Cowperthwait, general manager of the Northern States Power Company of the Faribault division, as president, opened the 1919 convention of the Minnesota Electrical Association in St. Paul, March 18. H. E. Young, sales manager of the Northern States Power Company, is a member of the executive board of this association. D. F. Parrott of the Minneapolis General Electric Company was scheduled for an address on "Recent Developments in Transmission Line Construction." Two hundred delegates were present.

Mr. T. B. Macaulay, president and managing-director of the Sun Life Assurance Company of Canada, has been elected a director of the Montreal Light, Heat & Power Consolidated, to fill the vacancy caused by the death of Sir Rodolphe Forget.

Mr. Lawford Grant has resumed his former position as managing-director and treasurer of the Eugene F. Phillips Electrical Works, Ltd., Montreal. The vacancy on the Board of Directors, caused by the death of Mr. G. H. Olney, has been filled by the appointment of Mr. A. J. Carroll. Mr. R. H. Balfour has been appointed assistant treasurer, and Mr. A. Richards assistant secretary.

American Welding Society Organized

The first meeting of the American Welding Society was held on March 28, 1919, at the Engineering Societies Building, 33 West Thirty-ninth Street, New York, and the Constitution and By-laws were adopted as recommended by the organization committee:

The following officers were elected:

President, C. A. Adams, Cambridge, Mass.; vice-president (for one year), J. M. Morehead, New York; vice-president (for two years), G. L. Brunner, Utica.

Directors for one year—W. M. Beard, New York; M. H. Roberts, New York; M. M. Smith, New York; L. D. Lovekin, Philadelphia; Alexander Churchward, New York; W. H. Patterson, Pittsburgh; Walter J. Jones, Philadelphia; C. A. McCune, New York.

Directors for two years—R. R. Browning, New York; A. S. Kinsey, Jersey City; Victor Mauck, Conshohocken; E. L. Hirt, South Bethlehem; J. F. Lincoln, Cleveland; H. M. Hobart, Schenectady; D. C. Alexander, New York; H. R. Swartley, Jr., Jersey City.

Directors for three years—L. H. Davis, New York; E. L. Mills, New York; D. B. Rushmore, Schenectady;

James Burke, Erie; D. H. Wilson, Jr., New York; Hermann Lemp, Erie; C. J. Nyquist, Chicago; Alexander Jenkins, Baltimore.

It was voted that the charter should be held open for ten days and that those applying for membership in the American Welding Society before April 8 should be considered charter members. At a meeting of the directors in the afternoon, W. E. Symons was appointed treasurer and H. C. Forbes, secretary.

Nation's Gear Makers to Meet at Cleveland

President F. W. Sinram of the American Gear Manufacturers' Association announces that their annual convention will be held at the Hotel Statler, Cleveland, Ohio, April 14, 15 and 16. The organization includes in its membership representative companies engaged in making gears in the United States and Canada and promises to be of unusual interest to the manufacturing world. For some years past the American Gear Manufacturers' Association has been striving earnestly to affect an organization that would develop definite means for standardizing their products. The coming convention will center its attention on this problem.

Papers will be presented as follows:

"Gear Steels," by Dr. Parker of the Carpenter Steel Company; "Proper Sizes and Materials for Gears"; "Worms and Worm Wheels," by a representative of the Timken-Detroit Axle Company.

The officers of the association are: President, F. W. Sinram of the Van Dorn and Dutton Company, Cleveland, Ohio; vice-president, H. E. Eberhardt of the Newark Gear Cutting Machine Company, Newark, N. J.; secretary, Frank D. Hamlin of the Earle Gear and Machine Company, Philadelphia, Pa.; treasurer, Frank Horsburgh of the Horsburgh and Scott Company, Cleveland, Ohio.

Faulty Installation and Fluctuating Voltage

By T. Schutter

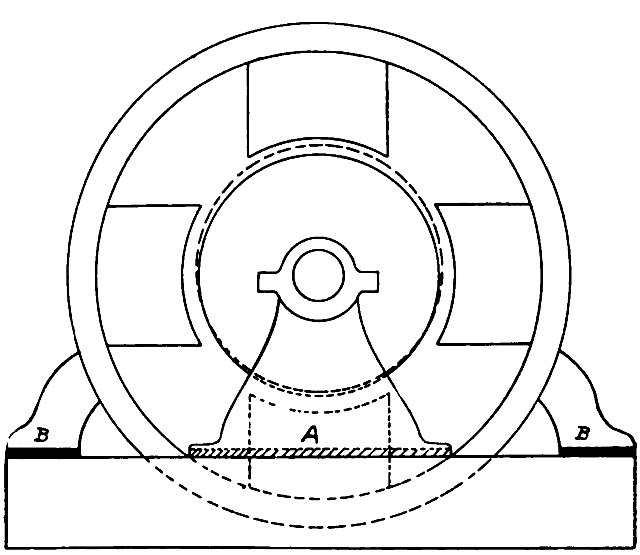
A 100 KILOWATT compound generator, which was belted to an engine, had been removed from one plant to another, and when installation was completed it was tested for service, without load. The load of the plant consisted of lights and motors ranging from 1/4 to 10 horsepower, which were operated intermittingly.

When the machine was started the voltage built up very nicely, but as soon as the load was thrown on the voltage would fluctuate, and also spark badly at the brushes. At first it was thought that the brushes were out of the neutral position, but after trying by shifting the brushes backward and forward there was no change in the voltage and the sparking was increased. This only proved that the brushes were set in the proper position at first.

A speed counter was placed on the shaft of the armature, and its speed was checked up and found correct and constant at no load or full load. This being a compound generator it was possibie to have the shunt and series field bucking, that is the shunt field on a pole piece may be connected so as to produce a north pole, while the series field on the same pole piece may be connected so as to produce a south pole. Since the series field windings are connected in series with the armature, the more the load on the armature, the more current would flow through the series field windings, and would tend to neutralize the magneto effects.

As stated above, this generator and engine were moved from one plant to another, and the men who were installing it at its new location were not electrical but steam engine men, and there was a possibility for them to make an error unknown to them, but all parts were checked up, such as board connections, field connections, brushes, etc., and all were found to be correct. While standing at one end of the generator it was noticed that the clearance between the armature and the pole pieces was not equal all around. At the upper side of the armature it was almost impossible to slide a piece of paper between the pole shoes and the armature surface, while at the lower side there was about three inches of clearance between the armature surface and the pole shoes.

This, of course, was the cause of all the trouble, since by having an uneven air gap the magnetic circuit is unbalanced, which at no load could not be noticed, but when the load was thrown on, fluctuating voltage and serious sparking was the result. The reason for this condition was easily explained. In order to have a uniform air gap all around the armature shims had been placed under the legs of the generator frame where it rested on the bed plate, but when it was installed in its new location these shims were placed under the bearing pedestal, and it can easily be seen how this would raise the armature up closer to the upper pole shoes. It was a very queer coincidence that these shims fitted properly in both positions. Had this been a direct connected generator instead of a belted one such an error would have been impossible because the armature shaft would not have lined up with the engine shaft.



The accompanying figure shows how the error was made. The shims were originally placed at point marked B and in reassembling they were placed at point marked A.

[Note—Through an unfortunate error, the cuts of Mr. Schutter's article on the grinding of brushes in the March issue were transposed with those of the article on installing and wiring a motor.)

The Motor Raced

By T. Schutter

SMALL motors may be connected directly to the line and started without a starting device, but the larger types require a starting box so as to prevent a heavy inrush of current on starting, as this is injurious both to the winding and fuses.

Two forms of modern starting boxes are shown in figures 1 and 2. Fig. 1 is known as a three point starting box, while Fig. 2 is known as a four point starting box. Those types of boxes are used in connection with shunt and compound motors. Fig. 3 shows how a three-point box is used with a shunt motor, and Fig. 4 shows how a four-point box is used with a compound motor, but it should be kept in mind that four-point boxes can be used on shunt motors and three-point boxes on compound motors.

The starting boxes used on series motors have only two points and they are used as shown in Fig. 5.

The following is a little experience which occured to a maintenance man, and for a time he was at a loss as to what had happened or what to do to remedy the trouble. The motor was a five-horsepower shunt machine and was connected to an old style starting in which the re-

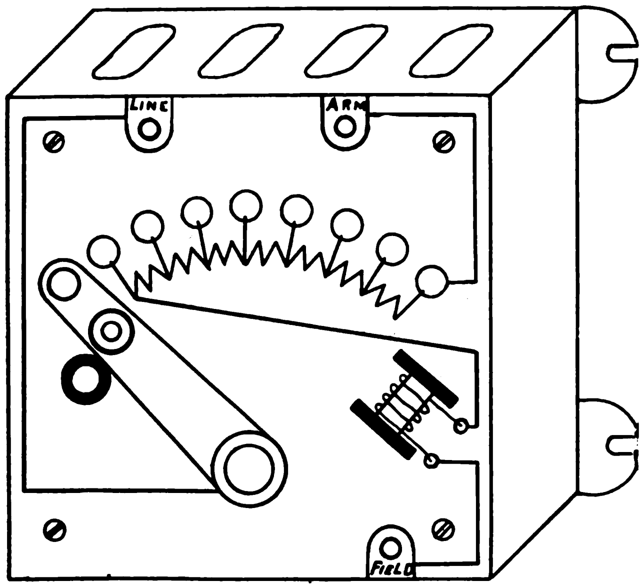


Fig. 1.

sistance units were of the porcelain tube type; that is, the wire was imbedded in porcelain.

This machine had been in operation for many years and at times carried heavy overloads which caused both the motor and the resistance units in the starting box to become extremely hot. On starting this motor one morning, as soon as the starting box handle was brought up to the first contact, which under normal conditions would allow a little current to pass through the armature and a full field current on (trace Fig. 3), which would be the slowest speed position, the armature began to run at an excessive rate of speed or, in other words, the motor raced, which caused the main line fuse to blow out.

The motor was disconnected from the starting box, the fuses replaced and a test made of the motor, and both the armature and the shunt field circuits were found to be in perfect order. Next the lines between the starting box and motor were tested and were also found to be in good shape. On making a test of the starting box circuits it was found that the shunt field circuit was open; this accounts for the increase in speed. When the shunt field circuit is open and a current applied to the armature circuit, it will begin to run on the residual magnetism which is very weak, and which in turn will produce a very small amount of counter electro-motive force and the armature will race. If the source of supply is not immediately cut off, the armature coils (the winding)

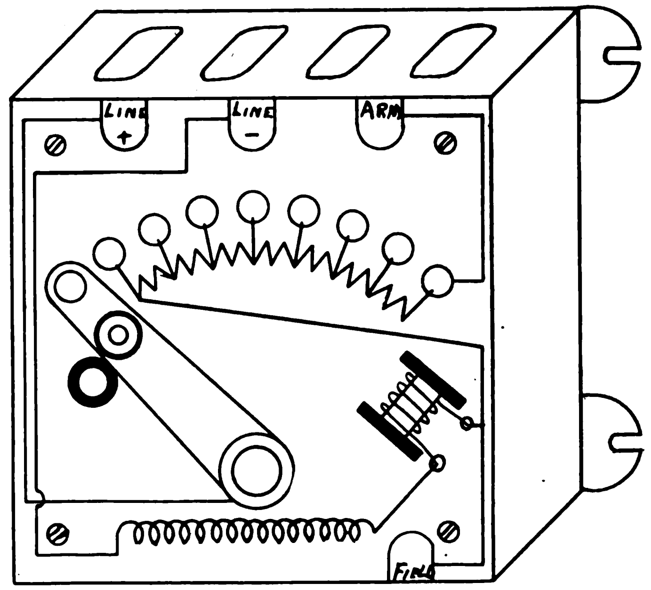


Fig. 2

would be thrown out of the slot and destroyed (coils being thrown out of the slots due to the centrifugal force).

As explained above, the resistance and all wire inside of the starting box were imbedded in porcelain, so for

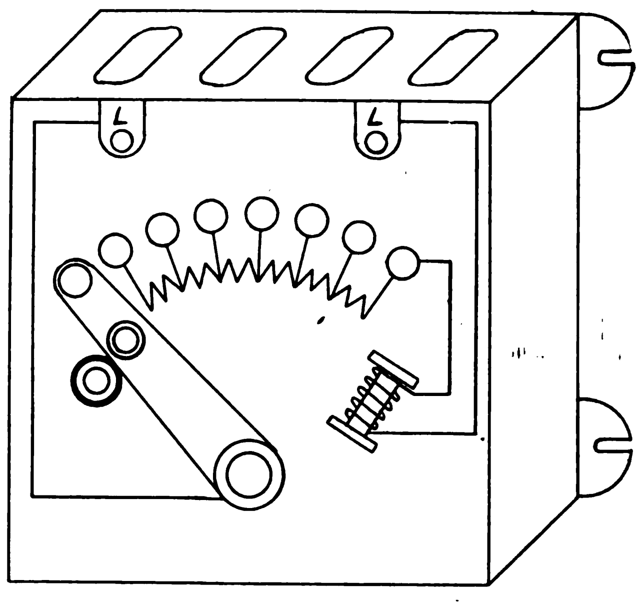


Fig. 5.

this reason it was impossible to make the necessary repair. Still it is impossible to get a new starting box for immediate use so some kind of a repair must be made in order that the motor can be operated. There are two ways in which a temporary arrangement can be made for starting this motor. The first is to discard the starting box and use a water resistance; that is, use a wooden, or a composition, water pail. Fill about three-quarters with clean water and add about two tablespoonsful of salt; place one electrode on one side of the pail in the water and the other electrode on the other and gradually bring them together. In this way the armature current will be regulated. When the electrodes meet, the switch A in Fig. 6 should be closed, so as to cut the water resistance out. The field is connected right across the line. When the machine is to be stopped, the switch A must be opened first and then the field.

The second way to make a temporary repair is as follows: First, remove the reset spring, which is found at the bottom end of the handle, so that the handle may be left at any on full point without the retaining coil being energized (as this is part of the shunt field circuit which is broken), then rim a wire from the side of the switch which runs to the box and conect it to the field terminal (F) on the motor. It will now be seen that the field current is regulated by the line switch, while the armature current is regulated by the starting box, as shown in Fig. 7.

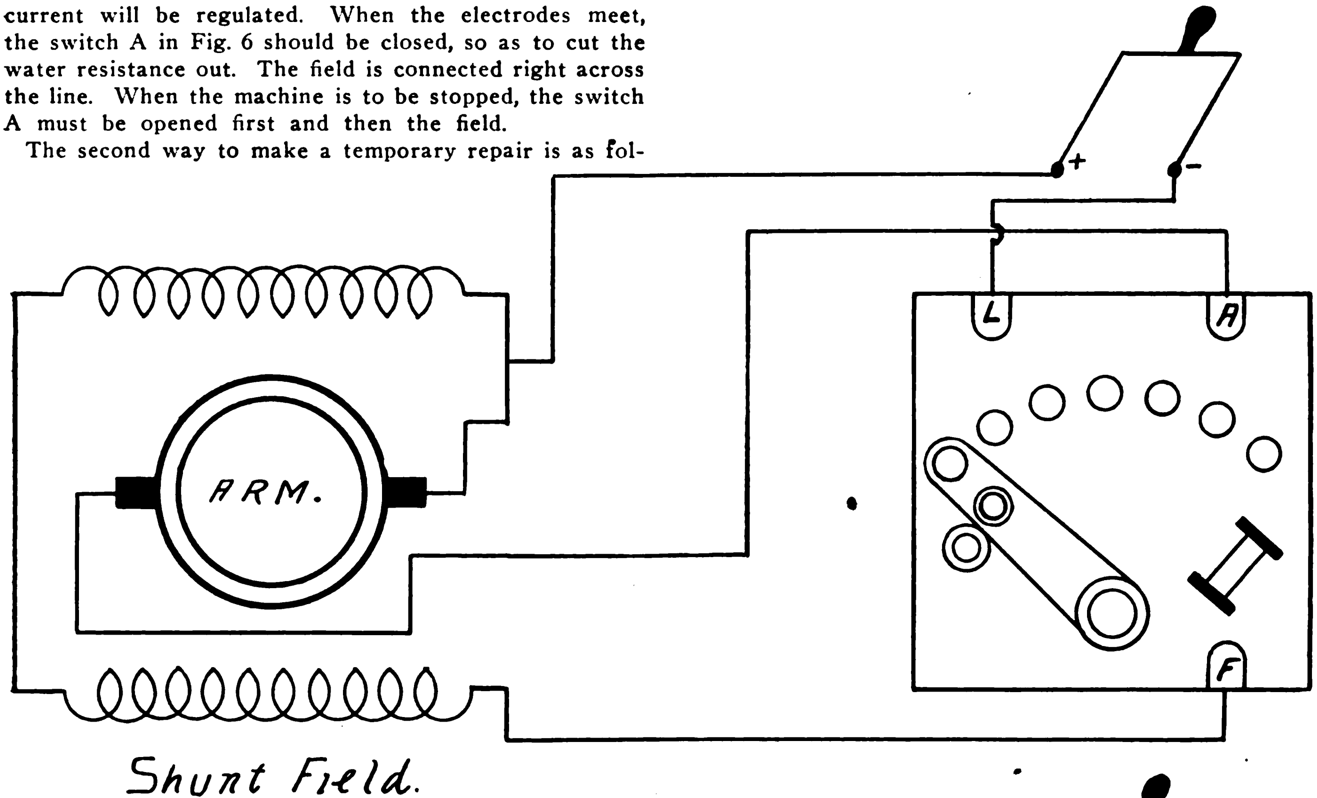


Fig. 3.

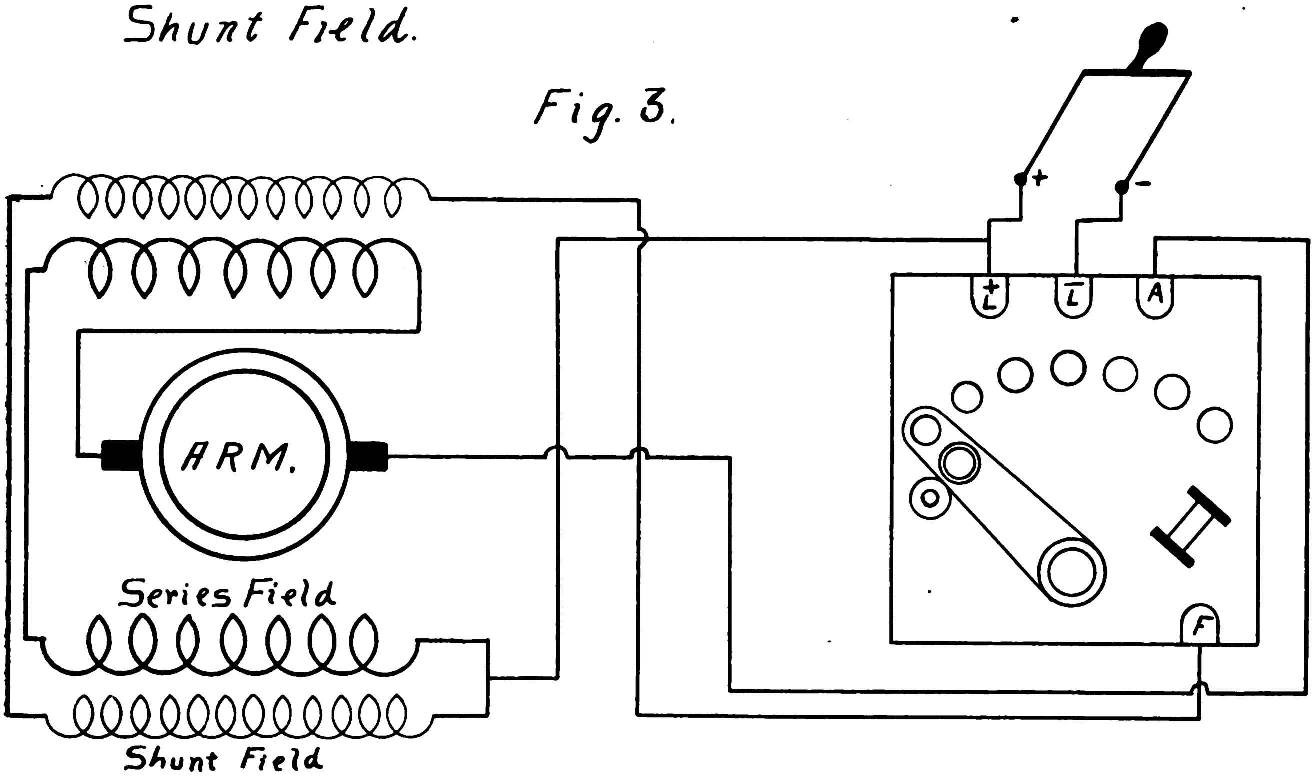


Fig 4.

Generator Fails to Build Up

A TEN kilowatt generator, which had been standing idle for a considerable time was to be put back into service. After being thoroughly overhauled was belted to a gas engine, but when started and brought up to the proper speed it failed to generate.

After several unsuccessful attempts the electrician who was in charge of the plant was called. He made a thorough examination of all parts and connections (which, of course, were all right). He decided that there was a short circuit in the armature windings. To rewind the armature meant a loss of time which could not be spared very well, but as he claimed nothing could be done unless the armature was rewound, so he at once to make certain adjustments. But after another unsuccessful attempt he gave up the job in disgust and another electrician was called on for help.

The first question that he asked after being told that the armature had been rewound and that the machine had been standing idle was: "How long has this machine been standing idle?" and when told that it was about three years, he smiled and called for a half a dozen of dry cells, and began to disconnect the shunt field leads from the machine. When he received the cells he con-

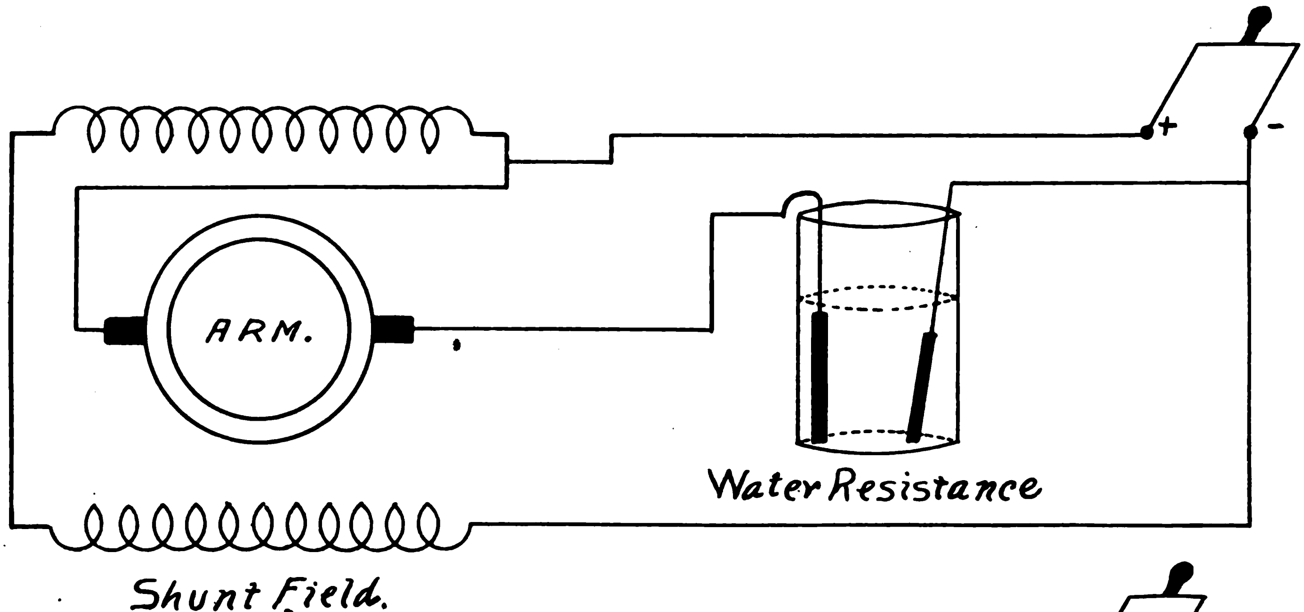


Fig. 6.

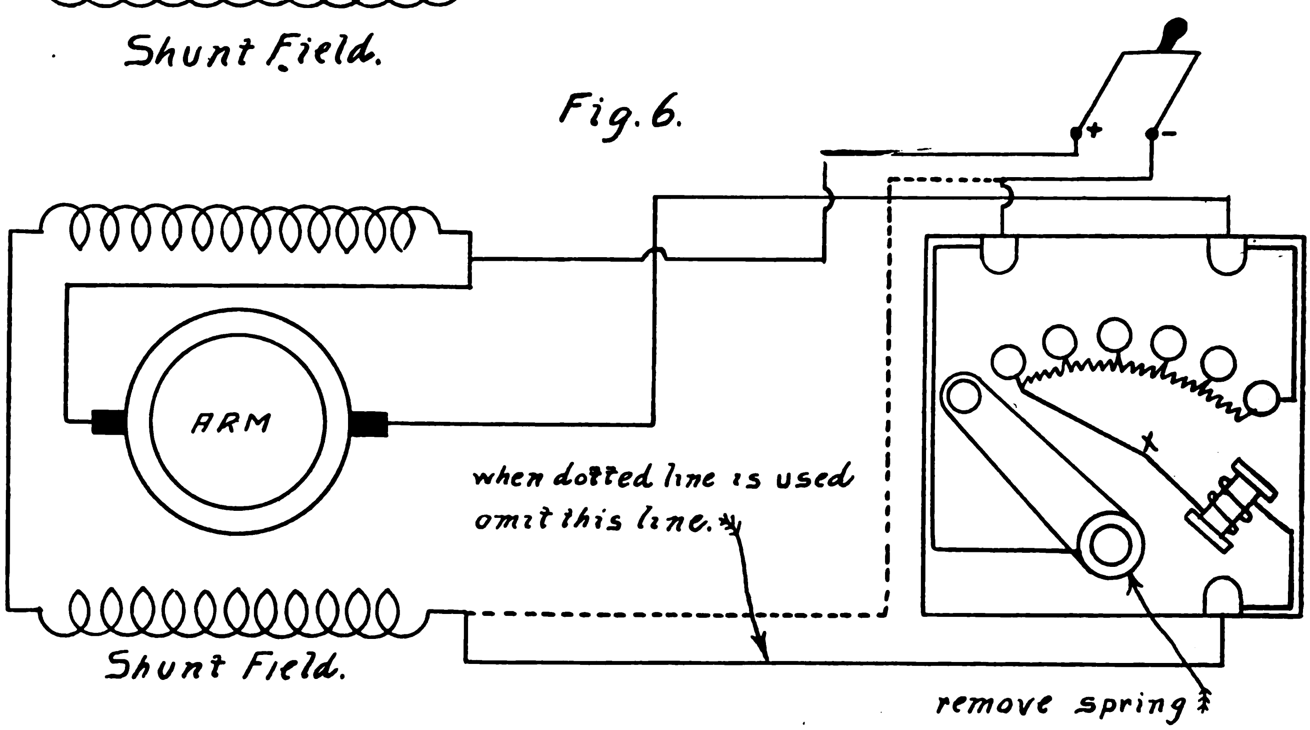


Fig. 7.

set to work stripping the old winding off, made a new set of coils and in due time the armature was put back in the machine and started up again, but the results were no better than at the first trial and again failed to produce a current.

This was about the limit of the owner's endurance, and he flatly demanded of this electrician whether he knew what the trouble was or not, and as a final attempt and after several excuses, asked time until the following day nected them in series and then connected them across the shunt field leads for a few minutes. Then he reconnected the shunt field to the machine and prepared the machine for another trial.

After making a few adjustments the engine was again started and as the speed was increased the needle on the volt meter began to leave the zero point and gradually come up to full voltage, 115 volts.

When the first electrician asked him how and why the dry cells were connected to the shunt field, the second or real electrician simply said: "If you stood still for three years you would loose your strength, and the the same applies to the pole pieces of this generator. In three years they lost their residual magnetism, which is their strength on which the voltage is built up."

The rewinding of this armature was entirely unnecessary as the only thing that was wrong with this machine was that by standing idle so long it lost its residual magnetism, which is necessary to start the generating of an electro-motive force. The residual magnetism may be very weak, but as soon as the armatures begin to cut a few lines of force, a current begins to flow in them and as the field windings are connected in parallel with the armature winding, some of the current is then passed through the shunt fields, which will increase their magnetic strength or lines of force, and in that way full voltage is gradually built up.

Here and There in the Electrical Field

Consul G. K. Donald reports from Sydney, Nova Scotia, that a new electric-power plant equipped with the latest type of high-efficiency turbines, capable of generating 11,500 kilowatts, or about 15,000 horsepower, is to be erected for the Dominion Iron & Steel Company in Sydney by an American corporation. It will be put up so that additions may be made as needed. It is expected to be completed by the fall of 1919.

Vice Consul Richard P. Momsen reports from Rio de Janeiro, Brazil, that the director of the Central Railway of Brazil recently reported to the government the intention of the directorate of this company to install in its workshops an electric furnace for the smelting of ferro-manganese, utilizing for this purpose the mineral products of the country. A small chemical laboratory will also be installed for guidance in the manufacture of steel.

According to the Swedish press, the Tingstaede radio station on the Swedish island Gotland is to be opened to the public on March 15, after which date private radiograms, inclusive of business messages, can be forwarded via London to all places in Siberia and to the stations Ekaterinburg, Perm, Tchelyabinsk, and Zlatoust, in European Russia. Radiograms will in general be higher than ordinary telegrams.

A club has been organized by the employes of the Oklahoma Gas and Electric Company at Oklahoma City, Okla. The first meeting was held on March 20, at which 142 employes were present. Officers will be elected at the next meeting and steps taken towards making the organization permanent with regular meetings.

The Railroad Commission of California has authorized increased rates of charge for both gas and electric service supplied by the Western States Gas and Electric Company, Stockton division. The decision grants increases over surcharges allowed for the duration of the war and establishes the new rates on a permanent basis without surcharge features. This is the third rate increase allowed this company since the start of the war.

An electrically cooked dinner was served to 130 employes of the Louisville Gas and Electric Company at the company's office, March 17. The object of the dinner was to stimulate interest in electric cooking. A. S. Witmer, commercial manager of the Louisville Gas and Electric Company, was in charge of the affair. Nine public demonstrations of electric cooking are to be held at suburban locations about Louisville during the remainder of March.

The Pittsburgh Chapter of the American Association of Engineers will have a secretary beginning April 1. This is the first chapter outside of national headquarters at Chicago to have a secretary giving all his time to the work of the association. F. E. N. Thatcher has been selected for the position and will have an office at 1312 Fulton building, Pittsburgh.

The Washington Chapter of the American Association of Engineers at its meeting, March 25, elected the following officers:

President, Harry Stevens, Civil Engineer, Union Trust Company Building; first vice-president, A. Y. Hess, designer, Navy Department; second vice-president, Clegge Thomas, Washington Loan and Trust Company Building; secretary, E. L. Howard, Bureau Yards and Docks, Navy Department; treasurer, O. M. Sutherland, mechanical engineer, Bureau Yards and Docks.

The Kansas City Club of the American Association of Engineers at its meeting, March 21, elected the following officers: Chairman, J. E. Jacoby, consulting engineer, Shukert Building; vice-chairman, W. B. Cast; secretary, R. N. Clarke; treasurer, S. M. Bate.

Stockholders of Cities Service Company at the annual meeting of the company in Dover, Dela., on April 8, will be asked to approve an increase in the authorized preferred capital stock of the company from $100,000,000 to $150,000,000. Cities Service Company at the present time has an authorized capitalization of preferred stock of $100,000,000, of which $70,807,936 is outstanding. The Company has outstanding approximately $31,000,000 of convertible securities, all of which will become convertible into stocks of the company within the next two years. To provide for the conversion of these securities will require approximately $27,000,000 par value of preferred stock, and it is felt provision for this conversion should be made now. No increase will be asked in the present authorized common capital stock of the company, as it is believed that there is no necessity for increasing this at the present time beyond the authorized amount of $50,000,000.

Under a Bill introduced into the Quebec Legislature, amendment is made to the law whereby power companies expropriate land on which to erect transmission lines. At present they are obliged to buy more land than is needed, and the change is to allow them to take only what is actually required.

The Gatineau Development Co., Ltd., of Maniwaki, P. Q., has been incorporated with a capital of $99,000 to carry on the business of an electric light company in the township of Egan, and to deal in electric fixtures and supplies.

Bruce County, Ont., Council plans installation of Hydro-electric system. Clerk, P. A. Malcolmson, Walkerton.

Plans are prepared for equipping Collingwood, Ont., Shipbuilding Company for electric operations. About 800 hp. will be required.

Toronto, Ont., will vote on appropriating $200,000 for the purpose of buying out existing lighting systems in the township and adding thereto. Engineer, Frank Barber, 40 Jarvis Street, Toronto.

It is proposed to submit a by-law to the ratepayers of Stouffville, Ont., on the question of introducing Hydro power and scrapping the present municipal power plant. This plant is operated by steam and since the coal shortage there has been much inconvenience caused by shutdowns.

The town council of Perth, Ont., have granted the Hydro-electric Commission amounts totalling $60,000 for the completion of work in connection with changing over the local system to Hydro.

Now that the war is over, the Administrative Commissioners of the city of Montreal will request the Quebec Public Utilities Commissioners to compel the public utility companies to place their wires in the underground conduits of No. 4 and

No. 6 districts. The Utilities Commission decided, in April last, that the companies be allowed to defer the work owing to the abnormal cost of materials and the difficulty of securing supplies, due to the war.

The annual report of the Toronto Hydro-electric System for the past year shows a gross revenue of $2,353,443, made up as follows: Lighting, $743,914; power, $982,859; street lighting, $300,594; exhibition, $15,748; current supply in bulk to other municipalities, $245,856; income from other sources, $64,472. The expenditures were: $842,251, cost of current: $661,361, cost of operation and management, and $846,164, fixed charges, interest and sinking fund, a total of $2,231,776, showing a net profit in the year's operations of $21,666. The assets of the system are valued at $10,628,232, with gross liabilities of $10,564,253, showing a surplus of assets totalling $63,979.

Officials at the plant of the Pacific Smelting Company's works at Edmonds, B. C., state that through electric smelting they are able to manufacture calcium carbide giving five per cent. higher gas yield than that manufactured under the older method. It is stated that plans are being drawn for a large and permanent plant for this company.

Foreign Trade Opportunities

The Bureau of Foreign and Domestic Commerce, Washington, reports the following inquiries for electrical goods. Further particulars may be had by addressing the bureau, mentioning the numbers given:

28897.—A man in Italy desires to receive an exclusive agency for the sale of electrical machinery, magnetic sheet steel, batteries, frequency meters, phrasometers, current compters, instruments of precision, electric apparatus for mines, for chemical industries, and for electric railways; also, insulating material, mica paper, varnish, fiber and cable insulators, medical applications, marine installations, magnetos, telephone apparatus, and telephone switchboards. Correspondence may be in English. References.

28918—A merchant in France desires to purchase and secure an agency for the sale of all sorts of electrical appliances and apparatus, such as motors, heaters, lighting fixtures, and tools. Terms of payment, cash against documents. Correspondence should be in French. References.

28928—A man in Italy wishes to secure an agency for the sale of electrical materials and machinery, automobiles and accessories, including pneumatic tires, rubber articles, technical articles for surgery, machinery of various kinds, greases, oils for lubricating, asbestos fittings, glass vials, bottles, etc. Payment guaranteed through bank deposit. Correspondence should be in Italian.

28930—A man in Belgium desires to secure an agency for the sale of all kinds of electrical supplies and material. Correspondence may be in English.

28959.—A merchant in France desires to represent manufacturers and exporters for the sale of locomotives, machinery and materials for railways, steamships, gas and electrical plants, waterworks, mining, construction work, etc. Correspondence may be in English.

28960.—A business man in Norway desires to secure an agency for the sale of electrical motors, transformers, storage batteries, dry cells, wires, cables, resistance alloys, apparatus for cooking and heating, insulators, insulating materials, tapes and other electrical supplies; also varnish, carbon and metal brushes, metals, transformers and dynamo plates, tools, etc.

28966.—A large import-export house in the United States with branches in Holland and Java desires to enter into negotiations with manufacturers of general machinery, motors, commercial motor cars and other technical articles for an exclusive agency in the Dutch East Indies. Reference.

28993.—A man in Sweden wishes to purchase electrical goods, wires, cables, motors, fans, dry batteries and other suitable goods. Reference.

28975.—A man in Switzerland desires to secure an agency for the sale of machinery, electrical apparatus and tools. References.

Obituary Notes

Emil C. Braun, for fifteen years connnected with H. M. Byllesby & Company as an electrical engineer and valuation expert, died suddenly at his apartments in the Bradley Hotel, Chicago, March 23, as the result of a fall which caused a hemorrhage. He was born in Germany in 1868 and came to this country in 1893 in charge of the German electrical exhibit at the World's Columbian Exposition, Chicago. He was educated at the universities of Frankfort and Berlin.

Herbert W. Kent, manager of the Northern Electric Company at Vancouver, B. C., died recently. Previous to going with the Northern Electric Company he had been for many years manager of the B. C. Telephone Company. His home town was Peterboro, Ont.

Burnett C. Kenyon, formerly president of the Diehl Manufacturing Company and for the past two years purchasing agent for the Crocker-Wheeler Company, died suddenly at East Orange, N. J., the past month at the age of 54 years. Mr. Kenyon had been associated with the electrical manufacturing industry for many years. Mr. Kenyon resigned from the presidency of the Diehl Manufacturing Company about four years ago, becoming associated with the Crocker-Wheeler Company.

Removal

The entire executive staff of the Okonite Company was transferred on April 1st from 501 Fifth Avenue, New York City, to the company's plant at Passaic, N. J., where their main office will hereafter be located.

A sales office will be retained at 501 Fifth Avenue, New York.

Trade Notes

The Edison Storage Battery Company, Orange, N. J., have a new price list, effective March 1, 1919, reducing the price of type A, B and C Edison cells approximately 16 per cent. This company is also boosting prosperity by using the slogan: "Procrastination murders industry—stir things up!"

The Quigley Furnace Specialties Co., Inc., of 26 Cortlandt Street, New York, has just published Bulletin No. 11, describing the Quigley system for preparing, distributing and burning powdered fuels. This has been developed as the result of twenty years' practical experience in the selection and application of fuels and in furnace design and operation. It has been in successful operation for some time in a variety of furnaces.

The Heine Safety Boiler Company, of St Louis, Mo., have just completed the printing of the latest edition of their "Boiler Logic," an 86-page treatise on steam boilers. This takes up in detail fundamental consideration of boiler design, the practical baffling of water tube boilers, the adaptation of boilers to different fuels, firing and service, and overloads.

Preliminary Bulletin No. 113, illustrating and describing the Wheeler Steam Jet Air Pump, is now being distributed by the Wheeler Condenser & Engineering Company, Carteret, N. J. This pump includes the valuable features of two or more steam jets working in series with a condenser between the jets—a feature which enables this type of pump to perform a given duty efficiently.

ELECTRICAL ENGINEERING

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The Continuous-Rated Motor

THE tendency of industry throughout the entire world is strongly towards standardization. Much of it has been done, however, by the individualistic method, and so a general desire has grown up for a common standard. In the electrical field this latter idea is embodied in the Standardization Rules of the American Institute of Electrical Engineers. Mr. L. F. Adams, of the Power and Mining Department of the General Electric Company, has written an interesting discussion of these Standardization Rules as applicable to the rating of motors. His article, "The Continuous-Rated Motor and Its Application," was prepared for the "General Electric Review." From advance sheets, kindly placed at our disposal, a summary may be given.

Mr. Adams tells of the steps taken by the Institute towards standardization, the formulation of rules and their revision into the present form. He confines himself to a discussion of these standards as applied to motors and to motor applications. What are the requirements for a successful operating motor, Mr. Adams asks. A motor produces torque and speed, the two elements required to drive any load. The load requirements have certain variations in the relations of torque, speed, and time. Consideration must also be given to the operating temperature. We therefore define a successfully operating motor as one of such size and design as will readily start and accelerate any reasonable load for which the driven machine may be called upon to sustain, carry any reasonable overload that may be imposed on the machine, and be capable of carrying the normal load for the period of time required without exceeding a temperature of 90 deg. C. as measured by thermometer.

The first point to consider in the selection of a motor is the starting and accelerating torque. For convenience the starting torque or turning movement of a motor is frequently spoken of in terms full-load torque. For greater accuracy, it is obviously better to use the actual torque developed by the motor at standstill expressed in pound-feet. After the starting torque requirements of the driven machine has been determined, the ratio of starting torque to normal torque should be noted. The ratio, if relatively large, indicates that a compound- or series-wound direct-current motor will be preferable to a shunt-wound machine, or that a slip-ring or high-resistance rotor alternating-current motor should be selected in preference to the standard squirrel-cage motor. Substantially the same method may be used for services requiring very fequent starting. Careful consideration of the starting and accelerating torques frequently permits the selection of a motor of smaller horse-power rating than would otherwise be employed.

The next question is one of peak load. This is usually expressed as a percentage of full-load torque. Here, too, it is better to express this torque in pounds at one-foot radius as this expression eliminates the full-load speed which is a variable. Ample margin must be allowed between the requirements of the driven machine and the maximum torque developed by the motor. The maximum running torque which the motor will deliver without undue drop in speed is usually of greater importance than the maximum horsepower output, because in many applications a slight drop in speed on the peaks is advantageous for the inertia or fly-wheel effect in the driven machines assists in carrying the load over that peak.

Heating in motors is primarily of interest only as it affects the life of insulation. The heating standard must be in the form of a limiting temperature, this limit to be sufficiently low that insulation continuously subjected thereto will not deteriorate, in so far as its insulating qualities are concerned. Evidently the logical upper limit should be based on the ultimate temperature at which the motor is to be operated, since it is above this that the insulation begins to weaken. After careful investigation, supported by tests, and in the light of practical experience, the American Institute of Electrical Engineers has set a temperature 5 deg. C. above that of boiling water, i. e., 105 deg. C., as a conservative and safe limit for the temperature at which treated fibrous insulation can be used without deterioration. The question arises: Would insulation last longer at a lower temperature? Experience indicates a negative answer. This is to be expected, because even the highest permitted temperature is well below the danger zone.

Having established a suitable upper limit, the next step was the selection of a conservative standard for the cooling medium, or surrounding air temperature, or as it is called in the Institute rules, the "ambient temperature." The value settled upon by the Institute is 40 deg. C. In a building this represents an extraordinarily hot day or a very highly heated room for ordinary industrial purposes. It is a temperature approached in all parts of the temperate zone at some time during the year. It is improbable that the average standard motor will normally be required to operate in temperatures as high as 40 deg. C. for any considerable period of time. For all except the hot days of summer, 21 deg. C. very closely represents the average mean room temperature. Therefore, under normal conditions, motors will seldom operate under as high an ambient temperature as has been proposed, and the value selected is consequently very conservative.

With reference to horse-power rating, the Institute has adopted two distinct ratings—one a continuous rating, the other a short-time rating. The meaning of the first is self-evident. The second is, briefly, the equivalent output which a motor can deliver for a specified time, such as during 5, 10, 15, 30, 60 or 120 minutes without exceeding a temperature rise of 50 deg. C. provided that, after each run and before starting on the next run, the motor be allowed to cool to within 5 deg. of the ambient temperature. It is also understood that the motor must operate without violating the requirements of successful operation, such as commutation, sufficient starting and maximum torque, suitable mechanical strength, etc. The short-time rating is primarily a method of expressing a thermal equivalent.

The capacity and rating of the machine although frequently used interchangeably are not synonymous terms, according to the Institute. The capacity of the machine is the maximum output which it can successfully deliver for a stated period. The rating of the machine is the output stamped on the name plate. The maximum limit for this rating is the capacity of the machine. There is no minimum limit.

The purchaser is usually interested in knowing all the facts about the possibilities of the machine that he is buying; i. e., the capacity of the machine consistent with the requirements of starting torque, maximum running torque, and similar factors. This logically means that the name plate rating stated in the accepted even ratings should closely correspond with the capacity rating. Such a rating has been referred to as a continuous or 50-degree rating. Possibly the term capacity rating, within the limits above specified is the most descriptive.

It is obvious that the system which has been widely followed in the past, of giving a normal continuous rating with 25 per cent overload for two hours, is not a capacity but a fractional rating, and that it represents but one form of duty cycle. Under this method of rating, a 10-h.p. motor will carry 10 h.p. continuously with a temperature rise of 40 deg. C., and at any time during such operation will carry 12½ h.p. for two hours with a temperature rise of 55 deg. The temperature rise in these few hours is only a few degrees less than the ultimate temperature which will be attained in eight or ten hours. Consequently, the capacity of such a machine (providing the rating does not under or over state the possibility of the machine) would be about 11⅜ h.p. continuously or a short-time rating, for 30 minutes, of approximately 15 h.p. This example illustrates that a continuous or capacity rated motor is classed conservatively with reference to heating, since the temperature rise for such an open motor is limited to 50 deg. C. Whereas the temperature rise on a 25 per cent overloaded motor is five degrees higher, i. e., 55 deg. C.

It must not be overlooked, however, that the intent of the Institute rules is not to require a 50-deg. rise but to fix it as a limit for good engineering practice. Designing engineers have long recognized that a temperature rise of 35 deg. in itself was absurdly low, but the object in operating at such low temperature, measured on a part of the motor accessible for the application of a thermometer, was simply to protect the motor in the hot spots where the temperature could not be measured. It had been found by experience that there were hotter parts in the motor than were indicated by thermometer readings. For this reason the exposed parts of the winding not infrequently showed, by thermometer, comparatively small temperature rises of 25 to 35 deg. Therefore, because the temperature rise was so small, it became the fashion to call for 35-deg. rise motors and no doubt the users never knew the real meaning of such low temperatures.

Compare the factor of safety of a motor rated in the old way with that of a motor rated in the new. Was the purchaser any better off? No, because the intended margin was not sufficiently definite. A motor of a certain rating with a certain overload guarantee gives much less idea what can be obtained from the machine than a motor rated on the continuous basis. By the old method a motor was capable of carrying 25 per cent overload. If the load is steady and there is no overload, 25 per cent of the possible output of the motor is wasted and the motor is larger than necessary. If it happens that the average load, equal to the rated load, fluctuates up or down ten per cent, there still remains an unnecessary margin of 15 per cent. If the load varies 50 or 100 per cent, the margin of 25 per cent is worthless and the motor would in all probability burn out. To drive a load requires a certain maximum horsepower output. Under the old method of determining the size of a motor, it was customary to deduct

25 per cent from the maximum output required by the machine the motor was to drive and thus arrive at the normal rating of the motor. The new method of rating simplifies the determination by omitting the 25 per cent overload, which is not really overload, and merely stating the maximum load is so much and therefore the motor is rated at that load.

This new and simplified method of rating places on the purchaser the burden of determining the appropriate margin to be provided. The industry is far enough advanced so that the users are capable of selecting their own margin. The application engineers of today are fully conversant with the diversified requirements of the industry, so that they will have no difficulty in selecting the proper motor for each specific case. There is no excuse for guessing at the duty a motor must fulfill. Twenty years of education should have taught the user how to make allowance for the conditions he has to meet. The new method of rating assists both the seller and the buyer by defining more completely the capability of the motor.

Some confusion exists due to the impression that continuous-rated motors will not stand any overload. The motors are guaranteed to stand 50 per cent momentary overload but they are not guaranted for any overloads which in heating effect are equivalent to greater than their rated output, i. e., that will cause the motor to exceed a 50-deg. C. rise at any time. In case a motor is subjected to peak loads in excess of the ordinary load and the peak endures for more than a short time, it must be included in the rating. If, however, the peak load lasts for brief periods only, the rating must be sufficiently above the ordinary load to give a continuous thermal equivalent to that required on the brief peak loads without exceeding the permissible temperature limits. From the explanation of the short-time rating it is obvious that the machine will actually carry overloads within the maximum-torque capacity of the machine, but the heating equivalent must be within the limits specified or the motor will not be used within the conditions specified in the guarantees.

It is common practice to rate generators on a continuous basis. During the past ten years, such generators, particularly those for connection to steam or water turbines, or gas engines, have been purchased very generally on the basis of a 50-deg. C. rise. The tendency is to rate the machine at the highest point it can be operated at safely in continuous service, thus getting the maximum output possible from the investment. In case a margin for overload is desired, it is necessary to increase the rating of the machine so that the name plate rating equals the maximum load desired. However, transactions arise where it is necessary to rate the generators on a 40-deg. C. basis and in these instances the rating is taken as 83⅓ per cent of the rating as a continuous-rated machine.

Under the new system, the continuous-rating system, the purchaser will know exactly what he is getting and pay for that only. Just a little thought will enable the purchaser, his engineers, or the application engineer to select the proper size and type of motor. In the transition period, however, it should be realized when applying these motors that it is particularly unwise to assume that because a 10-h.p. motor with 25 per cent overload for two hours did the work, a motor of the same continuous capacity will do the same work. It may or may not, depending entirely upon the starting and maximum load requirements and the heating equivalent of the cycle of duty, but it should be fully realized that the motor will carry its rated load continuously with as great a factor of safety as will a motor guaranteed to carry 25 per cent overload for two hours, and it will have equally long life and be equally reliable.

Electric Current Will Build Santa Fe Trail

W. F. Raber, vice-president and general manager of the Arkansas Valley Railway Light & Power Company, Pueblo, Ark., claims credit for his company as the first to supply electricity to be used exclusively in road building. Electricity is now playing a very active part in road construction in Pueblo county. In addition to the motorized vehicles for hauling road building materials, and the motorized machinery for grading and surfacing the roads, electricity is being used to drive the stationary machinery which prepares the materials for the road foundations and the surface. Perhaps no other county in the state is quite so favored with a combination of gravel, stone, and electric current service as is Pueblo county. Especially is this the case between Pueblo and Fowler where gravel beds abound every few miles, rock is within easy haul, and the high-tension electric wires of the Arkansas Valley Railway, Light and Power Company follow along the Santa Fe Trail down the valley. And this electric current is being utilized in building this Santa Fe Trail into a highway boulevard from Pueblo to Fowler—or to the East Pueblo county line.

Electric Equipment for a Slate Mill

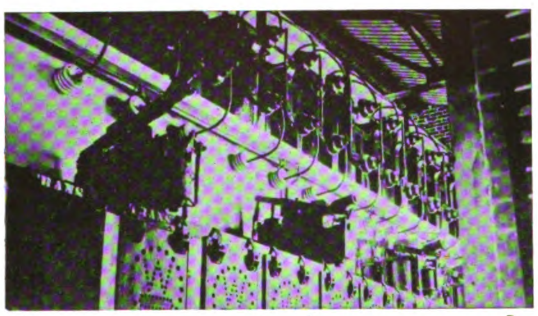
The Mahar Bros. Slate Company, of Fair Haven, Vt., are erecting a new grinding mill, costing about $75,000, for crushing green slate into granules for asphalt roofing. The slate is taken from the old Evergreen quarry. The mill will have individual electric motor drive, with a total of about 300 horse power. The current will be taken from the Rutland Power Company. Electricity will also be used for power in the quarry. The equipment of the mill will consist of a No. 5 Gates gyratory crusher from the Allis-Chalmers Company, Milwaukee, one set of 42 x 16 inch Superior crushing rolls, and three sets of 36 x 16 inch Superior crushing rolls. There will be other equipment, including air compressor, drills, blowers, screens, elevators and conveyors. It is expected that the mill can be completed prior to June 1.

Canal Substation at Columbus

By E. W. Clark.

THE Canal Substation which is described in this article is part of the extension to their generating and distributing system recently completed by the Columbus Railway, Power and Light Company. Due to various local conditions the new generating station was located about ten miles from the center of the city and this substation is located at the terminus of the principal connection between the new station and the city distributing system.

The lines coming into the substation are two three-phase, 60 cycle, 39,400 volts pole lines, each line being designed to deliver 10,000 kw. ordinarily, but 15,000 kw. can be carried without the voltage drop and losses becoming prohibitive. These circuits are of No. 1/O



"E" 13,200 Volt Oil Circuit Breaker Structure

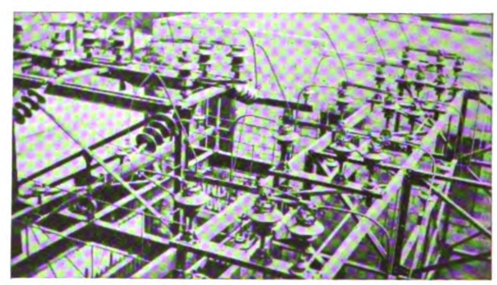
The top of the circuit breaker cells, and above the fuse blocks and fuses for potential transformers are shown in detail

B & SG seven strand hard-drawn copper and have 45,000 volt Ohio Brass pin type insulators, except on dead ends, angles and crossings where Ohio Brass 14-unit suspension type insulators are used. Poles are painted and treated with carbolineums at butts, gains and tops, and cross arms are similarly treated. The lines running out from the substation consist of a number of three conductor, three phase, 60 cycle, 13,200 volt and 4,150 volt lead covered underground cables. These cables are of No. 4/10 B & SG stranded copper and have a capacity of about 5,000 kw. at 13,200 volts or about 1,500 kw. at 4,150 volts. The 13,200 volt cables are used for tie lines between older stations and substations (of which there are a number in the city), and also for some of the longer power circuits on which comparatively large loads are carried. The 4,150 volt cables connect with the primary power and light distributing lines.

The substation is a compromise between the outdoor and indoor types. That is, the transformers, lightning arresters and other high tension equipment is located out-of-doors so that only a small building is necessary for the oil switches, buses, switchboard and auxiliary equipment. The substation building is constructed of brick, steel and concrete with concrete roof, so that it is practically fireproof. The substation is unusual in the completeness of the auxiliary equipment, the bus system which is used, the location of the transformers, and for the small amount of space covered, this latter feature being due more to the restrictions imposed by the site than to any intention on the part of the designer.

All of the substation equipment with the exception of the power transformers, control battery, air compressor and some of the high tension disconnecting switches was supplied by the Westinghouse Electric and Manufacturing Company. The same types of equipment, except for instrument transformers, are used for the 13,200 volt and 4,150 volt circuits, with the idea that the number of 13,200 volt circuits will increase, while the number of lower voltage circuits will decrease.

As stated before, practically all the other substation equipment is Westinghouse. The outdoor oil circuit breakers are 300 amp., 45,000 volt, type "GB." These are provided with bushing type current transformers, are solenoid operated and controlled from the switchboards, and are provided with type "CO" overload and type "GR" reverse energy relays. The lightning ar-



The Top of the Substation

A close-up view showing the incoming lines, lightning arresters and Burke horn gap switches

resters are type "AK" electrolytic arresters with grounded tanks. The indoor oil circuit breakers are solenoid operated type "E-8" and range from 300 to 800 amperes in size. These are mounted in concrete cells and have the potential transformers and fuses mounted above them and the current transformers and disconnecting switches behind them. The switchboard is located in a small room adjacent to the switch room and all of the electrical equipment is controlled from this point. The control cable to the various switches, etc., is mounted above the switchboard. A 5 kw. battery charging set is used. Provision is made for twenty circuits in the switch room but only thirteen installed at present.

Both the 13,200 and 4,150 volt buses are double, there being main and transfer buses connected together by transfer switches large enough to handle any circuit in the substation. Each circuit is provided with double blade disconnecting switches so that it can be transferred to the transfer bus without interrupting service, after which it is controlled by the transfer switch. The oil circuit breaker, instrument transformers, etc., for the circuit can then be cut off from the main bus by disconnecting switches, leaving them dead and available for inspection and repairs. Thus, in effect, there are two coil circuit breakers for each circuit, although as a matter of fact, there is only one extra breaker for each main bus. The auxiliary transformer bank consists of two 15 KVA., single phase, 60 cycle, 13,200/220 and 110 volt type "SK" transformers, which provide light and auxiliary power for the substation. The lights can also be operated from the control battery in case of power failure.

Circulating pumps for the transformer cooling water system are also used. In addition to circulating the cooling water through the cooling tower the piping is so arranged that either pump can be used to pump out the transformer pit or the substation basement in time of flood when the ordinary sewer connections have to be closed. The basement is rather deep, due to provision being made for installing feeder regulators on the outgoing circuits at a later date if necessary. The substation site is well above extreme high water level but both the basement and the transformer pit are below this level, so that the sewer connections from them are provided with valves and the above provisions are made for pumping them out in case of flood.

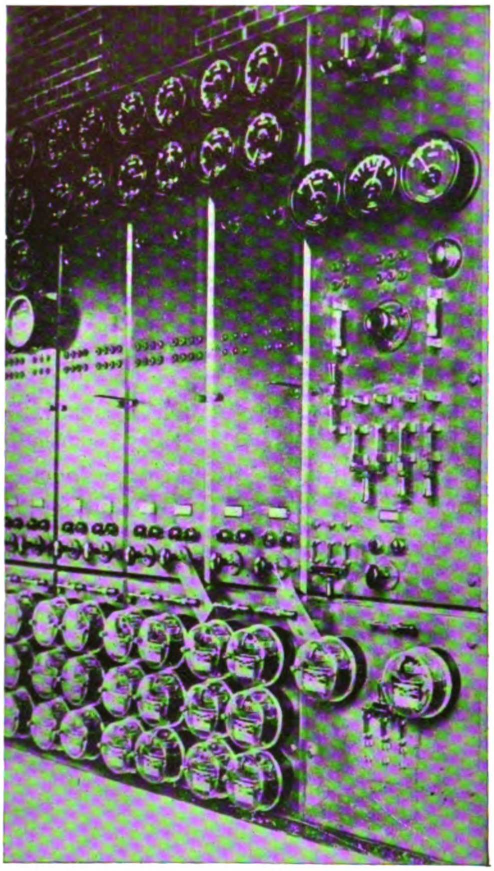
The compactness of the substation may be judged from the fact that it is all located on a plot of ground approximately 94 ft. long and 45 ft. wide. More ground is now available for extension when necessary, but local conditions made it necessary to get all of the substation equipment in the above space when it was constructed. Work on the Canal Substation was started on July 10, 1917, and it was partially put into operation about November 15, 1917. This substation was designed and built for the Columbus Railway, Power and Light Company by the E. W. Clark & Company Management Corporation of Columbus, Ohio.

New Hydroelectric Plant in Taiwan

The Formosan Government General, in co-operation with private capital, is contemplating establishing what, it is said, will be one of the largest hydroelectric plants in the Far East, at Jitsugetsu-tan (Lake Candidius) in Nanto Prefecture, Taiwan. It is planned to start the plant during the present fiscal year (April 1, 1919-March 31, 1920), probably in August, or as soon as the bill for the necessary appropriation for the undertaking has passed through the Diet, the Cabinet having already signified its approval of the sceheme, write Consul Max D. Kirjassoff, Taihoku, Taiwan.

Investigations were begun over three years ago, and a plan was submitted to the Imperial Japanese Diet in the latter part of 1917 by the Formosan Government General, with a view of making it a Government undertaking, to include the expenditures for this purpose in the budget for the 1918 fiscal year. At that time, however, because of the plan to send Japanese troops to Siberia, the bill had to be postponed to the next fiscal year. In the meanwhile the demand for electric current, for both lighting and power, steadily increased, and the Formosan Government was besieged with appeals for the speedy erection of the plant.

Several officials of the Central Government were of opinion that under the circumstances private capital should undertake the construction, and the Formosan Government, with the hope of thus bringing about a realization of the plan, made investigations along this line. However, there arose the question of rates, which according to the Government idea were to be as low as possible, whereas private interests would find it necessary to charge a high rate in order to obtain profits which they considered commensurate with the investment involved.



MAIN SWITCHBOARD OF CANAL SUBSTATION

Panel on right controls M. G. set for charging station storage battery; panel on left controls incoming high tension lines and A. C. feeder circuits

In order to keep the rates as low as the Government desires, either a subsidy or some sort of Government protection would be necessary, but the present state of the Formosan Government's finances would not permit the granting of a subsidy, and the plan of having the undertaking carried out by private capital could not be adopted. Such being the case, the Government General again submitted a bill in the Diet to make it a Government undertaking, and to include the expenditures in the budget for the 1919 fiscal year, but, after investigation, it was found that the Japanese Government's present loan policy would not allow the adoption of the plan, which aimed at the flotation of a five-year loan.

Finally it was decided to put up the plant as a joint undertaking of the Formosan Government and private capitalists. A limited company will be organized, the Government General to hand over to this company, as its share of the investment, all of the electrical industries (both immovable property and equipment) at present in it hands, the balance of the capital required to be subscribed privately.

As this is not a purely governmental undertaking, there will be no discussions in the Diet regarding expenditures, but certain matters will require the Diet's approval, and it is expected that particulars regarding the establishment and maintenance of the company will soon be made public in that body.

A pamphlet issued by the Formosan Government (a copy of which with the translation may be examined at the Bureau of Foreign and Domestic Commerce by referring to file No. 113547) gives full particulars concerning the plans which have been adopted for putting up a plant, capable of developing a maximum of 130,000 horsepower, and serving the whole island. Power is to be supplied for industrial purposes at from ½ to not more than 1 sen (¼ to ½ cent) per kilowatt. The work of construction will take five years and will cost 48,000,000 yen (about $24,000,000).

Capital for the undertaking will undoubtedly be largely subscribed by such Japanese firms as Mitsui Bussan Kaisha, Suzuki & Co., Kuhara & Co. and Okura & Co., all of which have branch offices in Taihoku and also in New York City. The engineers in charge will be Mr. Yamagata for construction, and Mr. Okoshi for electrical equipment, both of the Public Works Department of the Formosan Government General.

The American consulate at Taihoku has supplied the Public Works Department with the American catalogues, which it had on file, describing excavating, electrical and other machinery, and suggests that American manufacturers send new catalogues, with the latest f. o. b. and c. i. f. prices, addressed either direct to His Excellency the Director of the Department of Public Works, Taihoku, Taiwan, or to the consulate to be handed to the director. Catalogues should also be sent to both the Taihoku and New York offices of the firms already mentioned, as well as to the importing firm of Samuel Samuel & Co., Taihoku.

A Compact Lighting Plant for Tug Boats

A little electric lighting turbo-generator, that can literally be put out of the way on a shelf, is now being installed in a number of tug boats and other small harbor, river, and coast vessels. A set built by the Westinghouse Electric and Manufacturing Company, in use on a U. S. Government tug boat, is of 7½ kilowatt capacity, generates direct current at 250 volts, and has sufficient power to provide current for all the 14 or so lamps needed on board and for the searchlight as well.

It consists of an impulse-type steam turbine and an electric generator, combined to form a single, compact unit. It is easily installed, for all that is necessary is to bolt it to a light foundation, attach the steam and exhaust pipes, and connect the leads to the electric wiring system. The turbine consists of a single impulse wheel. It takes steam of from 70 to 225 lbs. directly from the boiler without a reducing valve, and can be operated either condensing or non-condensing, the exhaust steam is free from oil and can be used for heating purposes. The speed is 4000 r. p. m., and an automatic governor prevents over speeding. The generator is directly connected to the turbine and is a specially designed, high-speed machine. It is arranged so that inspection and repairs can be made with ease. The set has only two bearings, both of the ball type. All parts are readily accessible and very little attention is required during operation.

New York Electrical League

There were several interesting addresses given at the New York Electrical League luncheon April 30 at the Hotel McAlpin. Major David A. L'Esperance of the 369th Infantry (15th N. G., N. Y.) spoke of the wonderful bravery and accomplishment of the troops of this regiment. It was mustered into the United States Service August 17, 1917, as the 369th Regiment, commanded by Col. William Hayward, and holds the record for continuous front line trench service, 191 days. They went overseas after a period of hard training and many trials, arriving at St. Nazaire December 23, 1917. They were brigaded with the French Army and sent to the battle line. This regiment compiled an enviable record and received three decorations of the French Legion of Honor out of 61 conferred on United States troops. Major L'Esperance received one of these and also the Croix de Guerre, but of this he did not speak.

Dr. Charles T. Baylis, who has traveled from one end of the European battlefields to the other, spoke of some of his experiences in France and Belgium. He was the guest of Cardinal Mercier when that Prelate was being detained as a prisoner in his palace by General von Bissing. Previous to that time he had declined to be the guest of the Kaiser. He made an eloquent appeal for the further support of the Victory Liberty Loan by members of the Electrical League. A total of $25,000 in bonds were subscribed by members of the League and J. H. McGraw of the McGraw-Hill Publishing Company, put up a like amount, making a total of $50,000 that was secured at this luncheon.

Public Utilities Securities

THE outlook for the investor in public utility securities is most encouraging. While it is true that a number of street railways have gone into receivership, a far larger number are operating under increased rates of fare and with improving financial results. Electric and gas companies have stood up under the war test in a sturdy and reassuring manner, and comparatively few have failed to pay the agreed return upon their investment securities.

The war record of electric and gas companies, particularly the large organizations and the multitude of smaller companies having capable management, will prove to be a recommendation of great strength in the future, writes W. H. Hodge, of H. M. Byllesby & Co. While the reconstruction period will impose its own peculiar problems, these difficulties cannot possibly equal the conditions which these service companies faced and conquered during 1917 and 1918.

The durable character of the utilities has been emphasized again by the vicissitudes which they overcame during the war, and is already being reflected in the upward market trend of their securities. Generally speaking, sensational advances in the prices of their securities are not to be anticipated, but in all probability there will be a steady climb back to and exceeding the top levels existing before the war and in 1916.

A widespread and active construction period will hardly get under way in 1919, but next year should see unprecedented building, particularly of electric transmission lines, water powers and steam turbine power stations. Prices of money and materials are still too high to permit the construction of any except the most necessary extensions. No conservative utility operator will do any more financing at the existing high interest rates than he has to, nor will he buy machinery, wire, etc., of permanent construction until prices are much reduced, if it can be avoided.

A time of wonderful expansion in the electrical industry cannot be long postponed, however, if the United States is to continue its course of industrial prosperity. The war brought to the foreground the dependence of modern production upon mechanical power, and the superiority and economy of electrical power produced by large central stations. Every power company in a manufacturing district was seriously pressed to supply additional industrial demands during the war, and it is safe to say that nearly all of the new business gained will be permanently retained, and the demands for electric power will continue to grow with every factory expansion and the establishment of every new industry.

The use of electricity in households also is a growing demand, which in the aggregate is of enormous proportions. New business of this kind comes through the wiring of buildings where electricity has never been used before and the multiplied use of current in households already supplied. The war years were extraordinary ones for the sale of all kinds of electric household appliances, such as flat irons, toasters, cooking apparatus, washing machines, vacuum cleaners, etc., despite marked advance in the retail prices of these articles.

Even with every handicap of labor and material shortage, high prices, government restrictions, outdoor lighting curtailment, etc., central station companies gained domestic customers during the war. Housewiring proceeded in spite of a universal compliance by central stations with governmental policies and the absence of solicitation.

Industries inherently belonging to peaceful and industrious environment and grounded on the usages of peaceful times usually cannot hold their own during the dislocations of war, but the electric and gas industries have done better than this, and nothing stronger can be said to demonstrate their stability.

As evidence bearing upon the above statements, the situation as related to the electrical industry at Minneapolis during the close of 1918 may be cited. Minneapolis as the center of flour milling in the United States maintained a fair, but not abnormal degree of prosperity during the war. A considerable quantity of munitions were manufactured by the Minneapolis Steel and Machinery Company, but there was a large exodus of wage earners to eastern industrial centers.

Despite these conditions, the central station company supplying Minneapolis connected to its lines 3,540 already built houses newly wired for electric service in 1918 and ended the year with a total of 56,296 customers compared with 52,541 the year before, a gain of 7 per cent.

The industrial power business added by the company in 1918 amounted to 21,112 horse power, which was 30 per cent more business of this kind than the company gained in 1917.

The household electric appliance sales by the dealers jumped from 19,228 pieces to 23,857 pieces, a gain of 24 per cent. The total connected load served by the company grew from 140,689 kilowatts to 168,328 kilowatts, a 16 per cent advance, and the quantity of electrical energy demanded and used advanced 14 per cent.

The majority of utility companies during the war found it necessary to seek higher rates for service to meet unprecedented advance in the cost of fuel, labor, supplies and taxes. These rate increases for the most part were obtained from public authorities and are now in effect. No sensible operator will desire to see the higher rates remain longer than absolutely necessary. It is to the best interests of these industries and their security holders that the former rates be restored just as quickly as operating expenses permit.

There is always a tendency among utility investors to become nervous when the fanfares of the public ownership doctrinaires are blown with vigor, and the talk about the railroads and telephone and telegraph systems is a present-day example. Whatever may be the outcome of the railroad and wire line controversies —and it will hardly be government ownership and operation—there are several movements of profound significance taking place affecting electric and gas companies.

One of these is the rapidly widening distribution of utility investment securities among the people—not the citizens of wealth, but among the wage earners, the laboring men, the store-keepers, the farmers, professional men, executives and workers. Starting about 1908 with the expansion of all utilities, the grouping under centralized management of medium and small properties and the financing of these improvements by investment banking houses, there has been a constantly broadening ownership of such securities.

This has now been carried down to the man who works with tools and the widow coming into a little legacy, by the customer-ownership movement, whereby the utility companies build up a partnership interest among the people whom they serve. Beginning about 1918, this movement has made remarkable headway in various parts of the country. The government's war financing has helped the companies to get people of small means interested in their bonds and preferred stock. Investments in small lots of utility securities proceeded steadily in 1917 and 1918 along with the absorption of Liberty bonds. The high record months of Northern States Power Company in the sale of preferred stock direct to the public were during the heatless-Monday, terribly cold and gloomy months of the winter of 1917-1918. This company now has about 6,000 home shareholders.

Interesting the wage earner means giving him a chance to buy on partial payments, or a monthly savings basis. It means welcoming the one to five share order. There is no longer any question about enlisting the workers, for it is being done in many places and the results are gratifying in every way. The exclusive and remote atmosphere heretofore prevailing about utility corporations is melting away under the sunshine of the profit-sharing principle, and every new shareholder means an added opponent of municipal ownership.

The politicians are not slow to realize the changing order, and the utility company with a respectable list of citizen shareholders in the communities from which it derives its franchises is assured of fair consideration and decent treatment. Every added home shareholder means greater stability for the company and greater security for the non-resident investor. Customer ownership works hand in hand with sound investing everywhere, and the ten shares purchased from the Blank Electric Light and Power Company by John Jones and his neighbors at home make the $100,000 securities of Blank Electric Light and Power Company held by the non-resident investor more safe, desirable and valuable.

A second factor working against the public ownership of utilities is the fear of Bolshevism now prevailing in the United States and the growing organized opposition to this destructive poison. The fear of Bolshevism is causing citizens to regard with distrust all socialistic as well as anarchistic proposals, and the idea of taking over private property and business of any kind is becoming more and more distasteful to Americans. Every business man realizes that public ownership of utilities will inevitably lead to public ownership of other industries, and his own may be the next on the list. Where he formerly tolerated ideas of publicly owned utilities he is now exceedingly suspicious of such an innovation. The clamor of the public ownership proponents may grow louder, whereas the opposition will steadily increase among thinking Americans, and without their support no public movement can succeed.

It requires public credit, and lots of it, to take over and own the utilities. With the staggering volume of war bonds hanging over the country, with the majority of our cities bearing high loads of bonded debt, and with public improvements, such as roads, pavements, schools, etc., waiting for construction everywhere, the appetite of the public for assuming debts to operate the utilities is bound to be a dull one. Few cities governed by honest men in their right minds would care to purchase the utilities at present high values of metals, machinery, etc., or at the present high cost of money. From a business standpoint, this is the most unpropitious time for public ownership in history.

Altogether the investor in utility securities has no cause for alarm, and may expect to see his holdings increase in value as general conditions gradually approach the normal. In fact, electric and gas utilities are bound to be among the very first industries to benefit from the signing of the final papers at Versailles.

Electric Hot Table

There have been numerous applications of the electrically heated hot table, but one of the most important and most successful in every respect is its application to the working of celluloid in a comb factory, writes Mr. John M. Strait, of the Industrial Heating Section of the Westinghouse Electric and Manufacturing Company. The manufacture of combs requires that the celluloid strips be heated to a plastic or workable state and placed in a forming press. This press gives the desired thickness and moulds the rough outlines of the comb. The blank strips are heated again on the hot tables, this time to such a state necessary for the chiseling machine operation, which cuts the teeth into the blanks. They are dove-tailed together and very easily stripped apart. By this method there is practically no wastage of celluloid stock.

For such an application certain temperatures are required, and as can readily be seen, varying degrees of heat are necessary for the various steps in the process. The standard electrically heated hot table has just such characteristics as are required in the comb industry. The tables are normally rated at 1,800 watts or 110 volts, and equipped with a 3-heat snap switch control. They have six 300-watt steel clad heaters installed under the steel top plate and the heaters are so connected as to give 1,800 watts on high, 900 watts on medium and 450 watts on low, and this particular range is found to be very suitable for the comb heating application.

At the Ideal Comb Company plant in Lowell, Mass., with an initial installation of five electrically heated hot tables they increased their production about 20 per cent. The operator claimed he was "turning out from the dye press seven days' work in six days or about 2 gross increase per day." This was in comparison to the old steam-heated tables. This was due to the uniformity of the electric heat which permitted a more economical working of the tables.

The Comb Company estimated that operating the tables constantly or medium with a short period in the morning and another at noon on high, it cost about 17 cents a day per table. This power rate in this territory is 10 cents for the first 20 kw. hour and 2 cents thereafter. Using this rate they estimated it cost about 9 cents per day per table on the low heat. By changing from steam to electric heat it has been estimated that there will result a net saving of $100 per month on wages of firemen, and on coal.

Due to the uniform heating of the electrically heated hot tables, the comb company found it possible to use 0.125-inch celluloid stock on the electric hot table, while 0.140-inch stock was the smallest that was possible with the steam table. This item is of considerable importance in a factory of any great production. With the saving in fuel and labor, the saving in celluloid material, the increased quality and quantity in production and the low operating cost, the success of the electrically heated hot table to the comb industry has been assured.

Field Agent Reports Improvements in General Building Situation

Having traveled in the last six weeks all States in the Union except those of the southeast, Henry N. Teague, field agent for the U. S. Department of Labor, reports to the Information and Education Service that industrial and labor conditions show a marked improvement during the last 60 days. This results, in Mr. Teague's opinion, from the fact that State and municipal authorities have come to appreciate the necessity for buffer employment for labor and the possibilities of stimulating business through extensive public improvements.

Mr. Teague has traveled, during the last six weeks, from Boston to San Francisco, and from Seattle to New Orleans, calling on all the Governors and on the Mayors of the principal cities and carrying a personal message to them from Secretary of Labor Wilson. When asked to state his outstanding impression from his trips, Mr. Teague said:

"There is to be a great deal of public building during the next six months. I am convinced the public improvements program for 1919 will equal that of any five years in the country's history and the road building activities from the Atlantic to the Pacific, once under way, are to be tremendous.

"I have been much surprised to find the scope of improvement work in the west larger than in the east. Perhaps this may be accounted for in the fact that the west needs more improvements than the east. It is newer country. The Governors and Mayors of the west, almost without exception, realize the prudence of going in for public improvements as a source of buffer employment for labor and a means of stimulating general business. The west, too, is much interested in reclamation and is anxious to make land, heretofore arid and waste, available and suitable for farming by such former soldiers as wish to go back to the soil."

"Most of the Governors of the agricultural States," Mr. Teague said, "are anxious to get men from the Army to settle in their States. This is because they believe the Army represents the best manhood and brains of the country and if their respective States can absorb soldiers, the Governors believe the States will get the highest type of citizens and the best blood of the Nation."

Mr. Teague says there is much criticism in the west of the Federal Government's failure to go ahead with its own building operations. In many localities Federal buildings, for which sites, plans and appropriations were had before the war, are now held up because the original appropriations will not cover present construction costs on the buildings desired. Mr. Teague says, in such localities there is resentment over the fact that the Government has not been granted additional money to carry on these building activities and the fact that this has not been done is exerting a harmful influence on many private interests which feel that if it is prudent for the Government to refrain from building at this time, it also is prudent for the private interests to follow the same course.

"There are more building activities in New Orleans than in any other city I visited," Mr. Teague said. "New Orleans is spending $14,000,000 on the municipal docks. More than 10,000 men are employed in this undertaking.

"I anticipate no labor crisis throughout the country for the communities are awake to the situation. There is just as much unemployment to-day as thirty days ago, and yet the situation is much improved because local initiative is being brought to bear on local problems and as soon as the cities and States get under way with their improvement programs, for the time being at least, our employment problem will be far less pressing."

Electromobiles in Scandanavia

In all countries which produce much cheap electricity by means of water power, all other kinds of motor vehicles are becoming hard pressed by electromobiles, writes Commercial Attaché Erwin W. Thompson, from Copenhagen. The wear and tear on the engines of the latter is smaller and they are easier to run and therefore more practical in crowded thoroughfares. The *Berlingske Tidende* reports that the Danish postal service has ordered 30 electromobiles to substitute for the old horse wagons, and the Norwegian Government has ordered 50 electrotrucks for transportation of foodstuffs, etc. Electromobiles are also being used very much lately for private purposes.

Before the war, when gasoline was plentiful and reasonably cheap, electric automobiles were a rarity in the Scandinavian countries. During the war the subject was under constant discussion in Norway and Sweden, where there is cheap electricity from water-power. But the same blockade which made gasoline scarce prevented the importation of electric automobiles from the United States and elsewhere. Also the scarcity of coal tended to increase the demand for hydroelectricity, until even that source of power was becoming absorbed. Meantime no new hydraulic or electric machinery could be imported for developing the enormous natural resources, and so there has been a uniform reduction in all kinds of automotive service.

As soon as shipping becomes again free there will be an almost unlimited demand from Norway and Sweden for hydraulic and electric machinery. The lack of coal in all Scandinavia will tend to promote the electrification of all railroads, and the general replacement of steam engines and oil motors by electric motors throughout industrial establishments.

Cables will probably be laid from Norway and Sweden to transmit electric power to Denmark. (There is already a small transmission in existence from Sweden.) It is not impossible that some new form of storage battery may be invented which will be light enough to permit the shipment of stored electricity—canned power, so to speak—from Norway and Sweden to Denmark.

Training in Industrial Plants

WHY American industries should profit by a lesson the war taught of the value of industrial training, and maintain such training in peace time, is the subject of a bulletin entitled "Training Labor for Peace Time," which has been prepared for free distribution by the U. S. Training Service, C. T. Clayton, Director, of the U. S. Department of Labor, Washington, D. C. This vest-pocket booklet sets forth a number of interesting and significant facts with respect to the present and potential efficiency of labor and the future of industry. By "industrial training" is meant brief practical instruction for industrial workers in the one best way of doing their respective tasks, such training being given in the plant.

The benefits to employer and employee which such training brings are truly astonishing. Many far-sighted firms already have installed training departments but the majority have not given the subject sufficient attention. The war made training imperative in many instances. The lesson taught in that great emergency should be applied to peace times. We can not continue in the haphazard fashion that obtained before the war.

To-day the great majority of workers in America are at tasks, some simple and some complex, for which they have never been systematically trained. It is estimated that 7,000,000 out of the 10,000,000 industrial workers in this country are so handicapped. A training department such as the Training Service experts assist manufacturers in establishing is not only designed to start new employees right—important as that is—but it is intended as a permanent feature in the plant for the benefit of all, particularly the poor and mediocre workers. In the long run the systematic upgrading of these workers is the big function of the training department. A worker having recourse to such training in time can greatly broaden his skill and increase his earning power. Two-thirds of American children quit school on or before reaching the sixth grade and these are entitled to far more facilities for self-development than society now offers them. Training departments are urged as a most practical remedy for this condition.

The factors preventing industrial plants from realizing a maximum output by their workers are classified as follows:

1.—Power failure. 2.—Failures of equipment and repairs and like limitations. 3.—Lack of instruction. 4.—Lack of training. 5.—Failure to supply material. 6.—Personal slacking. To the last named item is attributed but 10 per cent of separations. The others, it is pointed out, are within the power of the employer to remedy. The fourth item, lack of training, is one to which much importance is attached. There are over 200 training departments in the United States, it is stated, and they have reduced by one-half the turnover of that part of the working force which they have served. Ninety-three per cent of the departments are reported to be operated without net cost to the employer because the increased production of the learner carries their wages, the cost of instruction, etc.

In the concluding discussion of the pamphlet there is this pointed paragraph. "There is still another consideration that should prompt manufacturers to install systematic training as one of the instrumentalities of their factories. If wage levels are to be maintained while the cost of living is lowered, and if foreign markets are to be opened to American manufacturers, it can only be by raising the national average output. That, in turn, can be accomplished only by increasing the production of the individual through intelligent, widespread industrial training of the workers."

Electric Motors for Ice Plant

There is a general belief that the ice supply of the city of Duluth is secured by weighting down large cakes of ice, and sinking them in Lake Superior where they are preserved indefinitely until wanted. That this story is a press-agent's yarn is conclusively proved by the success of the Duluth Ice Companw, whose plant employs Arctic Ice Machinery driven by Westinghouse Induction Motors. Raw water with compressed air agitation is used.

The plant equipment includes two 40-ton Arctic Compressors, each driven by a 125 h.p., 4000-volt Westinghouse induction motor of the slip-ring wound motor type; two 2½ inch brine pumps, each driven by a 3 h.p. Westinghouse motor; two 7½ h.p. vertical motors driving brine agitators; a 3 h.p. motor driving an air compressor and a 7½ h.p. motor driving a blower.

The storage rooms have a capacity of 3700 tons and they are filled early in the season in the customary manner. Should one unit be out of service, the other could be forced to deliver 60 tons per day. When both machines are running, and the plant output is 60 tons per day, the kilowatt hours per ton range from 43 to 50 per ton. During one summer month when the average output was 60 tons per day, the average consumption was 45 kw. hour per ton. Power is purchased from the local central station at 4000 volts for the two induction motors and at 220 volts 3-wire for other motors and lighting.

Electric Heating Furnace

An electric tool-tempering furnace, which uses the barium chloride and salt principle, is proving highly successful in the South Philadelphia Works of the Westinghouse Electric & Mfg. Co. The chief advantages of this type of furnace over those using gas, coke, oil or wood are constancy and ease of control of heat, cleanliness, equal heating of each atom of the specific part of the tool to be tempered, low cost of operation, and excellence of the finished work.

The furnace is of simple construction. The outer shell, a cast-iron cylinder, is about 3 feet high and 3½ feet in diameter, which is packed with firebrick and occasionally a layer of asbestos. The circular reservoir in the center, which forms the operating part of the furnace, is 12 inches in diameter and 14 inches deep.

The heat is supplied by two pairs of electrodes, built in on opposite sides of the walls of the reservoir. The electrodes operate on a 16 to 30-volt alternating current circuit which is controlled by the switchboard and transformer. Carbon sticks are placed between the electrodes in the reservoir to complete the circuit. The current is started on the 30-volt circuit. Salt is fed into the reservoir and when it is melted it acts as a conductor and completes the circuit. The carbon sticks are taken out. A mixture of barium chloride and salt is then fed into the reservoir, the final proportion being about 60 per cent. barium chloride.

When the temperature of the liquid reaches 1,425 degrees Fahrenheit, the voltage is lowered. The current regulation at the switchboard gives a quick and easy method of control so that the temperature of the liquid can be held at any predetermined degree of heat required for each specific tool. The liquid, kept at one temperature, heats the tool uniformly from surface to center and eliminates soft spots in the finished tool, which is seldom possible when a tool is exposed to a direct or indirect flame. The furnace throws off very little heat so that it meets with the approval of the workmen.

Meeting Electric Furnace Association

On the afternoon of Thursday, April 3, a meeting of the newly formed Electric Furnace Association was held at the Chemists' Club, 50 East Forty-first street, New York City, at the call of the president, Mr. Acheson Smith, and a large number were present. Reports of the various standing committees were made, and a tentative draft of the constitution and by-laws submitted. Resolutions were passed adopting the constitution as drawn for a temporary period until the new Membership Committee, which is to be created at once, can secure a representative list of members from the various industries interested in the work of the Association. After such membership is formed, the draft of the constitution will again be considered and accepted in final form.

An aggressive campaign for membership will be undertaken at once, and all manufacturers of electric furnaces, electric furnace supplies, power companies, manufacturers of electric steel, electric brass and other electric furnace products, designers, inventors of furnaces, etc., will be invited to become members. An early meeting of the Board of Directors of the association will be held to go into further details.

Electric Machines for Italy

THE ten years preceding the war were marked in Italy by the installation of new and important hydroelectric plants and the enlargement of many already in existence, says Lieut. Alberto Attal, one of the leading engineers of Italy. The total power developed by these plants, continues Lieut. Attal, has not only been entirely utilized but during the war has proved entirely insufficient to satisfy the ever-increasing demands. There are at present in the course of construction several very important stations, and plants for others have been made. As coal is entirely lacking in Italy, it is the purpose to utilize as far as possible the hydroelectric energy of the country.

It is estimated that there are still available, including the provinces newly taken from Austria-Hungary, upwards of 3,000,000 horsepower. It will be necessary for the State to construct some of the more elaborate plants, as it is the only body which can command the credit sufficient to carry out the work successfully. In any event it is estimated that in the very near future the companies already in existence and those in the course of formation will utilize 1,000,000 horsepower of the 3,000,000 horsepower remaining.

For a part of this development machinery will be necessary. Before the war a large part of this equipment was manufactured in Italy, but the rest came almost exclusively from Germany, principally from the A. E. G. and Siemens-Schukert Companies, whose products were not only held in high esteem but were marketed under advantageous conditions at reasonable prices. A small part was purchased through the Italian agents of American companies. It was the impression in Italy that one of the latter was in close union with the A. E. G. Company, as that company sold through its Italian agent goods of American manufacture. The other American company sold the goods of its English branch, but has recently established its own manufacturing plant at Vado, Italy, where it is proposed to make motors, railway traction equipment and electrical transformers. The branch of the German company was recently taken over by Franco Tosi, of Legnano, whose machinery is known throughout the world, and there is reason to believe that the German interest has been reduced to a small minority of shares,

There are in Italy several large manufacturers of electrical machinery, equipment and supplies and a fair number of smaller manufacturers, some of whom maintained a fair export business before the war. On the whole, however, Italian production is not enough to supply the increasing demand, and many types of machinery are either not manufactured at all or their manufacture has just begun.

Italy makes practically all of the direct-current machines needed, as well as dynamo turbines up to 1,500 kilowatts and 1,650 volts tension. Alternating machinery has been manufactured up to 15,000 kilowatts and a few direct-tension machines to 15,000 volts. Transformers have been made up to 12,000 kilowatts with a tension of 90,000 volts. Production and imports compare as follows (tons of 2,000 pounds):

Years	Production Tons	Imports Tons
1913	9,900	5,390
1914	9,200	7,600
1915	6,200	2,400
1916	7,500	2,400
1917	9,900	3,100

What are not manufactured in Italy are monophase motors or three-phase motors with collectors, induction motors with auto-exciters, and phase converters contained in a single machine. The Italian production of accumulators is sufficient to supply the local market. One-half the demand for measuring instruments was supplied by the home factories and the other half, before the war, came principally from Germany. At present the demand for the commoner types is supplied by Italian manufacturers, whereas the specialized type, such as vibrating frequency motors, synchronoscopes, phasometers and indicators, come from abroad. About a fourth of the 100,000 motors consumed annually in Italy before the war were manufactured within the country. Instruments of precision imported came almost entirely from Germany and Switzerland, except for a very few from the United States. Switchboards for large, medium and small installations for the production and distribution of electrical energy, as well as for its utilization for lighting, heating and power pur,-poses, are made in sufficient quantities within the country. Special equipment, however, was always imported from Germany before the war.

It is impossible to give an idea of the extent and use of machinery and equipment for ships; mining, chemical and explosive plants; or of appliances for automatic controls, block systems, and safety; but during the war successful types of ship installations have been made in Italy, and it is thought that all of these will be manufactured within the country before long. Italian factories have for some years been in position not only to supply Italian demands for insulated and uninsulated cables and insulated conductors, but also to manufacture for the export trade. The imports of copper cables made before the war were principally the result of the custom of foreign companies, especially Germans, requiring their branches or agencies doing business here to purchase supplies from them. Electric light bulbs came principally from Germany and Austria-Hungary before the war, but since that time Holland has supplied the market.

Central power station equipment, from powerful alternators to commutators, as well as direct-current dynamos and tensions, is practically all manufactured in Italy. Italian shops have also turned out tramway stock and the powerful triphase electric locomotives which haul the heavy trains on the Giovi, Monoenisio and Valtellina lines. Five strong Italian concerns are at present producing, in a very satisfactory fashion, all electrical equipment needed. Until very recently many cars, completely assembled, came from Belgium, because of the fact that control of certain tramways in Italy was in Belgium. An extensive development of interurban traffic might have been possible but for the progress made by autobus companies.

Electrical equipment for ship propulsion has not been developed, and if present plans for increasing the merchant marine are carried out there will be an excellent market for such machinery.

The manufacture of electric household appiiances has developed greatly within the past few years. Many new plants have been established for their manufacture, and existing plants have been enlarged. Further increase in this market depends upon the price charged for electric current. Government taxes on current for any other than purely industrial purposes form a heavy proportion of the cost.

Electric pumps, ventilators, searchlights, magnetos and sparking devices to be used in connection with internal-combustion engines, and of electric installations on automobiles and motor trucks, are manufactured in Italy in sufficient quantities and varieties to satisfy all present requirements.

The future of imports into Italy for electrical machinery, supplies and equipment really depends upon whether this demand comes suddenly or develops gradually after the war. If it should be sudden, imports would be necessary in many articles, but if it should be gradual it would find Italian manufacturers in position to meet all requirements except for a few special articles. The trade with the United States, as far as imports are concerned, depends, in the main, upon credit terms, speedy shipments and quality consistent with Italian standards.

American Gear Manufacturers Association

The standardization of gear making is one of the most important programs that automotive industries have outlined for the reconstruction period. It is a real undertaking and requires the serious co-operation of every gear manufacturer in the country. President F. W. Sinram of the American Gear Manufacturers' Association in urging to action the Standardization Committee, who are representative gear manufacturers, has begun a definite reconstructive movement. There was a well attended meeting of this committee at the Hotel Statler, Buffalo, N. Y., February 10th and 11th. Every committee had representatives in attendance, and a well defined program was laid out for their future activities. All phases of the subject were discussed and it was apparent that much thought had been given to them. According to action taken at previous sessions all committees were urged to seek the co-operation of other organizations interested in the standardization of gears. It is probable that quite an advance towards the standardization of some of the phases will be made by the time of the annual meeting to be held in April.

Prices Will Be Higher Rather Than Lower

It is rather a peculiar fact that at the time The Society for Electrical Development inaugurated its Wire-Your-Home campaign in 1917 practically the same conditions of high prices for material and labor and certain skepticism on the part of the owners of old houses as to the ability of the contractor to wire without muss or fuss, existed just as it does today.

In commenting upon the 1917 Wire-Your-Home campaign, J. M. Wakeman, General Manager of the Society, said: "In my opinion, based upon the general knowledge of conditions in the industry and the best information available, I do not think that prices of electrical products will decrease materially for months, possibly for years to come. History shows that when prices go up and remain up for any considerable period, they very seldom go down, especially with conditions such as exist today (April, 1917). This is true in the food and textile industries and will prove equally true in the Electrical Industry.

"Prices will be higher. The day of high prices is here. The central stations and contractors are beginning to realize this and to go after business as though they were at low basic prices. Undoubtedly next year and possibly for two or three more years to come, prices will be so much higher that people will be glad they went after the business in the spring of 1917, when there was more prospect of adding customers to the lines than there will be then, and we will look back reminiscently to the ante-bellum prices of electrical products."

Approximately 50,000 homes were wired during the above mentioned campaign. This in the face of what were then considered high prices for labor and materials. Figured on a basis of increase in labor and materials there is very little difference today between conditions now and in April, 1917, two years ago. Labor wage has increased tremendously and, according to the estimates of Government statisticians, average owners of unwired houses are fully as able to meet the small obligation of wiring as they were in 1917.

"There will always be some who hold back on any national electrical campaign," says General Manager Wakeman, "but it has been our experience that the great majority of central stations and contractors are alive to the opportunity afforded by Electrify-Your-Home campaign and the fact that we have had enthusiastic responses from over 460 cities in this country, for the Electrify-Your-Home material indicates the keen desire to go ahead with this co-operative movement. Owing to the desirability of securing last minute analysis of countrywide conditions, there was a slight delay in getting out the printed matter but this has been completed and mailed to over 11,000 individual contractors and central stations and also to all of the leading newspapers and periodicals in the country and campaigns are actively under way in many large and small cities, notably, Chicago, Boston, Brooklyn, Cleveland, Toledo, Chattanooga, Scranton, Schenectady, Albany, South Bend, Jackson and many others. The Pacific Coast cities, the most highly saturated from an electric standpoint, are not allowing this great oportunity to go by; special requests from San Francisco, Los Angeles and Oakland, Cal., Seattle and Spokane, Wash., Portland, Oregon. Every State in the Union, including Hawaii, has taken up this campaign."

Material Handling Machinery

Port and harbor development throughout the United States and the expected shortage of labor as business is resumed, is responsible for the many requests for information and suggestions which Chambers of Commerce, Harbor Commissions, and manufacturers and trade associations have made to the Material Handling Machinery Manufacturers' Association.

The first meeting of the Engineering Committee, appointed by President Calvin Tomkins (former Dock Commissioner of New York City), was held at the Association quarters, 35 West 39th Street, New York City, on April 9th. All members so far appointed were present, although the entire personnel of the committee will not be completed until the campaign for charter members is closed.

The members of the committee as at present constituted are: W. B. Clarke (Manning, Maxwell & Moore, Inc.), S. H. Libby (Sprague Electric Works), R. W. Scott (Otis Elevator Co.), D. V. Jenkins (Watson Elevator Co.), L. C. Brown (Elwell-Parker Electric Co.), A. F. Case (Wellman-Seaver-Morgan Co.), J. C. Walter (Alvey-Ferguson Co.), (ex-officio) J. A. Shepard (Shepard Electric Crane & Hoist Co.).

The work of the committee as outlined at this meeting will incorporate studies of large industrial plants and a special study based on the selection of one of the new port terminal projects for consideration of a complete installation of equipment for general cargo handling.

As the committee is made up of representatives of the different divisions of material handling equipment, such as cranes, hoists, winches, conveyors, telphers, elevators and elevating machinery, industrial trucks, tractors and trailers, mechanical bunkering equipments, chutes, etc., used in cargo and general and bulk material handling, these studies will include several lines of manufacturing plants and the special study will be made of a location and pier and warehouse development which would normally utilize all of this different equipment in the construction of one complete handling organization.

Arrangements have been made by the committee to meet with the engineers of the New York-New Jersey Port Commission to discuss the various phases of cargo handling and the application of machinery to the problem when plans are made for the complete development of the Port of New York and New Jersey; also with committee appointed by the Sanitary Potters' Association to discuss possible savings in their industry through the use of modern handling equipment.

Pre-War and Present Prices

The Department of Labor holds that wage scales have less to do with construction and manufacturing costs than efficiency of labor. Investigations in this field suggest a gradual improvement in efficiency of labor as the readjustment progresses and industry gets away from the high-speed, forced-production regime incident to war. Mr. Morton Chase Tuttle, who served as production manager for the U. S. Emergency Fleet Corporation, in a recent interview for the Christian Science Monitor called attention to this improvement in efficiency. The Monitor says:

"That a reduced wage scale is not an indispensable preliminary to resumption of activities in the building trades is the opinion of Mr. Morton Chase Tuttle, who has just returned to Boston after more than a year of service as production manager for the U. S. Emergency Fleet Corporation. Mr. Tuttle bases his judgment on recent investigations of large construction enterprises from New England to Florida, supplemented by studies carried out under his direction by a construction company in Boston, of which he is general manager. This indicated that increased efficiency of labor is bringing down costs even while wages remain at existing altitudes.

" 'In the course of viewing numerous undertakings more or less closely associated with the interests of the Government,' says Mr. Tuttle, 'I have been lately impressed to find the statement commonly made that cost of operation was beginning to show noticeable decline. And this, almost without exception, was attributed to increased efficiency of the labor force, due in part to the opportunity for weeding out the less dependable workers, in part to the growing desire of all members of the force to retain their jobs.

" 'Owing to inadequate or otherwise unsatisfactory cost studies maintained in connection with most of these undertakings, I found it impossible fully to check the statement by actual figures. Accordingly, I asked my own company to make out the cost of any one process in an operation continued over a period of several weeks. That which was selected was a piece of concrete work. The costs studied were those of the common labor employed in this work from January 7 to February 4 of the present year, inclusive. During the period the wage scale remained unaltered, but the personnel of the labor force underwent frequent change. A graph of the labor cost of the work during the period noted shows a sharp and almost undeviating decline from day to day. On February 4 these costs were exactly 50 per cent less per unit than were those on January 7. It is my belief that the experience of my company is by no means isolated, and that in almost any labor force there lies the opportunity of realizing economies ranging from 25 to 50 per cent without interfering with the wage scale.

"'This implies, of course, that there is now increased opportunity for selecting men according to their suitability for a given task and in increased eagerness on the part of the men to make good. The whole country ought soon to feel the effect of it in general improvement. It is a case of supplanting so-called liquidation of labor by proper adaptation of labor as a means of keeping the cost of doing things within the bounds of utility.

"'State of mind is often as potent a factor in ultimate labor cost as is the rate per hour. Anyone experienced in handling workmen has recognized the difference in output between cheerful, capable men, anxious to hold their places and one who is a little disgruntled, and quite conscious that he can get another job the moment he drops the present one. Multiply either case by thousands of individual instances, and I believe that there will be found, in shifts of mental attitude, the explanation of much of the variation which occurs in unit cost. And this, after all, is the element of labor which directly affects the profits of the employer.'"

Electric Railway Construction in Spain

At a general meeting of the stockholders of the Corunna Street Railway Company, Compañia de Tranvias de La Corunna, held on January 15, 1919, it was unanimously decided to increase the capital of the company to 2,000,000 pesetas ($386,000) in common stock and 1,500,000 pesetas ($289,500) in bonds in order that the construction of the tram line Corunna-Sada could be carried out. The present capital of the company is 1,000,000 pesetas ($193,000) in common stock and 145,000 pesetas ($27,985) in bonds, which will be canceled by the new issue. Subscription is now opened to the public for $231,000 of the new common stock, writes Vice-Consul W. Bruce Wallace, Corunna, Spain.

The length of the proposed Corunna-Sada line is 11.4 miles, but it is the intention of the company to extend it later to Betanzos, making a total distance of 18.64 miles. It will pass through a thickly populated part of the country, which at present is in practically no communication with Corunna. The stationary population will be greatly increased during the summer months, when families from Madrid as well as from Corunna go to the country for the summer months. Presumably many will remain there once the tramway is an accomplished fact.

The company proposes to run cars every 24 minutes to El Carballo, which is halfway, and every 62 minutes to Sada. The line will be divided into various zones, and the fares will be in accordance with; for instance, $0.09 to El Carballo and $0.145 to Sada.

The purchase of the material for the construction of this new line will be made in foreign countries, and the opportunity for American concerns to supply the material and to oversee the construction is favorable.

The construction of this interurban line will probably mark the beginning of an important era of tramway construction in the district. The Province of Corunna, with an area of 3,051 square miles and a population of about 1,125,000, has only 90 miles of railway. Santiago, the second largest city, with a population of about 40,000, has no direct railway connection with Corunna, although the construction of a tramway or railway between the two cities has been advocated for many years. A line is necessary both for the accommodation of the large passenger traffic and for the furtherance of commercial intercourse between the two cities.

The present estimated cost of freight per ton between Corunna and Santiago is $9.65 for the forty-mile distance, whereas a ton could be sent 264 miles per rail for the same amount. The fares by motor bus range from $2 to $2.70, or more than double what the railway fares would be.

From the latest newspaper reports it would appear that the project is nearing realization. One of the largest capitalists of Galicia, associated with an engineer who is an enthusiastic promoter of the Corunna-Santiago line, is reported to have purchased recently an important waterfall near Santiago for the erection of the power station to supply the necessary current.

Material will probably be purchased in foreign countries, and American concerns have here also a good opportunity of securing the contracts.

Iron and Steel Prices

The U. S. Department of Labor, through the Information and Education Service, is issuing the results of a study of prices during the war and readjustment period made by the Division of Public Works and Construction Development. Discussing iron and steel prices, the report says: "In the case of iron and steel products, war orders for the Entente Allies began to figure largely during the second half of the year 1915. Demands for steel production were greatly increased and prices advanced at that time. Steel prices continued to advance through the year 1916, and in 1917 it developed that a very large proportion of the steel output of the country would be needed for war uses. Prices of steel, iron and coke soared to unprecedented levels until the Government found it necessary to fix the prices on these commodities. The Government's fixed prices ruled the markets from the last quarter of 1917 until the end of 1918.

"Most steel prices, before the Government assumed control, were over three times the pre-war figures; some were nearly six times the pre-war figures. The Price-Fixing Committee brought these prices down very considerably. However, the Government's fixed prices were still very high in comparison with pre-war figures. If the average for the period July 1, 1913, to June 30, 1914, be taken as the pre-war base (100%), an average of prices on finished steel products in force at the time of the armistice shows an index of 228. Since the maximum possible production of steel was desired, these commodities being considered as essential for war purposes, it was necessary to fix the prices at such a figure that the producer whose costs were greatest might enter the market and make a fair profit.

"The steel industry announced reductions on various items early this year. These reductions brought the index figure on steel products down to 217. The declines, however, were not considered by the buying public as being sufficient to interest them. No orders resulted from these declines, and the steel interests found that further reductions would be necessary in order to stimulate business.

"Finally, on March 20, after conference with the Industrial Board of the Department of Commerce, the committee representing the steel companies announced a new schedule of prices. The new schedule presented an all-around reduction of 14¾% from November prices.

At the present time, the index figure for finished steel products is 195, that is to say, these products are now on the average 95% above the figure for the period July 1, 1913, to June 30, 1914. Since this average was obtained by a system of weighting similar to that used by the Bureau of Labor Statistics, it is comparable with the figures of that Bureau. The Bureau index number for wholesale prices of all commodities for the month of February was 197. It is thus seen that the action of the conference on steel prices had the effect of bringing these products down to the general level of all commodities.

"At the time the new schedule on steel was announced the steel companies stated that these prices would prevail for the rest of this year. It was also stated that the prices were the lowest possible compatible with the present wage scale. At the present moment owing to the desire of the Railroad Administration to secure lower prices if possible, there seems to be some doubt as to whether present steel prices will stand. It is hoped that this matter will be settled in the near future."

The New Pompton Lake Hydro-Electric Plant

A new hydro-electric plant at Pompton Lake, which is now under construction, provides an interesting example of the utilization of small water powers. When it was found that the present gas-engine-driven plant was inadequate for the needs of the community, serious consideration was given to the installation of a steam-turbo-generator, but in view of the high cost of coal and the desirability of conserving fuel, it was finally decided to put the local water fall to work. This fall is 22 feet high, and has a considerable volume of water so that it can take care of the power demands of the neighborhood for some time to come.

The plant will be built along the same general lines as the hydro-electric plant of the Society for Establishing Useful Manufacturers, at Paterson, N. J., which is close to Pompton Lake and has proven thoroughly satisfactory in operation. It will contain two Westinghouse vertical generating units, one of 250 KVA, and the other 100 KVA, and current will be generated at 2,300 volts to permit transmission over a considerable distance.

Power will be supplied for lighting the Borough, which has 3,000 population, and also be available for industries, which, it is hoped, will be attracted to the locality.

Utility Management a Public Trust

B. W. Cowperthwait, manager of the Faribault (Minn.) division of the Northern States Power Company, in his opening address as president of the Minnesota Electrical Association in convention at Saint Paul recently, said:

"To-day we are facing a new era in the history of our country. That it is to be an era of great prosperity we cannot doubt. The question for us is how we can administer the affairs of the utilities which are intrusted to us to the best interests of the communities served. I make this statement advisedly because it is now well recognized that we hold a position of public trust which we are entitled to administer only as long as we do so wisely and with due consideration of the rights of the public."

Municipally Operated Railways a Failure

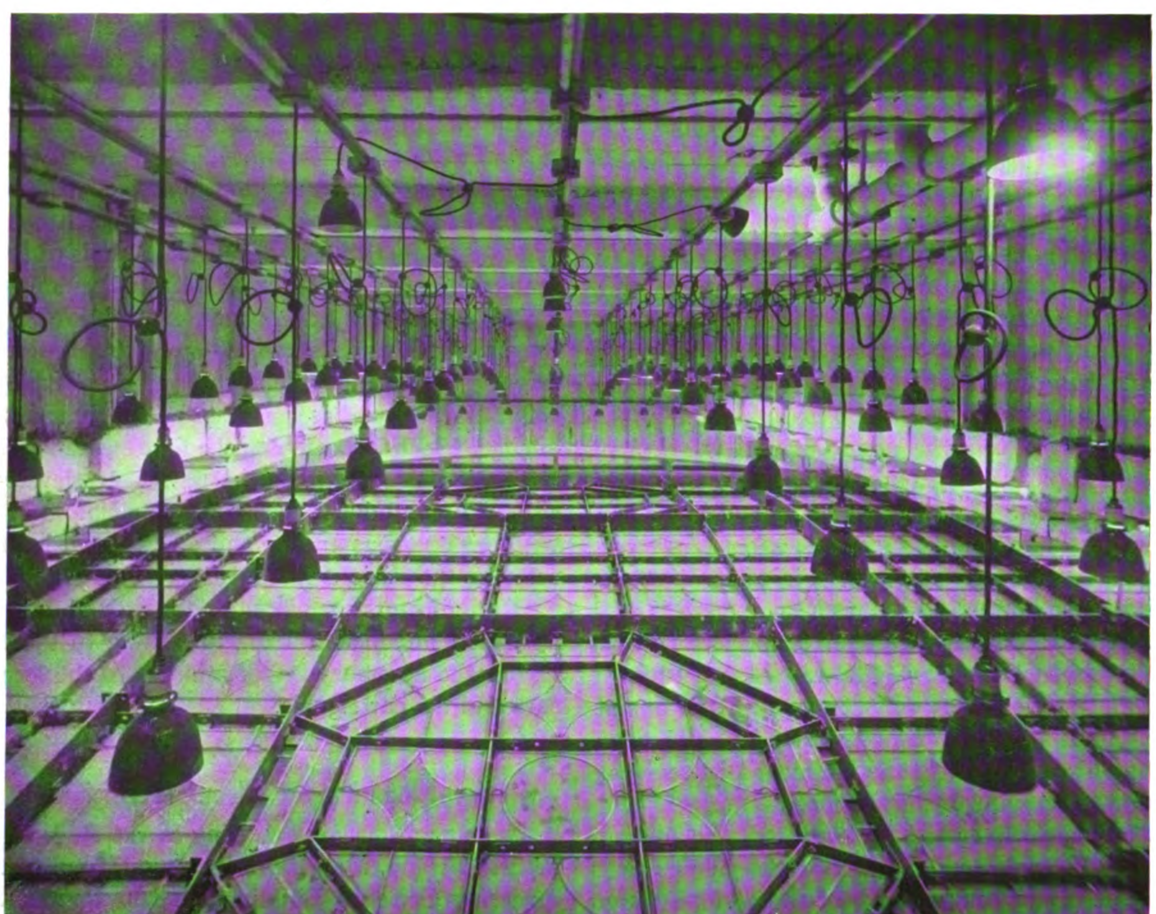
The following is quoted from the Minneapolis "News" of April 16: "In the opinion of Dean John R. Allen, of the college of engineering of the University of Minnesota, municipally operated street railways are a gigantic failure.

"In theory, he told members of the Minnesota Section of Electrical Engineers, public ownership is excellent; *in practice it is a fizzle wherever he has seen it tried*. The address was given in an open discussion on street railway matters at the engineering college.

Electricity in Hotel Service

NO LINE of industry has made a wider or more general use of electrical devices and appliances than the modern hotel. From the moment a guest enters a hotel until he leaves, electricity is in his service in a hundred ways of which he is unaware. During the past few weeks there have been opened to the public in New York two of the largest and most completely equipped hotels in all the world. In each of these electricity has been employed in many novel manners. Charles E. Knox, electrical engineer, has written an account of the electrical equipment of the Hotel Pennsylvania for "Architecture and Building." The current supply for the hotel is obtained from the Pennsylvania Railroad. The steam is obtained from the power plant of the Pennsylvania Railroad on 32nd Street between 7th and 8th Avenues, the electric current supply being obtained from the Long Island City plant of the Pennsylvania Railroad. The electric current supply is alternating current, a portion of which is changed to direct current by means of three rotary converters installed in the sub-basement of the hotel for supplying the elevators and ventilating fans and other large motors. The alternating current is used for lighting and for small motors so as to avoid the losses incidental to converting the energy from alternating current to direct current. A 500 KW steam diven generator is also installed in the sub-basement, this steam supply being obtained from the Pennsylvania Railroad. The object in installing this steam driven unit was to obtain the exhaust steam from the engine and use it for heating purposes during the winter months and at such times when there would not be sufficient exhaust steam from the other steam driven apparatus in the hotel.

Illumination: One of the main features of interest in the way of illumination in the hotel, is the lighting of the lobby. The ceiling of the lobby is of glass arranged in an attractive design supported on steel framework. Special glass in two colors is used and in the space above the glass ceiling are located a number of lamps with efficient reflectors arranged for control in three groups. The lighting effect is very attractive and obtained with an unusually small expenditure of energy for this type of lighting. Standard fixtures are also located on the floor which are used in connection with the lighting above the glass ceiling.



Courtesy of "Architecture and Building."

LIGHTING EQUIPMENT OVER LOBBY CEILING, HOTEL PENNSYLVANIA

Each of the bed rooms is provided with a center ceiling light controlled by a push button switch near the door. This ceiling fixture is of the semi-indirect type consisting of a simple but attractive etched glass bowl. This fixture is equipped with a rather novel and clever means for removing the bowl for the purpose of lamp renewals and cleaning. In addition to the ceiling fixture a desk lamp is provided, supplied from a plug. Two other fixtures are supplied from a duplex cord which fixtures are attached to the bureau and a third plug is provided for supplying current to a small fixture attached to the bed for reading purposes. In the bath room a simple fixture is provided over the mirror above the wash basin, and is controlled by a pull switch, in some cases, and in the larger bath rooms, by a push button switch located near the door. In each of the bed room closets a lamp is provided in a receptacle over the door controlled by a substantial pull chain socket.

It has already been mentioned that the electrical equipment has been simplified as far as possible. As an instance of this, no push button calls are provided in the bed rooms as the telephone is used entirely for calling maids or pages and for all meal orders, etc. This feature of the design resulted in a material reduction in the cost of the electrical equipment and also reduced repairs and maintenance. Telautographs and pneumatic tubes are used for transmitting messages, mail cards, newspapers, etc. A floor clerk is stationed at a desk on each floor opposite the group of passenger elevators. The floor clerk receives and distributes the guests' mail, the room keys, supervises the maids, pages and the operation of the floor generally. On each bed room floor is also located a service pantry, in charge of a waiter and bus boys. A bank of six dumb waiters extending from the kitchen pantry connects with and supplies these service pantries. Telatuographs and a separate pneumatic tube service are also part of the equipment of the service pantries. This pneumatic tube service extends to the main kitchen at the basement floor. From the main office at the ground floor a system of pneumatic tubes connects with a number of stations throughout the hotel, including the bar, grill, roof, restaurant, etc.

The watchman's detector system is of the portable type, with the addition that on each floor there is provided a separate watchman's station connecting with an outside supervised service. The fire alarm system is also of the interior type, connecting with the engine room, with an additional signal station on each floor, connecting directly through the National District Telegraph Company, with fire headquarters.

An electric clock system is provided, including a clock in each elevator corridor and in the public rooms on the main floors, and in some of the administration and service departments. This clock system is also operated in connection with the electric time stamp system, the time stamps being located on the floor clerk's desks, service pantries, bell captain and other service portions of the house.

Elevator Equipment: There is one group of main passenger elevators consisting of two rows of six elevators each, opening on the passenger elevator corridor. These elevators run from the basement to the roof floor and by locating all of the elevators in one group, it was deemed that better service to the guests would be provided and less confusion exist to the guest in locating the elevators. Two elevators are installed at the southwest corner of the building which serve to carry passengers, from the tunnel connecting with the Pennsylvania Railroad station and the subway, to the main floor.

At the 33rd Street side of the building near the ballroom entrance two elevators are also provided for carrying passengers from the main floor to the ballroom floor about twenty-five feet above the ground floor.

Eight service elevators in one bank are provided for the service requirements of the hotel. These elevators extend from the sub-basement to the roof and are arranged to be operated in three separate groups so far as signalizing is concerned, thereby permitting a certain amount of flexibility in assigning the elevators to different purposes. For example, one pair of elevators may be used for waiters exclusively, another pair for baggage, laundry, etc. The passenger elevators are arranged so that one side of (six) elevators may be run local and the other side may be run express. All of the passenger and service elevators with the exception of one large service elevator are of the one to one gearless traction type running at 600 feet per minute. The large service elevator which is approximately nine feet wide by seven feet deep is of the worm gear traction type, running at 450 feet per minute.

There are three additional elevators in the rear of the building which serve to carry supplies from the driveway to the lower floors and also to provide service between the sub-basement and the banquet room kitchen, which is located on the first mezzanine floor.

The signal system for the passenger elevators consists of up and down flashlight annunciators in the car with push buttons and up and down signal lanterns located at the various landings.

Dial indicators are placed on the ground floor as well as telltale annunciators for furnishing to the elevator starter the necessary information as to the location of cars and the car signals.

Honoring an Electrical Engineer

The annual business meeting of the A. I. E. E. will be held Friday, May 16, in the Auditorium of the Engineering Societies Building, at 8.30 P. M. At this meeting the Board of Directors will make its annual report, including a complete financial statement for the year ending April 30, 1919. The report of the

Tellers will also be presented, giving the results of the election of officers for the ensuing administrative year.

The Weaver Memorial Tablet, which is to be erected in the headquarters of the Institute "in acknowledgment of the services rendered to the Institute and to the Electrical Engineering profession by William D. Weaver," will be exhibited at this meeting.

Immediately following the business meeting will take place the ceremony of the presentation of the Edison Medal. This medal was founded by the Edison Medal Association, composed of associates and friends of Mr. Thomas A. Edison, and is awarded annually by the American Institute of Electrical Engineers "For Meritorious Achievement in Electrical Science, Electrical Engineering, or the Electric Arts." The Edison Medal has been awarded this year to Mr. Benjamin G. Lamme "for invention and development of electrical machinery."

Mr. Lamme was born in Springfield, Ohio, in 1864, and graduated from the Ohio State University as a mechanical engineer in 1888. He entered the Testing Department of the Westinghouse Electric and Manufacturing Company, May 1, 1889. The company was then engaged almost exclusively in the manufacture of high frequency, alternating apparatus for incandescent lighting. The development of practically all types of polyphase alternating current apparatus and railway generators and motors was a matter of the future, in which Mr. Lamme took a leading part. He has invented and designed much of the apparatus and many of the systems and methods which are now in general use. He has about 140 patents, many of which are of fundamental importance and cover inventions which have contributed very largely to the present methods of generating, transmitting and using electrical power. In 1900 he was made Assistant Chief Engineer and since 1903 he has been Chief Engineer of the Company. Mr. Lamme is the author of a number of standard books on electrical subjects.

Electric Generator Wanted in Norway.

American manufacturers of electrical machinery may be interested in the market offered by a local company for an electric generator of 5,200 kilowatts, alternating current, with the auxiliary machinery, to be delivered and installed in the company's power station at Svelgen, in Bremanger. If the machinery proves satisfactory after delivery and use, opportunity will be given to bid for larger orders, as the power available is more than 30,000 horsepower, so that later electrical machinery aggregating 33,000 kilowatts, with turbines to correspond, will be installed.

The intention of the company is to use its water power at Svelgen for the smelting of zinc concentrates. It is claimed that the annual capacity of the plant, when the plant is fully developed, will be 20,000 to 25,000 tons of low and high grade spelter. The name of the company mentioned above may be obtained and specifications and blue prints of the generator may be examined at the Bureau of Foreign and Domestic Commerce or its district offices by referring to file No. 112342.

Cost of Lighting Vancouver

C. H. Fletcher, city electrician, recently supplied some figures on the cost of lighting Vancouver. Of the lamp standards, such as those on Granville, Hastings and Robson Streets, there are 930 in the city. Each costs about $22 per year for all expenses, including about $12 for current consumption. The property owners on these streets pay the cost of installation and half the cost of maintenance. The standards are about 90 feet apart and each bears a cluster of five 60-watt lamps, giving about 250 candle-power actual light. There are 2,006 arc lights of about 600 candle-power, maintained at a cost of $35 per year. The city lights burn on an average during 3,000 hours each year. Vancouver pays over $80,000 per year for lighting, and at that gets a much lower rate than many eastern cities.

The Biggest Thing in Civic Life

Under the title "What Is It Chicago Most Needs?" J. E. Otis, vice-president of the Union Trust Company, of Illinois, is quoted in the *Chicago American* of April 7, as follows:

"The thing I would emphasize most forcibly is the importance of establishing, on a firm basis, an understanding between the public service corporations and the city.

"In order that public service corporations may keep pace with the demands of a city growing like Chicago, they must have the credit needed to finance themselves. They are absolutely dependent upon the sale of their securities for growth and extension.

"This credit can be assured only by a complete understanding between these public service corporations and the municipality, for the reason that sudden changes in these relations affect the securities and change their value. This spoils their marketableness."

Municipal Railway Rates Go Up in England

At a recent meeting of the Sheffield City Council a proposal made by the tramways committee to raise tram fares from 2 cents to 3 cents was adopted. It was also decided to reintroduce the system formerly in vogue of a reduced fare for certain specified short rides, the fare for these short distances to be raised from the former rate of 1 cent to 2 cents.

In introducing the resolution the chairman of the tramways committee outlined the present situation and stated that if the present efficiency of the service is to be maintained and the contributions heretofore made by the Tramways Department to the relief of rates (taxes) are to be kept up these increased fares are essential. From his remarks the following information has been gathered, writes Consul John M. Savage, from Sheffield.

During the war 97 British tramway undertakings increased their fares, in some cases as much as 70 per cent. Except for the abolition of the 1-cent fare for short rides, no change has been made in the prices charged persons using the Sheffield tramways for a period of 16 years.

Between 1915 and December, 1918, the working expenses of the local tramways increased 16 cents per car-mile and the revenue 11.58 cents. Until recently the undertaking continued to make a satisfactory profit, but at the end of December, 1918, it was running at a loss, and for the month of January, 1919, the loss amounted to $15,227.

During the same period wages, including war bonuses, have advanced: For inspectors, from $9.73 and $12.16 to $17.28 and $19.71; for engineers, from $10.22 to $19.30; for motormen, from $9.25 to $16.55; for conductors, from $8.14 to $15.45; for car cleaners, from $6.38 to $13.93, and for laborers, from $6.38 to $13.93.

The cost of timber during the same period has risen 500 per cent. In 1916 tenders for the construction of 50 cars were asked for, and the price quoted was $5,840 per car. Recently $14,600 apiece was paid for 50 cars of a similar type.

In consequence of the increase of wages, alterations in working hours, higher cost of materials and additional capital expenditure, and allowing for contingencies, the estimated increase in expenditure in conducting the tramways department will be $744,300 per annum and the estimated increase in revenue from the advance in fares $914,900 per annum.

Hydroelectric Development in Ontario

THE Hydroelectric Power Commission has recently commenced the construction of a dam and necessary waterpower buildings at Cameron Falls, on the Nipigon River (the most northerly river of Lake Superior), 14 miles north of the town of Nipigon and about 70 miles northeast of Port Arthur, Ontario, writes Consul G. R. Taggart, Fore William. A force of 100 men are now at work, and 200 more are expected within a month. It is estimated that the work will cost $3,500,000. The construction promises to be comparatively simple. Because of the natural fall of the water about 40 miles down the Nipigon River from the immense storage basin of Lake Nipigon (a lake about 2,000 miles in area), little construction will be needed besides the power house and a dam, with gates, at the intake. This regulating dam will be about 30 feet high and is to be built large enough to allow for the ultimate development of 70,000 24-hour horsepower. Such a dam will, it is estimated, impound the water back a distance of 15 miles and will give a total head of about 65 feet at the water wheels. A canal some 300 feet long will doubtless be needed for a tailrace. The forebay will serve as a penstock, and no flumes are regarded as necessary.

The number and size of the turbines (vertical) will depend upon the power contracts received by the commission within the next six months. At first, however, machinery will be installed for only two units of 10,000 horsepower each. This 20,000 horsepower is planned to be available by April 1, 1920. For each unit there will be needed, of course, a water wheel and generator and accompanying equipment. It is reported that bids for the furnishing and installation of the machinery will be invited. More detailed particulars about such bids can be obtained by addressing the commission at Toronto. The commission is a very large buyer of all kinds of electrical machinery, wire, insulators, transformers, etc. Although Canadian equipment is largely used (the generators, for instance, being generally made in Hamilton, Ontario, yet the commission is reported to have made considerable purchases in the United States, especially water wheels.

A small secondhand complete power plant capable of developing 1,500 horsepower has been transported by the commission from another part of Ontario and is being installed for electrical power for such work as pumping water for the camp, driving the concrete mixers, excavating and hauling, and operating air drills for rock blasting.

The pressure generated from the Nipigon plant will be 6,000 volts. This pressure will be transformed at the plant to 110,000 volts, so that the current may be readily transmitted to the main terminal transforming station (to be erected convenient to both Port Arthur and Fort William). At this second transforming station the pressure will be reduced to 22,000 volts and will eventually be further reduced at the subtransforming stations in Port Arthur and Fort William to 2,200 volts for actual use. The construction of the transmission lines to Port Arthur and Fort William will also be carried out by the Ontario commission's own staff.

This electric energy is being developed at the head of the lakes by this Ontario commission for the purpose of furnishing power to the cities of Fort William and Port Arthur, Ontario, to future industries outside these municipalities, and for the benefit of the Thunder Bay District in general. Both Fort William and Port

Arthur have municipal ownership for all their public utilities, including light and power, water, telephone, and street railways. There are no gas plants in either city. Each city has its own board of management, composed of a utilities commission. The electric power for the elevators and industries is also furnished by the municipalities, except in the case of the Canadian Pacific Railway. The cities are about four miles apart. In July, 1918, Fort William had a population of 19,523 and Port Arthur 15,059.

Electrical power is used in Fort William and Port Arthur for the operation of not only the public utilities and the grain elevators and other industries but also for the operation of the important transfer facilities at the head of the Great Lakes. These twin cities are regarded as midway between east and west Canada, and are, besides, the transfer points from lake to rail and vice versa. Here are stored and transhipped westbound coal, agricultural implements, and twine, and general merchandise, and eastbound grain products, sulphur ore pyrites, and tea. Facilities for handling this large bulk-breaking work must be reliable, hence practically all the power is furnished by electricity.

Both Fort William and Port Arthur have voted to take all their power from the Ontario commission, the Fort William contract calling for a minimum of 8,000 horsepower and the one with Port Arthur for 10,000 horsepower, with the privilege of increasing these amounts from time to time, as the requirements of the municipalities grow.

These cities have been receiving their power from the Kamanistiquia Power Co., whose plant is located at Kakabeka Falls on the Kaministiquia River, about 20 miles west of Fort William. This company has a remarkable record of uninterrupted service. Delays due to ice, backwater, or water shortage are unknown. For 12 years there has not been a single serious interruption of service from any cause, and the few minor interruptions have averaged about two minutes each in duration. This fine record has been made possible in this latitude mainly because of the reserve facilities of the plant, which not only has three aqueducts and four generators, but duplicate pole lines and triplicate circuits, thus permitting the transfer of power from one system to another.

The Ontario commission is reported to be building the Nipigon plant, instead of purchasing the one already in operation, because an advantageous transfer could not be arranged and also because the pulp and paper industries and other new enterprises of the district will require more power than is represented in the capacity of the Kamanistiquia company's plant—the immediate needs for industrial purposes being in excess of 35,000 horsepower.

One of the principal objects of the commission is to develop Canada's natural resources. In the Lake Superior region there are immense tracts of timber, particularly spruce, suitable for wood-pulp manufacture. Port Arthur has already a wood-pulp plant valued at $800,000, and turning out 50 tons of sulphite pulp daily, with an expenditure of 1,000 horsepower every 24 hours, night and day shifts being employed.

Electric Industry in Germany

The general manager of Siemens & Halske, one of the largest electro-technical manufacturing concerns in Germany, in a statement addressed recently to the labor organization of the plant, indicated in no uncertain terms that the German electro-technical industry was now facing a serious situation. He pointed out that the leading manufacturers such as themselves and the famous Allgemeine Elektrizitäts-Gesellschaft (A. E. G.) were investment trusts as well as manufacturing companies and that their investments had all, or nearly all, been made abroad with a view to controlling electro-technical companies, especially power stations, with the object of securing for themselves all the necessary orders in outfittings, accessory machinery and other apparatus required by consumers of electric current.

It was shown, however, that these companies are now suffering severely, due to the great bulk of their investments having been placed in enemy countries. Before the war, for instance, the investments of the Siemens Company alone in enemy countries amounted to 123,000,000 marks. Of this amount 45,000,000 marks were lost in Russia, 34,000,000 marks were expropriated in England, 17,000,000 in France were sequestrated and probably will be expropriated to go toward war indemnities, more than 20,000,000 marks were lost in Italy and smaller amounts were lost in Portugal, in Rumania and in South America. The investment concerns in neutral countries controlled by Siemens & Halske fell into the hands of neutral competitors.

The general manager's statement further warned the workers against believing that the war prosperity would continue. It was shown that war orders had entirely ceased, as had the large profits resulting from the circumstance that 90 per cent of the submarines during the war were fitted out with an apparatus for electrical navigation manufactured by the firm.

At the conclusion of the war the number of workmen engaged in Germany by this concern amounted to 64,124. Only 30 per cent of the work carried out during the last war year was work for peace purposes, the other 70 per cent having been done exclusively for the War Office. But already in 1918 the possibility of competing successfully in the electro-technical production had disappeared. Even before the last strikes in the coal districts the firm of Siemens had to pay for their annual coal requirements 5,500,000 marks, as against 1,500,000 in prewar days. Today peace work for export purposes has yet to be resumed. The output and activity of the workmen during the month of November, 1918, was smaller by 40 per cent than the average output during the years 1917 and 1918.

Development of Electric Welding

By Howard C. Forbes

WELDING attracted popular attention during the war because it was through its use that the German ships were repaired and later because of the welded ship the Emergency Fleet Corporation proposed to build, and the experimental welded ship that England had already turned out, writes Howard C. Forbes, secretary of the recently organized American Welding Society. While these were the most spectacular, it was used in many other war preparations. Depth and gas bombs were welded. The Liberty motor depended upon welding. The Otto gear which saved the ships from mines was welded to the bow of the ship. The army and navy were equipped with portable welding outfits for repairs in the field and at sea. Broken stern frames of ships which carry the propeller and rudder were repaired in place by welding in one-tenth the time that would have been required otherwise. Thousands of parts rejected in ordnance work were saved by welding, and its uses in general repairs were too numerous to mention. Previous to the war the process of welding had been well developed, and already had entered into industries of all kinds to an extent little realized by the general public.

Modern welding, as distinguished from that done at a blacksmith's forge, is a method of uniting metal in place by actually melting it together or by bringing the metal so near the melting point that it is soft enough to adhere when pressed together. In order to soften the metal in this way there must be applied to it an intense heat over a very small area. When the metal is in a molten conditions the heat is removed and the metal solidifies in place. So the development of welding depended upon developing a source of intense heat which could be sufficiently localized. The sources of heat which are at present in use are electric resistance, gas flame, the electric arc, and a chemical reaction known as thermit.

The first source of heat used for this purpose was that created when an electric current passes from one metal to another in contact with it. This heat arises from the resistance to the passage of the electric current across the contact, and the process is known therefore as "electric resistance welding." The current to accomplish this must be very large. When it is passed through the contact, as of two iron rods butted together, the surfaces where they touch immediately come to a red heat, a white heat almost immediately follows, and in from ten to fifteen seconds, depending upon the size of the rods, the metal will be so plastic that when pressed together it will unite in a homogenous mass. In this sort of welding it is not intended that the metal shall actually melt, but simply become plastic, as in the case of forge welding.

Another source of heat suitable for welding comes from the flame produced by burning acetylene gas, or other fuel gas, in combination with oxygen gas. Welding by this method came into use some years ago when the processes for manufacturing oxygen, acetylene, and fuel gases were developed so that they could be supplied in cylinders and delivered to the numerous factories and distributing stations at reasonable prices. The temperature of oxy-acetylene flame is very high, above 6,000 degrees Fahrenheit, and by means of suitable blow torches the flame in welding is confined to a small area.

Another source of heat is the electric arc which is formed by the passage of an electric current across an air gap and produces the highest temperature known. In electric arc welding one part of the circuit is connected to the metal that is to be welded and the other part to a piece of iron wire called the electrode and held by the operator in an insulated clamp.

When the operator touches the metal with the electrode and then draws it away, the electric arc is formed. The metal and the iron wire melt at once and in flowing together form the weld. Arc welding may also be accomplished by the use of a carbon rod.

The other source of heat, thermit, is chemical. It so happens that when iron oxide is mixed in the right proportion with powdered aluminum and touched off with an ignition powder the aluminum will burn, taking the oxygen away from the iron. This reaction is accompanied by an intense heat and leaves a mass of pure iron at a temperature far above its melting point. This molten iron is poured between and around the parts of the joint to be welded, previously encased in a sand mold. When the molten mass touches the surfaces of the joint the excess heat that it carries is sufficient to melt their surfaces and the result when cool is a solid connection.

All of these processes of welding result in a homogeneous mass of metal, but in the process the character of the metal has been changed by the action of the heat upon it. It is along the lines of determining and controlling these changes as well as perfecting and reducing the cost of the processes that further development is to come.

In considering the difference between welding and other methods of joining metals, it is obvious in the first place that in welding it is not necessary to cut away a portion of the original metal in order to secure holes for bolts or rivets. This cutting away reduces the effective size of the plate and must be made up for by using a thicker plate throughout, thus burdening the structure and wasting material. Practically all the structures that now exist are carrying 10 per cent to 20 per cent excess metal because of this cutting away. Moreover the process of welding involves fewer operations than that of riveting and is therefore more economical and quicker.

Further, a welded joint has the advantage of being water-tight. For instance, welded ships do not have to be caulked and do not come into port after every trip leaking, and tanks can be made to hold the lighter varieties of oil which work through every other kind of joint.

The field for the use of welding is enormous as it applies to the steel and iron industry and thereby extends into nearly all other industries which use steel or iron directly or indirectly.

An improvement in an industry of this magnitude becomes an enormous economic factor in the productivity of the country. It might be compared somewhat roughly with the improvements in the gasoline engine, in the extent to which this has multiplied vehicles of traffic, thereby increasing all kinds of business incidental to them; or perhaps better, though with results less far reaching, to the discovery of the Bessemer converter which made possible the commercial production of steel and thereby extended the steel industry to its present proportions. Under conditions that have occurred as an outcome of the war the country will rush to utilize all its economic assets, and welding is one of them.

Electric Railways in the United States

According to a preliminary report issued by the Bureau of the Census, Department of Commerce, the street and interurban railways of the United States during the year 1917 transported over 11,000,0000,000 fare-paying passengers, representing an average of something more than 100 trips for each man, woman, and child in the United States. The electric railway companies in that year operated 102,603 cars on 32,535 miles of line, comprising 44,812 miles of track; employed 294,826 persons, to whom were paid salaries and wages aggregating $257,240,362; and derived revenues amounting to $650,149,806 from their railway operations. The statistics cover electric-light plants operated in connection with electric railways and not separable therefrom, but do not cover mixed steam and electric railroads nor railroads under construction.

The report for 1917 gives figures for 947 operating companies, as compared with 975 in 1912 and 945 in 1907. The line mileage represents an increase of 6.9 per cent, as compared with 1912 and 27.4 per cent over 1907; and the corresponding rates of increase in track mileage were 9.1 and 30.3, respectively. The total number of care reported--comprising 79,914 passenger cars and 22,689 freight and other non-passenger cars—shows an increase of 9.1 per cent for the period 1912-1917 and 22.7 per cent for the decade 1907-1917. The electric locomotives in use numbered 357, as against 277 in 1912 and 117 in 1907. During the later 5-year period an increase of 4.4 per cent in the total number of employees was accompanied by an increase of 28 per cent in salaries and wages; and during the 10-year period 1907-1917 the corresponding rates of increase were 33.1 per cent and 70.4 per cent.

The total primary horsepower amounted to 4,200,192 in 1917, an increase of 14.7 per cent over 1912 and of 66.7 per cent as compared with 1907. The great bulk of this power was derived from steam, which contributed 3,543,915 horsepower to the total, as against 627,983 obtained from water and 28,294 from internal-combustion engines. A pronounced tendency to use larger units appears in the case of all three classes of power.

In addition to 11,304,660,462 revenue passengers, the electric railways carried 3,021,137,935 transfer and 181,116,176 free passengers, making a total of 14,506,-914,573. This total represents an increase of 19.5 per cent during the period 1912-1917 and 52.2 per cent for the decade 1907-1917. The revenue car mileage totaled 2,139,222,930, an increase of 11.3 per cent as compared with 1912 and of 32.2 per cent over 1907.

The electric power consumed in 1917 aggregated 12,187,850,831 kilowatt hours, an increase during the five-year period, 1912-1917, amounting to 35.1 per cent. There was a rapid growth in light and power business done by the companies.

The income of the companies from all sources in 1917 aggregated $730,108,040, of which sum $650,149,-806 represented revenues from railway operations, $59,675,286 was derived from auxiliary light and power business, and $20,282,948 was non-operating income. The revenues from railway operations increased by 21.3 per cent during the period 1912-1917, and by 62.2 per cent between 1907 and 1917; but those from light and power business increased by 89.4 per cent and 245.1 per cent during the 5-year and 10-year periods, respectively. The operating expenses aggregated $452,594,654, an increase of 36 per cent over 1912 and 80.1 per cent over 1907; and the deductions from income, comprising taxes, interest, and fixed charges, amounted to $221,062,456, an increase of 19.6 per cent for the later 5-year period and of 60.1 per cent for the decade. The net income, therefore, was $56,450,930, a sum less by 17.2 per cent than the net income of 1912 but greater by 39.9 per cent than that of 1907. Of the 947 operating companies, 300 paid dividends aggregating $48,337,435, a decrease of 6.4 per cent as compared with 1912.

ELECTRICAL ENGINEERING

With Which is Incorporated the

SOUTHERN ELECTRICIAN and the ELECTRICAL AGE

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FROM the news despatches the general public has gained the idea that Russia is wholly given up to revolutionary movements and counter movements. But an effort is being made along reconstruction lines, and to put commerce and industry on a stable basis again. The Commercial Department of the Representative of the Russian Soviet Government is organized for the purpose of making purchases in the United States of all materials required by the Russian Soviet Republic, and for the sale of Russian materials in the United States. The nationalization of the export and import trade by the Russian Government places the entire foreign trade of the country in the hands of the central purchasing institutions, under the Department of National Economy in Moscow, and of its representatives in foreign countries. A bureau has been opened in New York, under charge of A. A. Heller, as director. Mr. Heller says that the foreign trade of Russia, in the year 1913, amounted to 1,374 million rubles in imports and 1,520 million rubles in exports, of which the United States secured 79.1 millions in imports and 14.2 millions in exports, the bulk of Russian trade going to Germany, Great Britain, Holland and France. Now, however, there is excellent opportunity of diverting the stream of Russian trade to the American market. The United States is in a particularly favorable situation to replace Germany and Great Britain in the markets of Russia; she has some of the goods required practically in stock, ready to be shipped; she has the factories, the men, the raw material. Products of American manufacturers will have to meet, in Russia, topographical, geographical and climatic conditions, which, in many respects, are similar to those of America, rendering articles prepared for the American market readily adaptable to Russian needs and requirements. For example, American agricultural machinery, such as tractors, gang plows, harvesting machines, etc., answered admirably Russian requirements; American mining machinery, road-building machinery, etc., will meet in Russia almost the same conditions as here; and shoes, clothing, automobiles, typewriters—these products which characterize American methods of manufacture—are equally adaptable to Russian conditions.

THERE is little doubt that, in the not distant future, Russia will prove to be one of the greatest markets in the world for American goods and manufactures. Its enormous geographical expanse, covering a large part of two continents, its teeming millions of inhabitants, and its wealth of natural resources all tempt to commercial exploitation. In addition to this, the peasants, for many centuries oppressed and sunk in ignorance, have felt a genuine awakening through the revolution, and will demand their full share of the world's advantages and enlightenment as soon as they shall have attained political equilibrium. If Russia wants to purchase our goods, a most important question is the matter of payment. The American Bureau announces that the Russian Soviet Government is prepared to pay for its purchases in a manner which will make the trade independent of the depreciated value of the ruble. Firstly, it is ready to place $200,000,000 in gold in banks abroad as soon as trade relations are established. Secondly, there are large stores of raw materials in Russia, such as flax, hemp, bristles, hides, furs, platinum, precious stones, etc., ready for shipment to the American market. The value of these exports will go toward balancing the imports into Russia. Nor will the Russian purchases be limited to $200,000,000. Need of important products is far greater at this time than before the war. Not only are we confronted with the problem of rebuilding that which the war devastated, but Soviet Russia wants to build up a greater and more developed country than Russia ever was. The revolution elevated large masses of the people to a higher social standard, and every man, woman and child in Russia to-day is a potential customer for many kinds of articles which they never before used.

THERE is one point in this new Russian progress that will make strong appeal to Americans. In outlining its course, the American Bureau says: "We shall follow modern business methods in the establishment of standards of quality and value, and for goods measuring up to these standards we shall be ready to pay a price corresponding to their actual worth. We are not out for shoddy or sweat-shop products. Our instructions, naturally, are to buy goods made under trade union conditions, and we are going to carry out these orders not only because of the general solidarity of the Russian Republic with the interests of labor, but because we believe that the world is large enough and yields sufficient to afford an equal opportunity for all to live without exploitation, and that the quality of our products should not reflect improper working conditions. We shall not buy, for example, anything made by child or convict labor. If the cost of goods manufactured under proper working conditions is going to be higher than those made under sweat-shop conditions, we are willing to meet it." Among the articles of American manufacture which Russia has purchased in the past, and which it will need in the future, are electrical machinery, appliances and instruments; dynamos and generators, insulated wire and cables, motors, meters, transformers and telephones. The electrical industry will keep its eyes on Russia, ready to take advantage of the market at the earliest moment that seems safe and expedient.

Build Now!

Business, from ditch digging to banking, needs building as a stimulus at this time. Building investments, if made with reasonable prudence, are enhanced in value with the increase of population.

A universal building program means more to the United States right *now* than at any time in its history. It means individual efficiency for labor; it means increased production in all correlated industries; it means increased material demands until production reaches the quantity production level necessary for reducing unit costs; eventually, it means lower prices. This country is the soundest, healthiest, wealthiest in the world. If you need a home or a building do not hesitate a day longer in going to work on it.

Prices will not be lower until production is increased; costs will not go down until quantity production permits us to avail ourselves of the economy of the maximum efficiency of labor and machinery.

To increase labor efficiency, to increase production, to lower prices—BUILD NOW.

Telegraph Supplies for Trinidad

Consul Hendy D. Baker, Trinidad, British West Indies, writes that there is considerable agitation at present in Trinidad for better railway and telegraph service. Mr. Baker says that the telegraph department of the government railway has opened 138 miles of telegraph wire exclusive of duplicate wires, and also 116 miles of telephone wire. The total number of messages, public and railway, passing over the wires in 1917 was 114,120.

It is expected that orders will be placed in the United States very shortly for 30 miles of telegraph wire (No. 8 standard wire gauge), and also for 35 miles of telephone cables, 10 miles of which will be two-wire cables, and 25 miles, four-wire cables. This will be used for the railway line between Port of Spain and San Fernando, and for communication beyond that to La Brea at the asphalt lake. About 25 new telephone instruments will also be ordered in the United States. The telegraph wire will all be used for replacements.

A Decision as to Municipal Rates

In the case of the Springfield Gas & Electric Company against the city of Springfield, the Supreme Court of Illinois handed down a decision April 15, holding the clause in section 10 of the Public Utilities Act, exempting municipally owned public utilities from the operations of the act, to be unconstitutional. The decision of the Sangamon County Circuit Court was reversed. The decision in this regard was as follows: "The persons who use the products of service of public utilities are entitled to the benefits of the public utilities act and are entitled to its protection against exorties act and are entitled to its protection against extortion, discrimination and inferior service by whomsoever furnished.

"If a customer is oppressed by extortionate charges or discriminated against by wrongful rate or inferior service the wrong is the same whether done by a municipal corporation or a private corporation."

Personal Notes

W. J. Griffiths, for fourteen years connected with the Erner Electric Company, of Cleveland, has resigned his position and become active partner and director of the Cuyahoga Power Construction Company, of that city.

Melburn Brant, who was commissioned Captain in the United States Army, has rejoined the Byllesby forces as a salesman for the bond department in New York City. Before entering the service Mr. Brant was connected first with the publicity department and later with the bond department of H. M. Byllesby & Company, Chicago office.

Mr. C. C. Wallace. formerly manager of loading of munitions section of the Stenotype Company, Indianapolis, Ind., is now director of development and service of the Powdered Coal Engineering & Equipment Company of Chicago.

Capt. A. U. Wetherbee, who recently received his discharge from the Chemical Warfare Branch of the Service, and who was formerly chief engineer and assistant works manager of the Niagara Alkali Company, has accepted a position as chief engineer with the Powdered Coal & Equipment Company of Chicago.

Louis Jalovec has been appointed assistant to the U. S. Foreign Trade Commissioner to Czechoslovakia. He will be stationed in Prague, Bohemia. Information in regard to markets; also information of any kind concerning the country where he will be stationed, will be gladly furnished upon application. Mr. Jalovec is a member of the American Association of Engineers.

R. W. Spofford has been appointed local general manager of the Manila Electric Railroad & Light Company, Manila, Philippine Islands, by the J. G. White Management Corporation, New York, N. Y., the operating managers of that company. Mr. Spofford was graduated from the United States Naval Academy at Annapolis, and spent about five years in the navy. He was retired in 1911. Shortly thereafter he was engaged by the J. G. White Management Corporation and was assigned to the staff of the Augusta-Aiken Railway & Electric Corporation, Augusta, Georgia, and later was made general manager of that company. When the United States entered the world war, Mr. Spofford, as a naval reserve-officer, was called to the colors for service. With the signing of the armistice he was again placed on the retired list of the navy, with the grade of lieutenant commander.

Lieutenant Colonel W. R. Thompson, manager of construction and engineering of H. M. Byllesby & Company, landed in New York from overseas recently. Colonel Thompson has been in uniform since completion of the Second Officers' Training Camp at Fort Sheridan, from which he was sent as an instructor to Deming, New Mexico, commissioned as Captain. Later he was made a Major and sent to France with the 109th Engineers. About the time the armistice was signed he was promoted to the rank of Lieutenant Colonel in the same regiment.

Here and There in the Electrical Field

The Provincial legislature of Alberta, Canada, has made appropriations for the building of many telephone lines throughout the province.

The Ohio Electric Light Association will hold its annual meeting at Cedar Point, O., on July 15-18.

The Association of Iron and Steel Electrical Engineers will hold its annual convention in St. Louis in September.

A recent canvass shows that every single industry in the city of Enid, Oklahoma, uses electric power, 220 out of 224 industries of this city use electric power exclusively, and the other four use electric power for auxiliary purposes.

The Sitka Spruce Company is operating its plant at Coquille, Ore., on double shift. Electric energy amounting to 250 horsepower in motors is supplied by the Mountain States Power Company. The Buehner Lumber Company of North Bend, whose requirements of electric energy amounting to 700 horsepower are supplied by the Mountain States Company, expects to begin operation on double shift in the near future.

A new concern, the China Electricity Company, is being organized by the owners of the Sino-Japanese Industrial Company and the China Industrial Development Association to combine the Japanese firms in China dealing in electrical goods. The new concern will be capitalized at 3,000,000 yen, and, it is reported, will also lend money in China for telephone and electrical enterprises.

The American Association of Engineers received 123 applications for membership in one day, April 18. Secretary C. E. Drayer, of the Association, wishes to know if this is not the best day's record of any national society of engineers. Sixty-two of the applications came from Portland, Oregon, where the Portland Chapter of the American Association is in process of formation. Officers are: President, W. H. Marsh, principal assistant engineer of Spokane & Seattle Railway; secretary-treasurer, R. W. Barnes, principal assistant engineer Southern Pacific Company.

"To represent a public utility manager or owner as an autocrat, disposing of the lives of a subject population at will is grotesque," says the Saturday Evening Post. "They (public utilities) amounted to more than one-tenth of the total national wealth, aside from real estate. With hardly an exception they are also under public control. Their rates are prescribed, their practices regulated, and in many cases they have to bargain over wages with organized employees who are very far from helpless."

During the week ended April 19 the Sapulpa, Okla., Electric Company completed the installation of three 100 K. V. A. transformers for the Frisco Railway Company.

The new 33,000 horsepower turbine which is being installed in the Riverside steam generating station of the Minneapolis General Electric Company (Northern States Power Company) will be completed and placed in operation about June 1. It is of interest to note that the condenser, which is part of the equipment being installed in connection with the new turbine, contains 40 miles of copper tubing.

Foreign Trade Opportunities

The following inquiries from foreign sources for electrical goods and equipment have been received by the Department of Commerce, Washington. Particulars can be had by those interested by addressing the Department and mentioning the number given:

29,153.—A firm in this country with a branch in Italy, and also proposing to open offices in other European countries, desires to secure agencies for the sale of electrical railway equipment, metal goods and other electrical supplies, and especially insulated wires, cables, rubber goods and all the machinery and materials for their manufacture.

29,171.—A firm in South Africa wishes to purchase two complete wireless telephone or telegraphic equipments for use between two mines located about 80 miles apart. Quotations should be given f.o.b.

29,179.—A firm in Spain desires to purchase turbine for high-pressure turbines and electrical machinery of all sorts for developing waterfall power in that district. Quotations should be given f.o.b. New York. Payment, cash against documents. Correspondence may be in English. Reference.

29,106.—A firm in Norway, which is building a zinc melting and refining works, is in the market for twenty 1,100 kva and 10 kva furnace transformers, together with oil switches and instruments, to be delivered as quickly as possible, f.o.b. New York. Payment to be made one-third with order, one-third upon delivery, and one-third when erected, but not later than three months after second payment. Specifications may be seen at the Bureau or its District Offices (refer to Exhibit No. 112,357). Later the company will be ready to purchase a few storage locomotives, electric unloading cranes and other appliances and machinery for transporting raw material to the works and the finished product to the ship side. Reference.

29,115.—A man in Switzerland desires to secure an agency for the sale of electrical apparatus such as dynamos or electric locomotives. Correspondence may be in English.

29,088.—An electrical machinery manufacturer in France desires to secure an agency, on a salary and commission basis, for the sale of electrical, metallurgical, or mechanical products. Correspondence may be in English.

29,090.—The manager of a trading corporation in Belgium desires to be placed in touch with manufacturers able to supply all kinds of electrical machinery, fittings and apparatus, internal-combustion engines, motor cars, trucks and lorries.

29,099.—A man in France desires to purchase machines for laminating copper into bars; each machine must be capable of a daily output of copper bars measuring 60 mm. by 70 mm. by 1,300 mm., and it should comprise the necessary electric motors, flywheels, elastic couplings, rollers, cylinders and all other necessary parts and equipment, including accessories, tools and replace materials of first class. The electric motors must be triphase, with alternating frequency 50, voltage 115. The equipment should also comprise complete machinery for reducing the bars in size and finishing. Specifications, drawings, export conditions, etc., should be forwarded with the least possible delay. Correspondence should be in French. Reference.

29205.—An engineering firm in Italy wishes to purchase monophase and triphase motors; direct current motors and dynamos; electric machinery for ships and mines; automatic safety signal devices; electrical measuring and recording instruments; metallic filament light bulbs, for one-half watt; and Diesel motors for industrial and marine use. An agency is also desired for the sale of pig iron; argentana wire or other materials for electrical resistance; special small plates for the construction of motors and transformers; copper wire, diameter 3 to 8 mm. for electrical transmission lines; and copper braid, 6 to 10 mm. in diameter. It is stated that if advisable one of the members of the firm will visit this country in order to furnish additional information. Correspondence should be in Italian or French. References.

Dynamic Brake for a Small Motor

By J. Gintz, Jr.

SOME motors when driving a certain piece of machinery may be required to stop at a certain point in its operation, and the starting box and main line switch may be mounted so that they cannot be reached by the operator when stopping is desired. Take, for example, a machine for insulating wire. These machines insulate as many as 30 to 50 wires at one

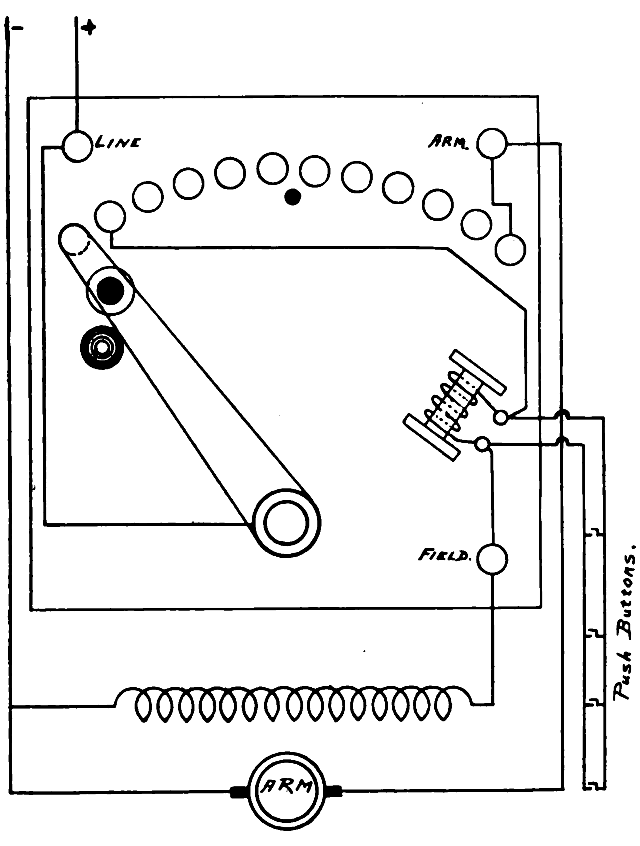


Fig. 1.

time. When the insulation on one of these wires breaks the machine must be stopped at once. To do this the main line switch must be opened or the starting box handle thrown to the off position. This can be accomplished by placing a number of push buttons at intervals along the machine. By pressing one of these push buttons the retaining magnet on the starting box will be short circuited, thus releasing the handle, which is then thrown to its off position by the spring on the handle. The wiring diagram is as shown in Fig. 1.

This method of stopping by short circuiting the retaining magnet will not bring the motor to an instantaneous stop but it will stop gradually. In order to stop a motor instantaneously and where a mechanical brake is not possible the armature current can be short circuited, which is known as dynamic braking. Fig. 2 shows how a dynamic braking device can be arranged on any starting box.

Drill two holes into the slate top of the starting box at point A; take two leaf or strip copper brushes, drill same and

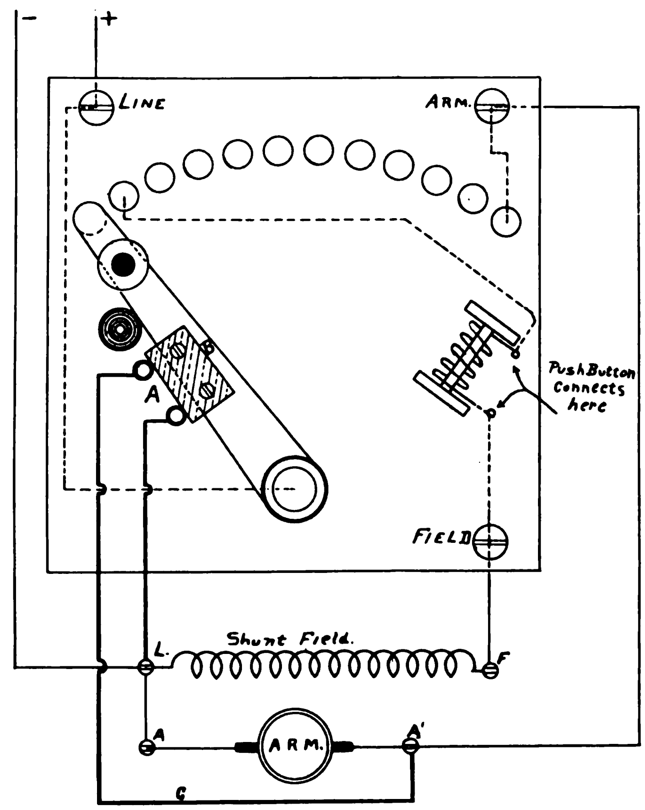


FIG. 2

bolt them fast to the slate. Run a wire from the line (L) terminal and from the armature (A) terminal on the motor and connect one to each of the strip copper contacts; also drill the starting box handle at point B, and bolt a piece of copper or brass on so that it will project about 3/16 of an inch. This strip should be insulated from the handle by placing a piece of fibre under and over it, and have the holds drilled large enough so as to insert small fibre or mica rings around the bolts. This insures thorough insulation.

When any of the push buttons, as shown in Fig. 1, are pressed, short circuiting the retaining magnet, which will release the handle, the strip which is bolted to the handle will make contact across the copper strips bolted to the box at point A and short circuit the armature current and cause the armature to stop almost instantaneously.

Should this method of stopping be too abrupt it can be eased somewhat my inserting a small resistance at point C.

Ball Bearing Manufacturers Combine

Of interest to all users of bearings is the just announced reorganization, effective May first, whereby the products of the Hess-Bright Manufacturing Company, the S K F Ball Bearing Company, the Atlas Ball Company and the Hubbard Machine Company will be sold through one central organization. The new company, under the name of S K F Industries, Inc., will thereby be able to offer a comprehensive line of ball bearings, including the Hess-Bright deep-groove type, S K F self-aligning radial and thrust bearings and ball bearings pillow-blocks and shafting hangers.

Through the medium of its engineering organization, backed up by a well equipped laboratory, the new company will be able to place at the service of bearing users the knowledge gained in many years' study of anti-friction bearings of all kinds. On request, manufacturers' problems will be analyzed in detail and that type of bearing recommended which (independent of sales considerations) is best suited to the conditions met. In addition the laboratory staff will carry on research studies affecting anti-friction bearing design and application.

The new company, S K F Industries, Inc., will be under the direction of B. G. Prytz, president; W. L. Batt, vice-president; J. P. Walsh, comptroller, and S. B. Taylor, sales manager. The principal office will be at 165 Broadway, New York City, with branches at Boston, Philadelphia, Atlanta, Buffalo, Cleveland, Detroit, Cincinnati, Chicago and San Francisco.

American Bureau of Welding

At a meeting of the American Bureau of Welding, held on April 11th, at the Engineering Societies Building, 33 West Thirty-ninth Street, New York, the by-laws of the Bureau were adopted and the following officers elected: Director, C. A. Adams; Vice-Director, H. M. Hobart; Vice-Director, A. S. Kinsey; Treasurer, W. E. Symons; Secretary, H. C. Forbes.

Regular meetings of the Bureau are to be held on the third Friday of each month.

The Bureau voted to establish a Research Committee for the purpose of carrying out the plan of co-operation in conducting investigations in welding, and appointed the following members:

C. A. Adams, American Welding Society, 33 West Thirty-ninth Street, New York.

D. C. Alexander, Quasi-Arc Weldtrode Company, 2897 Atlantic Avenue, Brooklyn.

Dr. C. K. Burgess, Bureau of Standards, Washington, D. C.

J. I. Banash, 1724 Forty-second Street Building, New York.

W. J. Beck, American Rolling Mill Company, Middletown, Ohio.

Alex. Churchward, Wilson Welders & Metals Company, 2 Rector Street, New York.

Jack Churchward, Wilson Welders & Metals Company, 2 Rector Street, New York.

Jasper H. Cox, Lloyd's Register of Shipping, 17 Battery Place.

G. H. Clevenger, National Research Council, 1023 Sixteenth Street, Washington.

L. H. Davis, Linde Air Products Company, Forty-second Street Building, New York.

J. H. Deppeler, Metal & Thermit Corporation, 92 Bishop Street, Jersey City.

J. G. Dudley, Chester Shipbuilding Company, Philadelphia, Pa.

F. C. Elder, Newburgh Steel Works, 8101 Broadway, Cleveland, O.

E. H. Ewertz, Bethlehem Shipbuilding Company, Elizabeth, N. J.

F. M. Farmer, Electric Testing Laboratory, Eightieth Street and East End Avenue, New York.

F. L. Fairbanks, Quincy Market Cold Storage & Warehouse Company, 69 Eastern Avenue, Boston, Mass.

H. C. Forbes, Secretary American Welding Society, 33 West Thirty-ninth Street, New York.

C. J. Holslag, Electric Arc Cutting & Welding Company, 222 Halsey Street, Newark, N. J.

J. H. Horn, Roeblings Company, 117 Liberty Street, New York.

H. M. Hobart, Consulting Engineer, General Electric Company, Schenectady, N. Y.

Prof. R. G. Hudson, Massachusetts Institute of Technology, Cambridge, Mass.

W. J. Jones, Chester Shipbuilding Company, Chester, Pa.

R. P. Jackson, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Zay Jeffries, Director of Research, Aluminum Castings Company, Cleveland.

H. W. Jacobs, Oxweld Railroad Service Company, 30 East Forty-second Street, New York.

Prof. A. S. Kinsey, Shop Practice, Stevens Institute of Technology, Hoboken, N. J.

Com. H. G. Knox, U. S. Navy Yard, Norfolk, Va.

Hermann Lemp, General Electric Company, Erie, Pa.

J. C. Lincoln, Lincoln Electric Company, Cleveland, Ohio.

W. L. Merrill, General Electric Company, Schenectady, N. Y.

John Martin, American Bureau of Shipping, 66 Beaver Street, New York.

Prof. H. F. Moore, University of Illinois, Laboratory of Applied Mechanics, Urbana, Ill.

S. W. Miller, Rochester Welding Works, Rochester, N. Y.

Victor Mauck, John Wood Manufacturing Company, Conshohocken, Pa.

C. A. McCune, Page Steel & Wire Company, 30 Church Street, New York.

J. W. Owens, Norfolk Navy Yard, Norfolk, Va.

Stuart Plumley, Davis-Bournonville Company, Jersey City, N. J.

E. J. Rigby, Quasi-Arc Weldtrode Company, 2897 Atlantic Avenue, Brooklyn, N. Y.

Prof. J. W. Richards, Lehigh University, South Bethlehem, Pa.

W. Remington, Thomson Welding Company, West Lynn, Mass.

M. H. Roberts, Air Reduction Company, 120 Broadway, New York.

W. E. Ruder, General Electric Company, Research Laboratory, Schenectady, N. Y.

Prof. A. W. Slocum, University of Vermont, Burlington, Vt.

Bradley Stoughton, American Institute of Mining Engineers, 33 West Thirty-ninth Street, New York.

F. N. Speller, National Tube Company, Pittsburgh, Pa.

H. S. Smith, Prest-O-Lite Company, 30 East Forty-second Street, New York.

Wm. Spraragen, 33 West Thirty-ninth Street, New York.

H. S. Starling, Bureau Veritas, 17 State Street, New York.

R. E. Wagner, General Electric Company, Pittsfiled, Mass.

H. I. Walsh, Newport News Shipbuilding Company, Newport News, Va.

Prof. H. L. Whittemore, Bureau of Standards, Div. VII-I, Washington.

Chas. Wirt, Wirt Company, Armat and Lena Streets, Germantown, Pa.

This membership will be increased from time to time.

Helpful Hints About Dry Batteries

By T. Schutter

In many cases a dry battery is the source of much trouble, as they are usually run down long before the zinc shell or case is eaten away or even punctured.

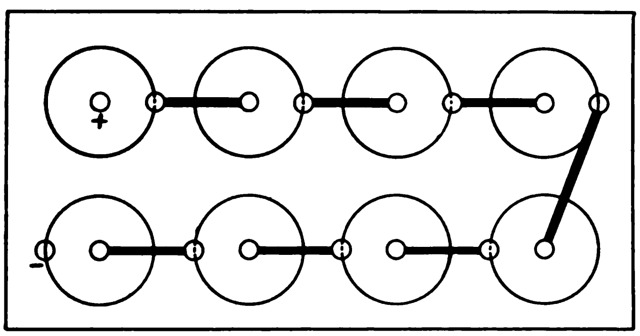
The reason for the failure of a dry battery to produce a flow of current is that it is dried out, due to the sealing compound which covers the top of the battery being broken, which will allow the moisture in the battery to dry out. Once this moisture is dried out there is no longer a chemical action which produces the flow of current.

As long as the zinc shell or case is still unbroken it is a very simple matter to recharge or refill the battery. Use a sharp chisel and break away a portion of the sealing compound on top of the battery so that the inner packing of the battery can easily be reached; then make a strong solution of salammoniac and water, then pour as much of this solution into the opening on top of the battery as it will absorb, until the packing is thoroughly saturated. Then reseal the top of the battery with sealing wax or with molten rosin. The battery will then be very nearly equal to a new one.

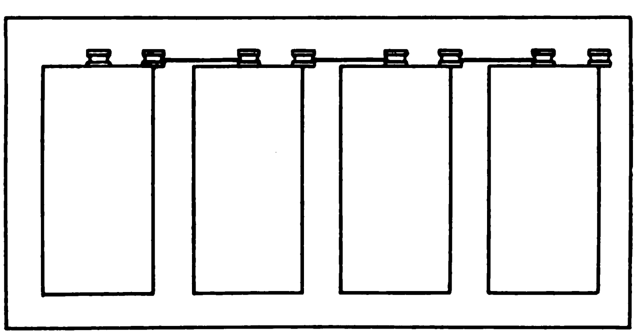
Another way to renew the life of a dry battery is to punch a lot of holes in the zinc shell or case, and place it in a glass jar (a one quart preserve jar will do nicely) and fill the jar with a strong solution of salammoniac and water so tnat the dry battery when placed in the jar will protrude abou one-half of an inch above the solution. In order to prevent the crystalizing and creeping up over the top of the battery and also up to the the top of the jar, they both should be dipped in hot paraffin about half an inch at the top.

A dry battery treated in this manner will be productive as long as any part of the zinc shell or case remains.

Dry batteries when used on call bells, burglar alarms, tank alarms, signals, ignition work of all kinds, etc., are required



Top View



Side View.

to operate in and under some most unfavorable conditions at times; their life more often depends on these surrounding conditions than on the actual amount of work they are required to do.

Some dry batteries are only used a few minutes a day. Still if they are located in a very warm place they will dry out and become useless in a very short period of time; as above explained, if the packing of the battery dries out, the chemical action stops and consequently the flow of current stops also, since it is the chemical action between the carbon and zinc which causes the flow of current.

To prevent this drying out of dry batteries to a very marked degree, arrange the cells in a convenient grouping, and then make a wood box to fit around them as shown in the sketch below, in which eight batteries are fitted in two rows of four each. When the box is completed it should be about one inch higher than the batteries, and an allowance of one-half inch between each battery and also between the sides of the box. When the batteries are placed in the box, they should be raised about one-half inch off the bottom, by means of a wood strip. The next step is to make the desired connections and make sure that all connections are solid; then melt enough of paraffin to fill the box within about one-eighth of an inch from the top. Then be sure the box is set level and allow the paraffin to get hard. This will make an air proof casing around the batteries and in this way prevent them from drying out.

By this process the life of the batteries can be improved and they will last two or three times as long as they would otherwise under most favorable conditions. It requires about three pounds of paraffin to fill a box of this size, which will cost about 30c., plus the cost of the box, which is about 20c. Then by adding this cost to the cost of eight dry cells the saving can easily be estimated.

Trade Notes

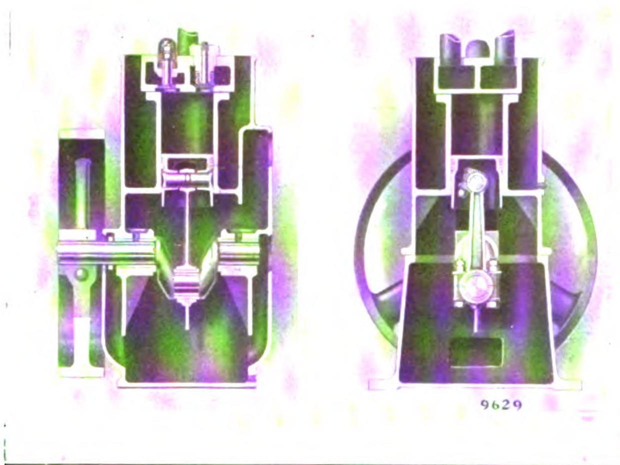
The Bailey Meter Company will move its main office and works from Boston to Cleveland, Ohio, effective May 1st. The Boston office, with Mr. H. D. Fisher as manager, is retained to handle sales and engineering service work in the New England district. For the present New York and Philadelphia districts will be covered from Boston and all other districts will be covered from Cleveland.

Removing cell plates from batteries has always been a great problem for the charging stations, because of the difficulty in getting the plates out without injury to the batteries and the time consumed for the work. There is now a new, compact, strongly built device marketed, which does away entirely with the time and labor trouble formerly experienced. Plates of a three or six cell battery are removed in 5½ minutes. The new apparatus has a steam generator with six jets, three of which are controlled by a valve. The valve is closed for three cell batteries and opened when all six jets are used. Time required to get up sufficient steam is from 2 to 4 minutes. The steam generator is fitted with a safety pop valve, which blows off pressure at ten pounds. However, the manufacturer claims pressure is never above three pounds. The process of softening the sealing compound is exceptionally simple. The vent caps of the battery are removed and the jets inserted on each cell. Steam is forced direct into cells. Within four or five minutes the plates are removed. Cost of operation is 3 cents. Grease and other impurities can be steamed and cleaned off the batteries also. The outfit is operated by kerosene, although when desired gas burners can be furnished. A one gallon capacity melting kettle for melting wax for resealing—a 35 lb. capacity lead melting pot for reclaiming lead and a lead mould to make lead sticks are furnished with the apparatus, which is manufactured by the Hauck Manufacturing Company, of Brooklyn, N. Y.

Manufacturer's and jobber's catalogs of electrical goods as well as samples of all kinds are desired by the electrical department of the Coyne Trade and Engineering Schools. This institution has conducted a course in Electricity for the past 20 years. A large illustrated catalog, which described the various courses, will be sent to interested parties who address the Coyne Trade and Engineering Schools, 45 East Illinois Street, Chicago.

The Automatic Reclosing Circuit Breaker Company, of Columbus, Ohio, have just issued Bulletin No. 301, describing their new types of breakers "ARL," "DRL" and "CRL." These are not only automatic in operation, but operate with more than human intelligence. The human operator guesses on the condition of load circuit, and often closes the circuit breaker while the short circuit exists or while controllers remain in the running position. The automatic reclosing circuit breaker takes no such chances, being governed by an index which responds only when load conditions are proper. This index is readily adjustable to suit any load condition.

The Society for Electrical Development is sending out a booklet entitled "What Licked the Kaiser?" There may be room for discussion as to *who* licked him but there is no question as to what did it. The secret is whole-souled co-operation, and the book is a plea for genuine and wide-spread co-operation throughout the entire electrical industry to put this great business where it belongs. It is very brightly written and makes appeal to every wide-awake man.



Sectional View of Imperial Fourteen Compressors

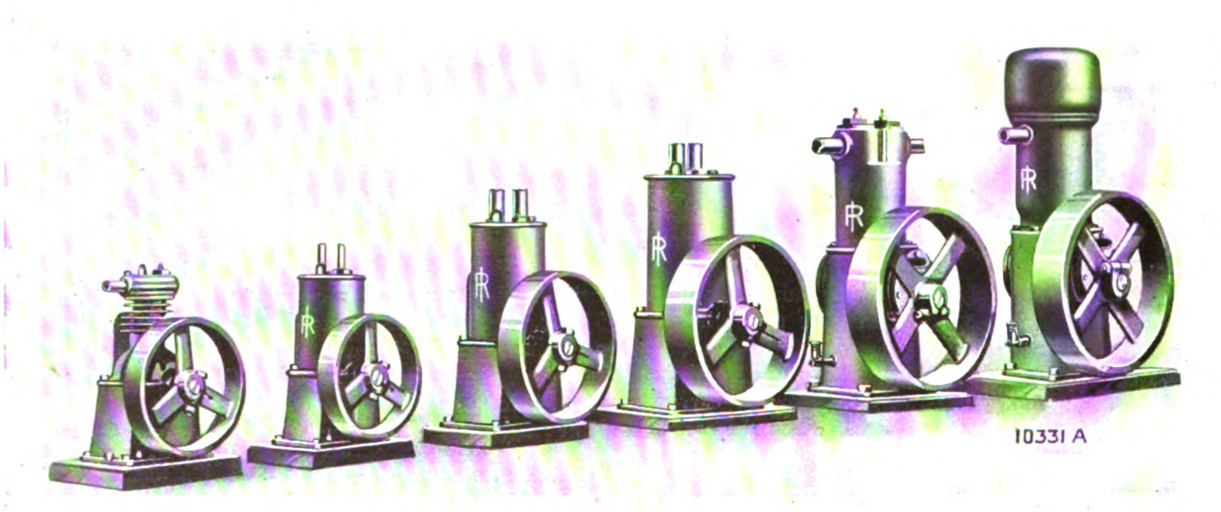
The Latest in Small Air Compressors

When, in the emergency at the outbreak of the war, there was a sudden call for a large number of small air compressors for service where reliability was imperative, the Ingersoll-Rand Company's offer, to produce for immediate use the Imperial Fourteen Compressors which it had just completed testing out and had adopted as the new standard small compressor type, was accepted. The field performance of these built-on-hurry-order machines was watched with critical eye, but after a year's service their record was clear. They had proven themselves efficient, reliable, and inexpensive to operate.

Now, these little machines have been placed on the general market. There are four sizes and the capacity range runs from 3 to 45 cubic feet per minute at pressures to 100 pounds per square inch. The small compressors can, however, be used for pressure requirements up to 200 pounds per square inch, the horsepower needed being, of course, slightly increased. They are single acting machines of the vertical type built for belt drive. Where driven from line shaft, tight and loose pulleys are supplied; where the use of independent motor is planned they are ordinarily furnished as a unit complete with motor, endless belt and short drive attachment. In the latter case a hardwood base plate is included with the standard equipments.

The machines are so well balanced as to operate satisfactorily if bolted to any solid flooring, but where permanency of installation is desired the building of a concrete foundation is advocated. The smallest size is built with ribbed cylinder for air cooling where the service is intermittent, and with water cooled cylinder of the reservoir type for continuous operation. Larger machines are water cooled only, employing the reservoir jacket system except that, in the case of the largest size, a closed jacket for connection to pressure system is optional. In this connection it is worth noting that the reservoir cylinder design affords unusually ample water capacity and that both cylinder barrel and head are cooled. The manufacturer states that a single filling of the water space will suffice for a 10 hour day's run.

In general design the Imperial Fourteen Compressors remind one strongly of an automobile engine. There is the same drop-forged crank shaft and connecting rod, the die cast renewable bearings, the automatic splash lubrication system and general ruggedness and simplicity which have come to be recognized as guarantees of satisfactory service under all sorts of operating conditions. It is pointed out, however, that these little units were designed to meet exacting efficiency tests and that, while simplicity was sought, efficiency was the outstanding requirement.



Different Sizes and Types of Imperial Fourteen Compressors.

ELECTRICAL ENGINEERING

VOLUME LIII | JUNE, 1919 | No. 6

Society for Electrical Development

THE annual meeting of the Society for Electrical Development, held at the Society offices in the Engineering Societies Building, New York City, Tuesday, May 13th, brought to light the interesting fact that notwithstanding the handicap of the war, the Society has accomplished a tremendous amount of development work. The main feature of the report was the review of the work done and an outline of the greater activities which the proposed expansion of the Society will permit. Mr. J. Robert Crouse, Vice-President of the Society presided at the meeting.

Members of the Board of Directors were elected as follows. Representing Manufacturers, W. D. Steel, four years; Representing Jobbers, E. C. Graham, four years: Representing Contractors, James R. Strong, four years; Fred B. Adam, two years; Director at Large, Charles W. Price, two years.

The annual report, read by J. M. Wakeman, General Manager, covered the activities of the Society during 1918. Although with reduced staff and expense, the Society continued its work to the utmost with the funds at its disposal. This was done largely through the daily newspapers, popular magazines and the trade press; the last mentioned being chiefly used to extend the application of the electric motor. In many of the newspapers special electrical pages were resumed upon the stopping of the war; many newspapers never before having inaugurated electrical pages were induced to start them; and in the magazines the Society prepared and supplied scores of articles, photographs and data on electrical subjects.

In addition to this education of the public, the Society has distributed many interesting and instructive booklets direct to the Industry. The more notable being "Industrial Heating," "More Than 3,000 Uses for Electricity," "Useful Electrical Information for Architects, Contractors and Engineers" and the "Electric Range Handbook," all of which served a very useful purpose in disseminating desirable propaganda for the Industry.

Mr. Wakeman went on to outline the national campaigns recently carried on by the Society. In recalling the services rendered by the Society in preparing and conducting such national campaigns as "Electrical Prosperity Week" and "America's Electrical Week" he showed that while the movements "Save-By-Wire," "Brighten Up for the Boys Coming Home" and the one just closing, "Electrify Your Home," have not been carried on so colossal a scale as the above mentioned, nevertheless they served to catch the Industry at the psychological time and to supply the further impetus it needed to keep going.

Mr. Wakeman said specifically: "We are greatly indebted to the trade journals for their splendid co-operation in keeping this campaign before their readers."

Continuing, Mr. Wakeman said that the Society had given special attention to central station problems. Valuable booklets entailing a great deal of work in compiling the necessary data were sent to central station members, who found them extremely valuable and almost invariably asked for more copies for various officials or department heads. Among these booklets were "Where Increased Rates Have Been Granted," "Customers vs. Population," and "Customer Ownership of Public Utilities." In addition, many of these books were distributed to manufacturer members as they proved of great value in compiling market analyses, and planning selling campaigns.

As long as it was in existence, the Society co-operated with the National Committee on Gas and Electric Service, in the fuel conservation program. It was also able to render assistance to the Fuel Administration, which was acknowledged with thanks. It supplied information to the electrical appliance manufacturers for submission to the Priorities Committee and the War Service Board.

Mr. Wakeman made a supplementary report on the results of the successful "Electrify Your Home" Campaign. He showed that 596 cities requested this campaign material and each one was going after house-wiring orders in one way or another. In these cities over 1190 individual companies "enlisted in the movement," including many newspapers which are co-operating.

Roi B. Woolley of the Society's staff, stated that the cities where the campaign was conducted on a co-operative basis showed the largest results ever obtained. Chicago, Cleveland, Brooklyn, and other cities were mentioned where the results in actual housewiring contracts closed have broken all records. Mr. Woolley also spoke of favorable replies received from 300 newspapers to an inquiry whether they were interested in national campaigns such as the Society conducts. Only two newspapers went on record as expressing unfavorable opinions.

J. Robert Crouse claimed that the support given by the Industry to the work of the Society is altogether too small. Starting originally to get $200,000 annually, it was figured that this was the minimum on which the Society could be conducted. Mr. Crouse said that he personally never had any idea but that the amount would grow gradually. He believed that $400,000 or $500,000 would be required to give adequate support to the work. He declared that the work done so far had produced excellent results and that it was absolutely logical that the industry should express itself as a unit in favor of the Society and a still broader, bigger continuance of its activities.

Great Field in France for Public Utilities

Lieut. Robert Montgomery of the 146th U. S. Infantry has received his honorable discharge and resumed civil life as commercial manager of the Louisville Gas and Electric Company. As Town Major for a number of towns in France he was thrown in close contact with the French people and given excellent opportunity to study their needs. He is quoted as follows:

"France realizes that commercially and industrially she needs American system and standardization in rebuilding towns destroyed during the war. The French, as is well known, are inherently an artistic people. In that capacity they excel, but industrially they are centuries behind and in many towns manufacture is done by hand, when machines could be used and quantity production result.

"Yes, I believe France will look to America for machines and mechanical engineers and scientific managers. Not immediately, of course, but in the next two years there will be this great opportunity opened for American industrial genius. In the rehabilitation of French industry, it is necessary that it be put on a basis to compete with English and German trade and it will be necessary to change the method of slow hand-made articles to quantity production. There is the best of feeling between the two countries.

"I was all over France and was able to make a thorough survey of conditions. One case that struck me was a compass factory, a kind of community, which makes compasses by hand. For 600 years these people have worked in their slow, painstaking way, turning out a few articles in a year, that would be the output of a day for some American machines.

"There is also a great opportunity in France for public utilities. With the exception of four or five of the larger cities, the towns are without proper sanitation and water supply. An American engineer could do wonders in these places and the French people admit the fact."

Westinghouse Company Establishes Memorial Scholarships

As a proper war memorial to the more than 8,000 employes of the Westinghouse Electric and Manufacturing Company who have entered the service of the Government in the great war, this company has decided to establish a number of technical scholarships. The details of the plan by which this will be done have been given out by President E. M. Herr as follows:

Four War Memorial Scholarships will be established each year under the following general conditions:

(a) Candidates will be limited to sons of employes of the Westinghouse Electric and Manufacturing Company and its subsidiaries who shall have been employes in good standing for a period of five years.

(b) Two of such annual scholarships may be open to the younger employes of the company or its subsidiaries who have been in their service for a period of at least two years and who do not exceed the age of 23.

(c) The selection is to be determined by competitive examination to be conducted annually by the company's Educational Department under the direction of the committee hereinafter provided. The examination is to take into account not only the applicant's academic training and preparedness, but due consideration will be given to personal qualifications, general character and aptitude.

(d) Scholarships will entitle the successful candidate to pursue a four years' course in any technical school or college that he may select with the approval of the committee. The scholar may pursue a course in any branch of engineering that he may select.

(e) Scholarships will beg ranted for one year only, but will be continued for the full four years, provided the scholar pursues a course in any branch of engineering that he may select.

(e) Scholarships will beg ranted for one year only, but will be continued for the full four years provided the scholar maintains the academic and other standards required by the college or institution in which he elects to pursue his course of study.

(f) Each scholarship carries with it an annual payment of $500 to be made in two installments and the number of new scholarships will be four each year.

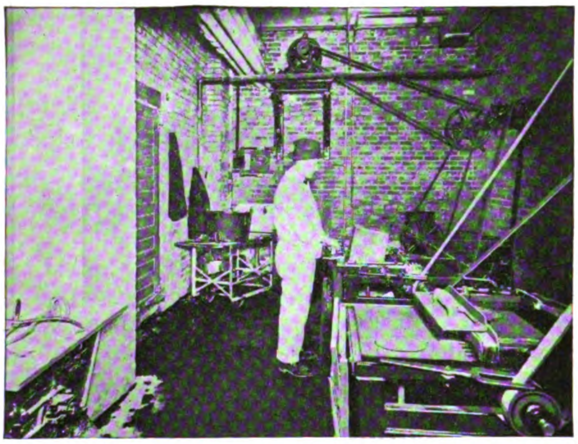
(g) The company will establish a Memorial Scholarship Committee consisting of three vice-presidents of the company, to whom shall be referred the names and records of the candidates and who will select therefrom the four successful persons, who, in its judgment, have most satisfactorily met the tests applied. The said committee will also be charged with the duty of establishing the detailed rules and regulations and such other matters of administration as have to do with this particular matter.

It is the intention of the company to continue these Memorial Scholarships from year to year, but the company reserves the right to recognize changing conditions and to modify the plan or discontinue it entirely if, in its judgment, it seems wise and expedient to do so.

Electricity in the Largest Hotel in the World

THE New Hotel Pennsylvania, at the Pennsylvania Terminal, New York City, has 2,200 rooms, each with its bath, and is the largest hotel in the world. It was also planned to be one of the most modern, convenient and comfortable, and consequently electricity has a large part in its service to guests.

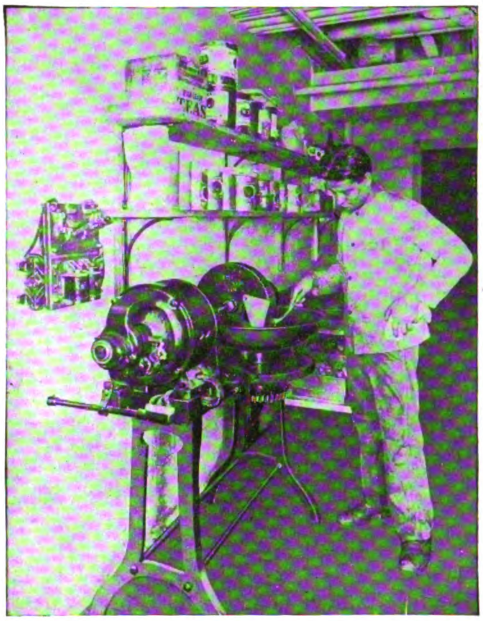
In fact, so important is this mysterious force to the life of the hotel that special precautions have been taken to prevent the failure of the supply. It would, for example, be a veritable catastrophe if the lights should all go out and the elevators stop running. So arrangements have been made to supply current from three independent sources—from two stations outside of the building and from a generator inside. The cables come in through a tunnel deep under ground and the power could not be cut off even by an earthquake or an air raid (fire need not be considered, as the hotel is absolutely fireproof).



Motor-driven Ice Cutting Machine

To provide further safety, the lights are operated from three separate circuits and some of the lights in each corridor and at other emergency points, are lighted from each of these circuits, so that even if trouble developed on two circuits at the same time, no important part of the hotel would be plunged into darkness.

The guest is constantly meeting novel applications of electricity. When he enters his attractive bathroom, the first thing he notices is a faucet, labelled "ice water," which is supplied by an electric pump in the basement. Should he order his breakfast served in his room, he receives it in a surprisingly short time, and the secret of this rapid service is the electric breakfast kitchen located on every one of the guest floors. These kitchens are equipped with electric coffee percolators, stoves, toasters, egg boilers and other cooking utensils. Each one also has a "cold box," or refrigerator, set in the wall and kept cold by refrigerated brine circulated by an electric pump.



Motor-driven Hashing Machine

He may, perhaps, notice that the air in the restaurants and other concourse rooms is fresh and pure in spite of the many people and the smoke from hundreds of cigarettes and cigars. This is due to the fact that air from these rooms is drawn in from the outside by electric ventilating fans, forced through cheesecloth filters, washed in running water and heated in winter and cooled in summer, while the foul air is drawn out by exhaust fans. Each of the 2,200 bathrooms is also ventilated by exhaust. Twenty-seven Westinghouse motors, specially selected because of their silent operation, operate these fans, and 800 tons of sheet metal were required for the ventilating ducts.

Everything is neat and clean, because two twenty-horse power motors drive vacuum cleaners that draw dust and dirt from 487 openings and carry it through a total of three miles of pipe to dust receptacles in the cellar.

A trip through the kitchen and other service departments brings to light many other interesting tasks performed by electricity. Here are electrical grills and

Motor-driven Potato Pealer

ovens; there, electrical potato pealers, meat choppers, cake mixers and dishwashers. There is also an electric machine that cuts ice into cubes for the water glasses, crushes it for iced drinks and "snows" it for cooling bottles, etc. The laundry, which is one of the largest private laundries in the country, is electrically operated throughout.

Perhaps the most unique electrical machine is the one that reproduces writing and is used to convey instructions throughout the hotel. These machines can be seen in operation at various points, and to watch the pen of one of them busily spelling out a message in the handwriting of someone perhaps twenty floors below, is fascinating and almost uncanny.

One of the inconspicuous, but very modern, features of the electrical equipment is the switch panels for controlling the lighting circuits on the various floors. These panels differ from the ordinary type in that it is impossible for anyone operating the switches to come in contact with live parts. Hence they are absolutely safe and cannot cause injury to the operator. The fuses and connections are locked in a separate compartment and are accessible only to authorized electricians.

Head of Big Plant Endorses Industrial Training

The superintendent of one of the country's large manufacturing plants has given emphatic testimony regarding the benefits of industrial training, in a recent bulletin issued by the U. S. Training Service of the Department of Labor. The pamphlet is entitled "A Business Man's Experience With Industrial Training," and E. A. Barnes, superintendent of the General Electric plant at Fort Wayne, Ind., is the author. Mr. Barnes believes that industrial training as promoted by the Training Service should be generally adopted in American industries.

"In too many cases," he says, "the old system of letting shop foremen hire men without much consideration for the applicant's ability or training is still in effect, with the result that many new employees spoil work, ruin expensive machinery and tools and really produce little work that is perfect enough to be shipped."

After reviewing the benefits which came from establishing training in his plant to meet the war emergency, Mr. Barnes goes on to tell of his conversion to the permanent value of training. He found that his foremen were especially anxious to secure the workers who had been through the training department, which fact of itself was strong endorsement of the idea. Experience with what was first considered a temporary feature led to making it permanent. To this training department all new employees are sent and also old employees who from lack of proper training are not doing as well as they might. Mr. Barnes lays special emphasis on the fact that training gives employees a better opportunity to advance and so appeals to the ambition which is to be found in the majority of workers.

Building Activities in New York Cities

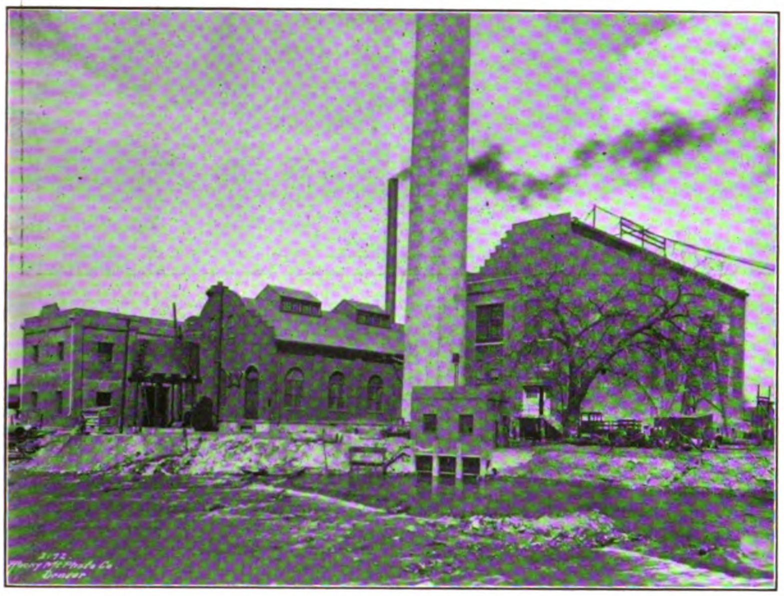
According to reports made to the New York State Labor Bureau, the estimated expenditures for building construction in March amounted to $12,255,241. This is an increase of 36 per cent. over a similar figure for February and shows a gain of 117 per cent. over January. Every city contributed to this gain except Troy, where the decline was 3 per cent. Compared with March, 1918, the advance was 91 per cent. Estimated building costs reported for March, 1918, 1917 and 1916 were, respectively, 6, 16 and 20 million dollars. All boroughs except the Bronx and all cities except Yonkers authorized larger building expenditures in March, 1919, than in March, 1918. Every borough except Manhattan and Richmond and all cities except Troy reported larger prospective expenditures in March, 1919, than in the preceding month.

New Electric Generating Station at Denver

By T. O. Kennedy and H. H. Kerr

THE new Lacombe plant of the Denver Gas & Electric Light Company embodies so many new features that a brief description will, perhaps, be of interest, say T. O. Kennedy and H. H. Kerr, of the Denver Gas & Electric Company, in an article written for the "Doherty News."

In 1917 the Denver Company had 13,000 K. W. in steam generating capacity distributed in two stations among four turbine and four engine units. About 12,000 K. W. was available from two hydro-electric plants located in the mountains.



Lacombe Station, Denver, Colo.

The rapid growth of the Company's business together with the increased efficiency that could be obtained by concentrating the steam generating capacity in large units in one centrally located plant, led to the decision to build the new station that has just been completed.

The site chosen adjoins the old Lacombe station on the South Platte river and is an ideal location, being practically in the center of load distribution. The only new buildings necessary were a boiler room and a transformer house since there was ample space available in the existing engine room for the turbine and condenser equipment. Railroad facilities connecting the new plant to the Denver and Inter-Mountain and the Colorado and Southern Railroads were easily obtained and insure adequate service for coal supply and ash removal.

Stream flow records on the river cover a period of five years and indicate sufficient condensing water for 30,000 K. W. plant capacity. The river water is not suitable for boiler feed purposes without treatment and two artesian wells were put down to provide boiler water. One of these wells is pumped by an air lift, the other by means of a motor driven deep well pump. Both wells discharge into an overhead storage tank 20 feet in diameter and 10 feet high.

The boiler room is a concrete, steel and brick building 58 feet by 158 feet having a 13 foot basement and 45 feet headroom above the firing floor. The building is roofed with large gypsum slabs covered with tar paper and gravel. The north and west walls were made permanent of brick and the south and east walls are of temporary construction, being hi-rib steel plastered with a cement gun. This will facilitate future extension to accommodate additional boilers up to a total of eighteen 750 H. P. units set singly.

Four 750 H.P. Connelly four drum water tube boilers were installed. Each boiler is set singly and covers a floor space of 20 feet. A 15 foot aisle is allowed between adjacent boilers. Working steam pressure is 275 pounds and it is expected the boilers will operate normally at 200 per cent of rating, being crowded up to 300 per cent on peak loads. The boilers have been set very high and the furnaces are lined with carborundum brick in order to increase the life of the settings and to eliminate clinker trouble. A four-inch thickness of insulating brick in the boiler walls practically eliminates radiation losses. Recording thermometers, draft gauges, steam flow meters and Bailey boiler meters are provided to enable the operators to obtain the most efficient results.

The boilers are fired by Westinghouse underfeed stokers, nine retorts per boiler. Foster superheaters provide 200° F. superheat which brings the total temperature of the steam up to about 650° F.

Vulcan soot cleaners for operation with superheated steam were installed for keeping the heating surfaces of the boilers free from soot and dust accumulations.

The four stokers are chain driven by either of two Westinghouse trunk piston engines. Forced draft is provided by two Buffalo blowers; each driven, through gearing, by a Westinghouse turbine.

Two Green economizers were installed, each one taking the heat from the flue gases of two boilers and transferring it to the boiler feed water. These economizers are located on a balcony back of the boilers.

Fifteen feet headroom is allowed above the boilers and economizers, and this, combined with the fact that a large overhead monitor and sash and large windows were provided, insures planty of light and ventilation.

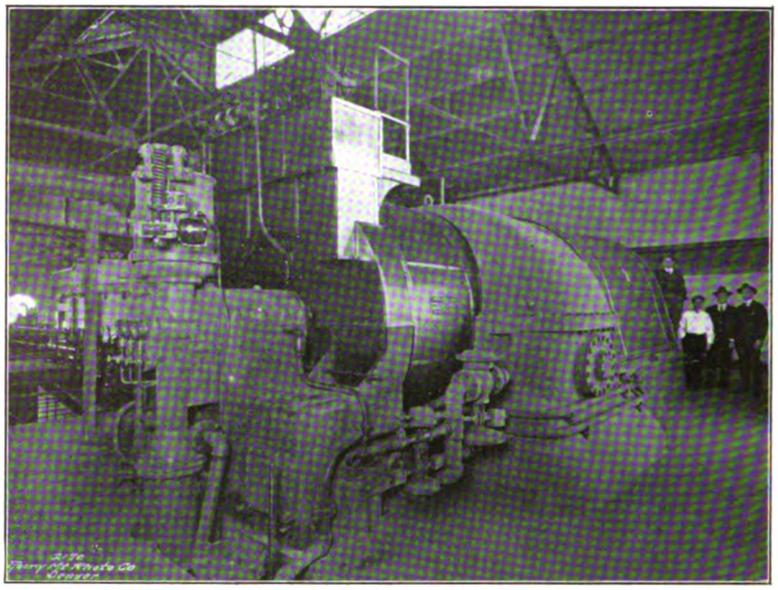
The space under the economizer balcony is utilized for flue passages with the exception of one section which is fitted up as a locker room where shower baths, steel lockers and other facilities are provided for the station operators.

A 300 feet by 12 feet reinforced concrete stack was erected which will provide sufficient draft to carry normal load through the economizers. The base of the stack for a height of ten feet is used for storage of hot water for boiler feed.

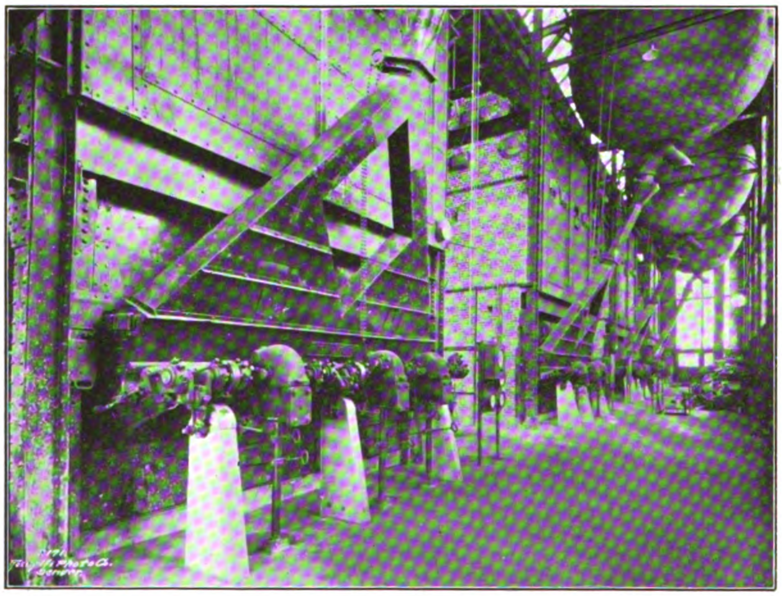
The boiler feed water is handled by three units each consisting of two Manistee four stage centrifugal pumps directly connected to a 95 H.P. steam turbine. Each unit has a capacity of 300 gallons per minute and is so arranged that the first pump forces the water through the economizers and the second pumps from economizer to boilers. The total head pumped against is 410 feet.

A discarded surface condenser is utilized as a feed water heater, the hot water then passing into the hot well in the base of the concrete stack from which the pump suction is supplied. The water is metered by a Bailey fluid meter.

For unloading and storing coal a stiff-leg jib crane was installed. The boom swings over a 160-inch diameter circle and a traveling grab bucket allows coal to be piled 20 feet deep over the entire area. The crane is operated by a motor driven hoist, and is so set that an underwater storage pit can be excavated at any future time without interfering with the crane foundations.



12,500 K.W. Turbine, Lacombe Station, Denver, Colo.



Main Aisle, Boiler Room, Lacombe Station

A track hopper has been provided for dumping hopper bottom cars. This hopper can also be served by the crane. A Jeffrey single roll coal crusher is installed under the track hopper and feeds an inclined belt conveyor which delivers the crushed coal through a tunnel to the basement of the boiler room where a bucket elevator raises it to a scraper conveyor near the roof. This scraper conveyor delivers the coal to any one of four bunkers above the firing aisle.

Each of the four overhead bunkers has a capacity of 70 tons and will ultimately supply two boilers, one on either side of the firing aisle. Coal to each boiler is measured through a volumetric meter installed in the down spout. The construction of these bunkers is unique, consisting of steel reinforced bars and expanded metal supported from the building columns and concreted with a cement gun.

A concrete ash pit is provided under each boiler with arrangement for quenching. Each of these pits discharge through three dumping gates into a sluice directly under the pits. Large clinker is broken over a grizzley and all refuse is sluiced into an outside pit within reach of the crane, by means of which it is loaded on railroad cars for disposal. River water for the sluice is provided by a motor-driven centrifugal pump.

All steam and hot water piping is well insulated and welded joints were used wherever possible on high pressure lines.

A 12,500 K. W. 4,000 volt General Electric turbo-generator was installed and under the excellent operating conditions as regards steam pressure, superheat and vacuum it will carry 15,000 K. W. at a very low steam rate. A 100 K. W. General Electric turbine driven exciter provides excitation for the new unit.

The condensing equipment consists of a twin No. 19 Westinghouse Le Blanc jet condenser installed immediately underneath the turbine which is supported on a reinforced concrete foundation. The auxiliaries of each condenser are driven by geared turbines and in addition one condenser has its auxiliaries directly connected to an induction motor.

An intake and screen house was built on the river bank in which is installed two stationary and one revolving, self-cleaning screen. From this screen house the condensing water flows through a concrete tunnel into an open settling basin in the basement of the boiler house. This settling basin is 18 feet wide and extends the full length of the boiler room, the side walls are brought up sufficiently high to prevent overflowing during floods in the river.

The various condensers in the engine room take water from this settling basin through cast iron pipes and all discharge into a common wood stave pipe which enters the river about 100 feet below the intake. By means of a tile line connecting with this wood stave pipe a small amount of hot water may be discharged above the intake in the winter time to prevent the clogging of the screens by ice.

Since the main distributing switchboard is at the West Station, it was necessary to provide a heavy tie line between the two stations which are about one-half mile apart.

A 4.000 volt 8,000 K. W. line was already up and arrangements were made for a 13.200 volt 8.000 K. W. line to handle the additional load. This necessitated the construction of a high tension switching and transformer house. This house is of brick 42 feet by 54 feet and two stories in height. Four banks of transformers can be located on the first floor and all circuit breakers, lighting arresters and switches are on the second floor. Several high tension suburban feeders and the connections to the hydro-electric transmission lines are taken care of in this switch house in addition to the West Station tie lines.

The need for the additional capacity provided by this new plant has been demonstrated by the fact that the electric output of the Company for the first three months of 1919 exceeded the output for the same period last year by over thirty per cent.

Build Now for Present Prices Will Remain

In the opinion of the Minneapolis *Daily News*— "Judging by history and by sound economic theory, it will be a generation before prices get back to pre-war levels, if they ever do." In an editorial regarding present-day prices the *News* recently said:

"Cold, hard facts are only one of the features in the 'Own your own home' campaign. There's the very important matter of sentiment to be considered. But the cold facts gathered by the Government say 'go ahead.'

"Up to the first of the year farm produce prices had advanced 116 per cent. over pre-war prices. The corresponding figure for lumber was 73 per cent.

"Commodities in general advanced 113 per cent. Building materials (not including steel) advanced 84 per cent.

"These are the facts. An advance of 73 per cent. or 84 per cent. looks pretty big right now. But whether we like it or not, we must realize that we have come to a new level of prices. Judging by history and by sound economic theory, it will be a generation before prices get back to pre-war levels, if they ever do.

"Probably there will be a gradual decline, but meantime there will be an evening up. Prices which have gone up fastest and highest will come down first and most. Prices which have made the smallest comparative advance are apt to stay put until other prices come down to their level. This last applies to the building materials.

"There's no sense in waiting."

Water Power Development in New South Wales

In the State of New South Wales there is under consideration a scheme of hydroelectric development of the Nymboida River, writes Consul General J. I. Brittain, Sydney. It is estimated that the cost would be about $175,000, and would comprise in part alterations to tunnel inlet works on the river, the installation of two 800-kilowatt generators, a transmission line of 23 miles, and a distribution system in the towns of Grafton and South Grafton. It is the purpose to furnish power to farmers along the way for small engines as well as to the towns of Grafton and South Grafton.

When the great Burrenjack Dam, in connection with the Murrumbidgee irrigation scheme, was under construction the possibilities for hydroelectric development were also considered. Apart from the large volume of water drawn from the reservoir for irrigation purposes, a small continuous supply will be released for domestic. stock, and riparian requirements. By this release there will be always available from the reservoir the equivalent of 165 cubic feet of water per second discharged under a head of 100 feet. This is equivalent to approximately 1,400 kilowatts at the dam, or, converted into electricity and transmitted to a distance of 100 miles, 938 kilowatts, or 8,217,000 electric units per annum. The power thus generated could be utilized by about six or eight towns within a radius of 100 miles of the dam.

Prices Reaching a Permanent Higher Level

Irving Fisher, professor of political economy at Yale University, says: "The fundamental practical question confronting business men is whether the general level of prices is going to fall. In my opinion, it is not going to fall much, if at all. We are on a permanently higher price level and the sooner the business men of the country take this view and adjust themselves to it, the sooner will they save themselves and the nation from the misfortune which will come, if we persist in our present false hopes

Electric Light Association Convention

THE forty-second convention of the National Electric Light Association, held at Atlantic City the past month, gave proof, if any were needed, that the electrical industry is fully alive to the possibilities in store in the great work of reconstruction and readjustment that must follow the war. There was an attendance in excess of 2,000 and the greatest optimism as to the future was manifested by all. The papers and discussions covered a broad range of topics, dealing not alone with matters pertaining directly to the electrical industry, but also with those social topics that must concern every gathering of thoughtful men. During the past two years, when the activities of the association were directed solely to the winning of the war, the immediate problems stood in the way of a full consideration of future policies and prospects. As a result of this meeting it is found that there is a necessity for greater sectionalization of the work now done by the central office, and it is expected that a great many more members will become affiliated with the national organization through the various geographic sections.

The convention was called to order by President W. F. Wells. Owing to illness, the secretary, Thomas Commerford Martin, was unable to be present, and S. A. Sewall, acting secretary of the association, presented the report showing the varied activities at the association headquarters. The general and special sessions were all largely attended, and the discussions proved lively and interesting. The following officers were elected:

President—R. H. Ballard, vice-president and general manager of Southern California Edison Co., Los Angeles, Cal.

First vice-president—Martin J. Insull, Middle West Utilities Co., Chicago, Ill.

Second vice-president—M. R. Bump, Henry L. Doherty & Co., New York City.

Third vice-president—Frank W. Smith, United Electric Light & Power Co., New York City.

Fourth vice-president—Walter H. Johnson, Philadelphia Electric Co., Philadelphia, Pa.

Treasurer—H. C. Abell, American Light & Traction Co., New York City.

Executive Committee (for three years)—W. H. Atkins, Boston, Mass.; P. G. Gossler, New York City; D. H. McDougall, Toronto, Ont.; and (for two years) R. J. McClelland, New York City.

In the "Public Policy" session, W. H. Hodge, of H. M. Byllesby & Co., Chicago, chairman of the Committee on Sale of Company Securities to Customers and Resident Citizens, was unable to be present, but his report was presented. It declared that "Since 1913 upwards of fifty and possibly one hundred or more, central station companies have sought to interest their customers and other citizens of the communities which they serve in their interest and dividend-bearing securities. Some of these companies are very large ones, serving under a single organization hundreds of cities and towns of various sizes. Others serve great American cities, and a number are small organizations requiring an inflow of new capital only once or twice in a decade. Forty-eight of these large and small companies during the past few years have marketed locally among a multitude of people: $27,134,057, of Preferred Stock; $3,862,500, of Common Stock; $2,294,000, of Bonds; $6,724,600, of Short Term Notes; Total, $40,015,157, of central station securities.

"From an estimate, based upon incomplete figures, these securities were distributed among 36,000 individuals or an average purchase of about $1,100 par value, and it is safe to say that 90 per cent of these investors had never before owned a stock or bond of a public utility company.

"The figures just given, as before indicated, are by no means complete. A full showing probably would expand them by 50 per cent.

"Customer ownership occupies the middle ground between private ownership and operation as we have known it in the past, and public ownership and operation—that is, by the municipality or the state. It represents an effort to combine generally beneficial features of each and to broaden and extend these benefits rather than to contract them. Holding fast to the principle of individual property ownership as opposed to communism, it seeks to have many people in a given community own in their individual right fractional parts of their utility companies, thereby sharing in the profits, if profits accrue. At the same time it seeks to preserve the initiative, the resourcefulness, the economy and the efficiency of private enterprise. It represents one of those economic compromises which seem to be necessary from time to time in the progress of civilization, which at first inspection seem revolutionary, but which soon become the accepted order."

Mr. F. G. R. Gordon, of Haverhill, Mass., read a paper on "The Trend of Socialism." After citing the many failures of socialist colonies in many parts of the world, Mr. Gordon took up the socialization of business enterprises. He said that governments require two men and two dollars to secure the same results that private ownership accomplishes with one. Every government operates industry with waste, inefficiency and lack of progress. Every nation in Europe owns and operates the wire systems. The wages before the war averaged $2.68 a week in Belgium to $5.80 a week in Switzerland. The service is rotten. A large majority of the telephone users have no service after 10 o'clock at night or on holidays and Sundays, yet, before the war you would have had to pay a little over

$77 for a telephone in your house in Paris. Chicago has more telephones than all of France and 90 per cent of the American telephone service is cheaper than the European rate. although the wages are three or four times the wages of the government-operated lines of Europe.

Director George Otis Smith, of the United States Geological Survey, read a paper on "Planning for Power." Electric power from central-station plants was highly endorsed by Dr. Smith for both industrial power and railway service. He stated, however, that he did not believe the electrical industry as efficient as it should be, as it is not uncommon to find many individual, inefficient and frequently obsolete power plants supplying isolated communities. He recommended the establishment of large, modern and efficient power stations to be connected to those now in existence and the development of water power to supplement this supply.

In order to accomplish this much desired end, the Government and the power companies must work together and, in this connection, Secretary of the Interior Lane has already asked for an appropriation from Congress in order to conduct a power survey of the entire country and more detailed surveys in the congested manufacturing areas, as in the Boston-Washington district. In this latter area about one-fourth of the total power generating capacity of the country is installed and the control stations in this district consume annually in excess of ten million tons of coal.

Referring again to the urgent need for the development of water power, Dr. Smith pointed out its importance in relation to the conservation of labor. A report of the Alabama Power Co. was cited showing that 84 men are used in a steam plant as compared to one in a hydroelectric plant. To further emphasize the importance of steam-railway electrification, Dr. Smith pointed out that one ton of coal burned in a central-station plant supplying energy to a railroad is equivalent to four tons burned in a steam locomotive.

Rodney K. Merrick, Commercial Truck Company, Philadelphia, read a paper on "Present and Future Status of the Electric Vehicle." In Mr. Merrick's opinion, the outlook for the electric truck has never been brighter than at the present time. This is shown by the changing attitude of the public towards these trucks at the recent motor-truck shows. At former shows the general truck-buying public was distinctly hostile to electrics but at the recent ones showed a remarkable interest in them. This change of attitude is due to a number of reasons. In the first place a large number of fleets of trucks now in use have proven very satisfactory and there is a vast improvement in the electric truck of the present time as compared with its predecessor of eight or ten years ago. In addition many large users have learned that the added speed of the gasoline truck is not as great an advantage as they formerly supposed. The prevailing high cost of labor has also forced many firms to consider the electric to replace the horse in order that they may get more work out of the men by giving them better tools with which to work. Another reason is that large concerns having solved their long delivery problems by using gasoline trucks are now turning their attention to city hauling and for this purpose the electric offers many advantages.

Regarding central-station co-operation Mr. Merrick believes that this can be accomplished by giving good service as well as low rates to the users of electrice trucks. He pointed out the advantage of delivering the proper current, 110 or 220-volt direct current, to the customer without additional investment on his part by supplying converting apparatus for the customer's use in alternating-current districts. If this equipment could be furnished either by the central-station or the manufacturer it would aid considerably.

The technical, hydroelectric, electrical vehicle accounting and commercial sessions brought out much live discussion and will give the members food for thought for months to come. The exhibit of electrical devices and appliances was large and varied, exceeding that at any previous convention. There were about 80 exhibitors in all.

Evolution of Mail Delivery System in a Large Manufacturing Plant

Think of collecting 20,000 pieces of first class mail from hundreds of mail baskets distributed over several floors of a manufacturing plant that is nearly a mile in length! Add a more difficult proposition, and that is the collection of third class mail—bulky, heavy, and cumbersome. This is only a detail for a distributing department when this work is compared with the interdepartment mail collection and delivery of every piece of mail from a note to a roll of valuable blue prints. The Westinghouse Electric & Manufacturing Company's Works at East Pittsburgh has dealt with this problem in an interesting manner, from time to time, as their force has expanded from 200 employees to 16,000, and their works over a floor space of 91 acres. It is hard to visualize the size of the job. If the first class letters sent out daily were put end to end, so that the addresses could be read easily for sorting, they would reach over two miles. This is only one branch of the mail. The quantity of mail handled has converted the little third class office of East Pittsburgh into a first class office doing a yearly business of over a quarter of a million dollars. This office handled just recently 75,000 pieces of third class mail from the publicity department alone. When one catches a vision of the details of such system, the story of its development becomes interesting.

For several years mail delivery boys were used, until the mail-boy organization became a problem in itself. One boy cannot carry any quantity of mail on a trip, and collect outgoing mail at the same time, especially if his trip takes him to a point three-quarters of a mile from the central office. A person can just nicely walk that distance on a pavement in 15 minutes.

During the year of 1916 and 1917, considerable saving was affected by a change from the boy-delivery system to the use of a storage-battery truck. The truck was equipped in a manner similar to a railway mail car and furnished the same kind of service; as one man on the truck sorted the mail received, while the truck was making its trip. The truck was very successful in handling heavy and bulky mail but had a questionable efficiency for the smaller sized mail. Two of these trucks were used. However, a more effective method has been evolved since for lighter mail. The principle objection to carrying all of the mail by trucks was the difficulty experienced in getting through the shop-aisles, and as the work became more congested due to war work crowded aisles delayed the mail service.

The pneumatic tube system similar to that installed in any large business organization now handles the small first class mail and interdepartment mail, but a year ago the collection and distribution of such mail as magazines, circulars, packages, blue-prints, etc., pieces too large for the tubes and hardly large enough for truck service—was still a problem.

Then a rather novel but inefficient scheme was used to deliver the local house-organ. Boys were supplied with roller-skates. Often the floors were greasy and there was danger of accident, and again, boys will be boys, especially on roller-skates—so this test proved its inefficiency for general use.

Early in 1918 some one, thinking of a system used for delivering merchandise, suggested a light tricycle which would support a mail box. Nothing that answered the requirements was on the market; so one was especially designed and built.

This tricycle is narrower and lighter than the truck, thus making it easier to handle in a crowded aisle. It is considerably cheaper, as eight tricycles can be bought for the price of one truck. Only one person is required to operate it. A tricycle carries three times as much mail as a boy and makes the trip in less than half of the time. At present there are four in use besides one which is kept for emergency.

The tricycle weighs 150 pounds and is of regular bicycle construction with the addition of a sheet metal box. The box contains 22 small and 3 large compartments, each marked with a metal label. The lower portion is divided into two large compartments for packages and long rolls of blue-prints.

The shortest complete trip made by any tricycle is .09 miles and the longest 2.1 miles. Two tricycles in the service make ten trips a day; and two, eight trips. In a year all of these vehicles travel approximately 14,295 miles.

The opening of the year of 1919 brought a pleasing feature into the mail service and that was the use of attractive uniformed girls on the tricycles. The tricycles are light and easy to pedal and the work because of this system was so easy that the girls are taking to it readily. The tricycles were also improved by the addition of steel spoke guards.

Odd Ways of Starting Gas Engines

Not every motorist, as he presses his starter pedal, stops to think how fortunate he is that the process of cranking the engine has been so simplified for him. Electric starters were developed because the old method of cranking by hand proved intolerable to the exacting American motorist. Yet, hand starting of an automobile engine is child's play compared with the methods necessary to start some other types of engines.

When a tractioneer starts the engine of his big caterpillar, he fits a bar into one of a series of sockets in the big engine's flywheel and rocks the engine up to compression. No one can spin these monsters. Rarely can they be rocked past compression, but are usually rocked backward up to compression, where, thanks to generous priming and a hot spark, they usually fire and the wielder of the pinch-bar pulls it from the darting socket hastily.

The petty officer on a submarine chaser relies upon compressed air to start his unwieldy engines. He, too, must prime copiously and has the additional responsibility of an auxiliary engine, hand-started to pump the air.

A most picturesque but risky method is ordinarily used to start airplane engines. The mechanic shouts "Off!" as he approaches the propeller and is answered in kind by the pilot at the switch. He then spines the great wooden blades by hand to charge the cylinders with gas. Having worked up a warm perspiration, even on the frostiest mornings, he springs clear and shouts "Contact!" The pilot indicates that he has closed the switch by repeating the signal and the mechanic once more approaches the propeller. Gingerly this time, however. With a single swift motion he twirls the blade through an arc of more than 90 degrees and steps quickly away from and to the side of the murderous whirling stick.

A 150-horsepower engine is about all any but a Samson can swing. When heavier engines, culminating in the 400-horsepower Liberty, made their appearance, new methods had to be devised. At first, the blade was pulled over compression, by running past it, giving it a smart pull in passing. Sometimes two men with hands joined were required. As many as three were required to do the preliminary "winding up" or charging. More than one unwary mechanic was sucked into the whirling circle of the propeller and cut to bits before a safer method was devised.

Owing to their weight and complication, electric starters were not considered seriously, but an ingenious auxiliary magneto was contrived by the Spitdorf Electrical Company of Newark, N. J. This magneto was operated by a small hand crank in the pilot's cockpit. The engine was charged in the usual way, whereupon the mechanic stepped back, shouting "Clear!" The pilot then closed the switch and turned the crank of the starting magneto a few times. The supercharged cylinders received a shower of white-hot sparks and a failure to start at a lively clip was exceptional. With the Dixie starting magneto a lone pilot might start a 400-horsepower engine unaided, a thing previously impossible.

The same company has greatly simplified the starting of big truck and tractor engines by applying the impulse starter to the regular Dixie magneto. This contrivance comprises a coupling which with the engine idle is not solid. When the engine is cranked, the first motion merely compresses a spring, with the magneto stationary. At a predetermined point, a trigger is tripped and the magneto twirls around at high speed for part of a revolution. This naturally generates a hot starting spark, even though the engine may be turned over very slowly. Two or three snaps of this sort generally suffice to start the engine and no battery or coil is required. When it starts running, centrifugal force acting on weights locks the coupling solid, so that it drives as ordinarily.

New Cable Route to South America

Arrangements for direct cable service between the United States and Brazil, and thence along the entire eastern coast of South America, have been entered into between the Western Union Telegraph Company and the Western Telegraph Company of Great Britain.

The laying of 3,200 miles of new cable, which may be accomplished within six months, will connect Miami, Fla., with Belem, Brazil, by way of Barbados, the termini of the new line meeting the Western Union system at Miami and the coastal cables of the British company extending from Belem to Rio Janeiro, Buenos Aires, and the principal cities of South America's eastern seaboard.

Though the contract between the Western Union and the Western Telegraph for mutual operation of the new service has not yet been signed, Newcomb Carlton, president of the American Company, said he believed it would be consummated in the near future. The Western Union, he added, already had an option on materials required for its part of the construction undertaking, from Miami to Barbados, the British concern having arranged to extend its South American lines from Belem to Barbados.

Mr. Carlton said it had been decided to route the Western Union link in the intercontinental cable direct from Florida to Barbados instead of utilizing the present line to Cuba in order to provide service without relay between the two Americas.

Completion of the new line, he stated, not only would bring the United States in wire contact with eastern South America, but, by utilizing overland and cable routes already in operation, would provide communication also with the western South American coast cities.

While the Western Union has a concession from the Brazilian Government, permitting laying of a cable from Rio Janeiro along the eastern and northern coast line, Mr. Carlton declared the arrangement with the British cable owners, which would guarantee non-discriminatory service to Americans, offered a prompter and more economical means of instituting the North and South American connection. He said no decision had been reached as to disposition of the concession.

French Commission Inspect Electric Plant

The officially approved French Commission, consisting of a group of engineers, railway operators and Government officials, arrived in Pittsburgh from Altoona, Pennsylvania, to visit and familiarize themselves with the operation and manufacture of electric railway equipments.

They spent several days in Pittsburgh, inspecting electric locomotives at the Westinghouse Electric & Manufacturing Company plant, East Pittsburgh, Pennsylvania. The locomotives in course of construction are being built for the New York, New Haven, and Hartford Railroad Company, and will be operated on the New York connecting railway across the Hell Gate Bridge, connecting the New York, New Haven and Hartford Railroad and the Pennsylvania Railroad. They also saw one of the ten new passenger engines which are being built for the Chicago, Milwaukee and St. Paul Railroad. These will be the most powerful locomotives running in passenger service, any one of the ten locomotives having a capacity sufficient to haul 950 tons (12 steel cars) over the entire mountain section at the same speed as called for by the present schedule.

In addition to inspecting locomotives, the delegation also made an inspection trip of the entire Westinghouse plant at East Pittsburgh.

Members of the group are as follows:

Chairman, Professor Mauduit, Professor of Electrical Engineering, Nancy University; Major D'Anglards, Official Representative, Minister of Public Works; Messrs. Parodi, Chief Electrical Engineer, and Sabouret, Assistant Manager, Paris-Orleans Railway; Messrs. Japiot, Chief Mechanical Engineer, and Ferrand, Electrical Engineer, Paris, Lyons and Mediterrean Railway; Messrs. Debray and Barilliot, Electrical Engineers French State Railway; Messrs Bachellery, Assistant Manager, and Leboucher, Assistant Motive Power Superintendent, Midi Railway, and M. Balling, Chief Engineer, Paris-Orleans Railway.

The Commission were the guests of Mr. E. M. Herr, President of the Westinghouse Electric & Manufacturing Company, during their stay in Pittsburgh.

A Novel City Substation

By Roy R. Kime

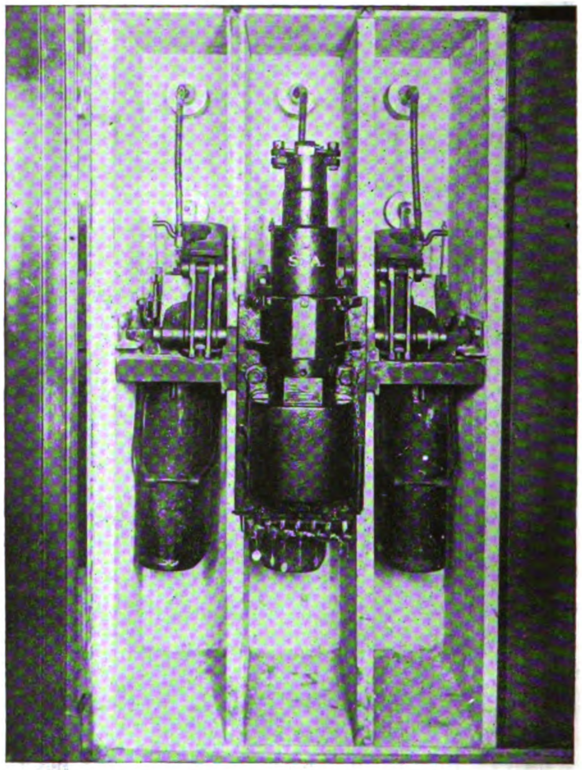
As a general rule substations are located in out-of-the-way places where few restrictions hamper their design. Of special interest, therefore, is the new 45th Street substation of the United Electric Light and Power Co., New York, because of the unusual conditions which had to be met in its construction and arrangement. This substation serves the area between 27th and 82nd Streets, and the Hudson and East Rivers, a district that is thoroughly built up and inhabited by hundreds of thousands of people. In order to place it near the center of load, it was necessary to select a site among residences where real estate values are very high and where quiet operation and freedom from vibration are essential.

On approaching the station one is immediately struck by two peculiarities, both of which are due to the exigencies of its situation. One is the narrowness of the structure and the other the space that has been left between each side wall and the adjoining building. The building is narrow because it is confined to a plot intended for a single moderate-sized dwelling. The dimensions of the floor plan are 24x100 feet, which is a very cramped space for a building that will ultimately contain 12,500 k. v. a. of electrical apparatus. Yet as

Oil Circuit-breaker Aisle

can be seen from the illustrations of the interior, though compactly constructed, is in no sense crowded. Careful designing and the utilization of every single cubic inch of space were, however, required to obtain this result. The floors and walls consist in reality mainly of cables, conduits and pull boxes; and some of the apparatus installed had to be specially designed in order to take up a minimum amount of room. The capacity is ten kilowatts per cubic foot, which is about double the usual concentration.

The space between the walls of the station and the adjoining houses is one of several precautions that have been taken to avoid disturbing the neighbors with noise and vibration. It was decided that an air space would be preferable to the use of deadening material, to retain the noise within the building; and in order to guard against contact at any point, aprons were



Detail View of Modified Type E Circuit-breaker

carried along as the brick work progressed, which established the proper distance between the walls and kept out pieces of brick, mortar and other material that might have fallen down the openings.

Every effort was also made to eliminate noise at its source. All rotating apparatus was arranged to operate as quietly as possible, and in addition, sound insulators, consisting of alternate layers of cork and sheet iron, were placed under the transformers, induction regulators and synchronous condenser. The condenser, being the machine most likely to cause disturbances, was mounted on a foundation that extends to bed rock and is in no way connected with the rest of the building, thus preventing the vibrations of this machine from being transmitted to and magnified by the steel frame work.

As an illustration of what the company had to contend with, it may be mentioned that when the station was first placed in operation, before all the refinements were perfected, the neighbors on both sides promptly threatened to move out. Since the completion of the work, however, no serious complaints have been received.

The building, which is 46 feet high above the sidewalk, has three floors and a basement. On the main floor are the switchboard and its operation desk, the main transformers, the induction feeder regulators, a synchronous condenser, and a motor-generator set. On the two upper floors are the oil circuit breakers with their accessories and the busbars. In the basement are vaults containing the connections for the apparatus on the main floor, the motor-driven blowers for ventilating the transformers and regulators and an air washer.

At present, the station has three 7,500-volt incoming feeders and ten 3,000-volt outgoing feeders, but is designed for an ultimate capacity of five incoming and twenty outgoing feeders. Arrangements have also been made to raise the incoming voltage to 15,000 in the future, and all high-tension apparatus is insulated for this higher voltage and all the transformers are provided with taps so that the change-over can be made with little trouble and with no additions to the present equipment.

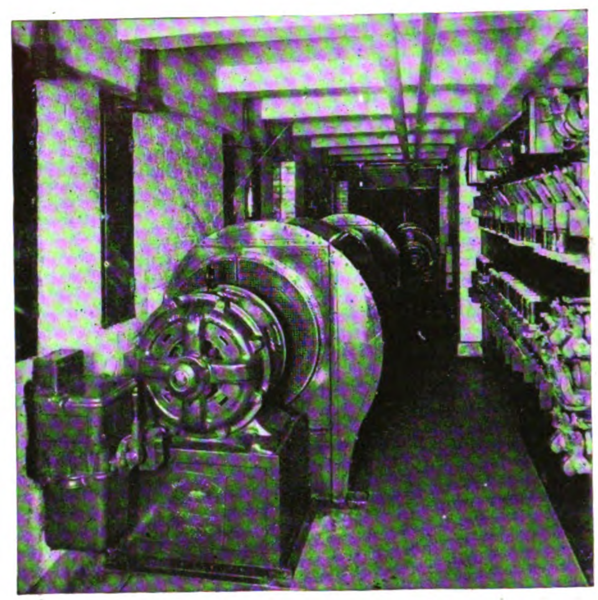
Compartment Below the Induction Regulators

The load is mainly residence and theatrical lighting, the maximum power being but one-third of the maximum lighting load. The power load is nearly constant throughout the day, while the lighting peak occurs at the close of the business day in winter and an hour or two later in the summer.

Continuity of operation under all imaginable conditions is the ideal on which the plan of the station was based. Each piece of apparatus is safeguarded as completely as possible; spares are provided for all vital devices; any desired combinations of incoming high-tension and outgoing low-tension circuits can be obtained; and any piece of apparatus and any circuit can be cut out of service without interfering with the operation of the station.

Three-phase, 62.5 cycle current is transmitted from the United Company's 201st Street power house to the Waterside bus, from which tie feeders about 1.5 miles long run to the 45th Street station. These feeders terminate in separate manholes outside the station so that the burning out of one will not affect the others.

The feeders, in the form of 350,000 cir. mil., lead-covered cables, enter the basement of the station through tile ducts and run up the west wall in separate fiber conduits and to pull boxes in the wall of the second floor, where the lead sheaths end in pot-heads. From each pot-head a cambric and braided cable runs to a 600-ampere oil circuit-breaker with connecting switches on both sides.



Ventilating Blowers and Their Magnet Switch Starters

Each line now divides into two branches, which are ejuipped with a 600-ampere oil circuit-breaker with disconnecting switches in each branch. One branch runs to the high-tension side of a main transformer and the other to a common high-tension bus. Ordinarily each line from feeder to transformer is kept independent, but by means of the bus, any or all of the transformers can be supplied from the other feeders should one feeder be cut out, while, on the other hand, should any transformer be cut out, the other two can be supplied from all three feeders.

From the secondary of each transformer, a line provided with a 1,200-ampere circuit-breaker runs to each of two bus-bars, called No. 1 and No. 2 respectively. From each bus, a line runs to each outgoing feeder, the difference between these last two lines being that in the line from bus No. 1 there is an induction regulator, with a circuit-breaker on each side, while in the line from bus No. 2 there is a circuit-breaker only. Thus each feeder can be supplied either through a regulator or from a low-tension bus direct. A tie with a regulator connects the two buses, and provides means for regulating any feeder while repairs are being made to the regulator or circuit-breaker in the line from bus No. 1 to that feeder.

Both low-tension buses can be divided into sections, each connected with a transformer and with several outgoing feeders, so that any group consisting of a transformer and its outgoing feeders can be operated independently of the rest, or can be cut out if desired. The foregoing arrangement provides a very high degree of flexibility and permits the various elements to be grouped into a large number of different combinations.

The bus-bars, circuit breakers and their accessories are mounted in concrete compartments and are protected by light asbestos-board covers mounted in steel frames. The barriers between the circuit breakers are 3.5 inches thick and those between the disconnecting switches are two inches thick.

The circuit breakers for the incoming feeders are of standard Westinghouse construction, but the type E circuit breakers, for both the high-tension and the low-tension circuits have been modified according to designs by Mr. McCoy, of the United Company. The standard type E circuit breakers are made up of singlepole units, each with its own supporting frame and contact-operating mechanism. In the 45th Street station units, however, a special base has been provided which carries all the circuit breaker parts, and all closing levers are connected to a single shaft. When the circuit is in place, the only part that shows is the cast-iron casting of the operating mechanism, all live and moving parts being concealed behind covers.

There are at present three banks of T-connected air-blast transformers, but two more will be added when needed. Each bank consists of a 2,000 k. v. a. unit for lighting purposes and a 500 k. v. a. teaser for power. The primary winding of the teaser transformer is wound for 86.6 per cent. of the voltage of the main transformer, giving a standard three-phase T-connection. The teaser secondary is wound for 70.7 per cent. of the main transformer secondary voltage, giving 2,100 volts between phases and 3,000 volts between the two outside wires. The power load is supplied at 2,100 volts in the usual manner. The lighting load is obtained from the two outside wires at 3,000 volts, and is transformed through the main unit practically as a straight single-phase load. The connections between the transformer units are such that the teaser is in service only when two-phase power is being used. Two transformer banks are at present sufficient to handle the full load, so that the third is a spare.

All wiring enters the transformers from vaults in the basement below. This arrangment makes all connections easily accessible and adds greatly to the appearance to the main floor. Each transformer bank has its own ventilating blower, which starts automatically when the transformer is energized; but if any one of the blowers is out of service, air can be supplied to its transformer from the other blowers.

Eleven 85 k. v. a. air-cooled induction regulators are at present in operation, ten controlling outgoing feeders and one for use in the tie between the two low-tension buses, but ten more can be installed to meet future requirements. These regulators have a range of 10 per cent. above and 10 below normal voltage. Line-drop compensators are installed in connection with the regulators, which provide for a normal voltage of 2,750 volts across the outside lines of each feeder at the center of distribution. In order to conserve space, the operating mechanism on the top of the regulators has been so arranged that none of it projects beyond the case.

All the leads to the regulators run up from a compartment in the basement below. The regulator relays and the compensators are also mounted here. A large ventilating blower forces air into this compartment, from whence it passes out through the regulators.

To assist in correcting the power-factor and in stabilizing the voltage of the system, a 1,000 k. v. a. synchronous condenser is connected to low-tension bus No. 1. A second condenser will be added when the contemplated additions to the station are made. The condenser is provided with a special regulator which has two elements; a voltage element which responds quickly to voltage changes and prevents rapid variations of the bus voltage; and a current element, which operates to maintain an approximately constant current in the condenser, bringing the current very slowly back to normal with changes in voltage. The object of this combination is to correct quickly for sudden changes of voltage and to allow sufficient time for the feeder regulators to readjust themselves to any new voltage on the bus.

The condenser has a direct-connected 27.5-kw., 220-volt exciter, which also acts as a starting motor. Direct current for starting (and for other purposes, such as operating relays, switches, etc.) is supplied by a similar direct-current generator operated by an alternating-current motor. The exciter has twice the necessary capacity to serve the condenser so that when the second condenser is installed there will be available three direct-current machines, any two of which will be sufficient to excite the condensers and supply current for all other purposes, leaving the third as a spare. This is another example of the precautions taken to insure continuity of operation at this station.

All apparatus in the station is controlled from the switchboard. This board is semicircular and the control desk is located at the center of the circle formed by the board, so that all the points on the board are equidistant from the operator. All instruments, control switches, relays and other devices are mounted on the front of the board. In the rear are terminals and switches for testing the relays and instruments. Leads are carried from every voltage transformer in the station to a small panel on the control desk, so that readings can be taken on any instrument with a standard volt-meter.

Each circuit breaker control circuit is fused separately and all control and instrument wires are carried through the floor to the basement and connected to the control cables through terminal blocks so that every wire is easily accessible. Beginning at the left are the high-tension panels, the graphic meters, the voltage regulator for the synchronous condenser, the outgoing feeder panels with meters, circuit breaker control switches and relays and at the extreme right the house circuit panel.

Each incoming high-tension feeder is protected by a reverse-power relay and an overload relay, which causes the circuit-breaker to open under overloads of definite duration. Relays are also used to cut out the transformers in case of internal trouble and also to protect the outgoing feeders. Each outgoing feeder is provided with a polyphase indicating wattmeter, the energy being metered on the secondary side of the transformers.

Portable Electric Tools

The application of portable electric tools are many and various. Most people find, whether it be an electric tool or an automobile, a certain fascination in extraordinary uses for such things, and for that reason there is general interest in the Van Dorn Machine used for tightening screw bolts in a New York subway.

It is just 17 years ago—1902 to be exact—since the first portable electric drills were commercially used in this country. Since that time wonderful strides have been made in their development, with the result that the most modern iron and steel industries, to say nothing of other branches of industrial work, find them indispensable.

Like most every other innovation in commercial circles their arrival was looked upon with many misgivings, and criticisms of most profound impracticability were rampant, which, however, future developments quickly dispelled. Continual hard work, and diligent research, culminated in the elimination of previous shortcomings, and the development of larger sizes in electric tools opened up wider and broader fields of endeavor.

In actual tests it was by no means a difficult matter to demonstrate the enormous superiority of the electric drill over its predecessor, the pneumatic article. The latter in many cases could only be operated at a cost about five times greater than the electric; not taking into consideration at all the losses in transmission between these two kinds of power, the loss in transmission of compressed air being considerably greater than in the transmission of electric power.

Is it any wonder the electric machine earned a popularity of phenominal proportions? Even irrespective of the great saving in cold cash it rendered an immeasurably superior service to its fortunate possessor, and this latter is one of the predominating factors in business today.

The enormous possibilities of electrical equipment in the direction we speak of are so apparent as to prohibit criticism. The subway incident previously referred to is merely one of the many uses to which electric tools can satisfactorily be applied. With all our modern wonderful electrical advancement there is no question but that the entire field is merely in the embryo stage and developments of a revolutionary and astonishing nature can be anticipated, with equanimity on future electrical endeavors.

Selling Up, and Selling Down

By Sidney Neu, Editor of "Contact."

When you buy a tooth-brush at the drug store, the clerk is more than apt to suggest a tube of tooth paste. When you buy a collar at the haberdasher's, the clerk will suggest a new tie or shirt. The least that any store clerk, in a mercantile line, will do, is ask "Is there anything else?"

If you ask to see a two-dollar shirt it will be shown you, but the clerk won't stop there—he will bring out some three-dollar ones, and five times out of six you buy the more expensive one.

Processes such as these are called "selling-up." They require some tact and skill, but they result in increasing sales from 15 to 50 per cent. without increasing selling expense, and therefore, in some lines of business, double the profits.

But what would you think of a store-clerk who when you asked to see a three-dollar necktie suggested that you buy one for two-bits? If you went to buy a desk for your office and had picked out one you liked and the salesman suggested that you take another with half as many drawers and with rough splinters along the edge, saving $6.23, would your opinion for that store rise very high? It would not.

You never experienced the process of "selling-down," because "it isn't done"—except in the electrical business. And there it is done with a vengeance.

Mr. Ownahouse wants his house wired. He sends for John T. Wiringmain, a reputable contractor, to figure on the job. John T. figures a center outlet, a side outlet, and a snap switch outlet for every room in the house—he knows if he puts in any convenience outlets, the figure would be, oh, very much too high. Ownahouse gets the figures and whistles. "I didn't know," he says, "that it would cost so much."

Right there John T. gets nervous about the knees. Does he explain that the figure is reasonable, that he was even about to suggest additional floor outlets in the dining room for table appliances, extra outlets in the bedrooms for curling irons, warming pads, radiators and other conveniences, in the sewing room for a sew-motor and an iron, and in the bathroom for a radiator, and so on? Does he "sell up" as the cheapest clerk in a store would?

Not if he is the John T. Wiringmain that we have met. His first suggestion is that Mr. Ownahouse may be able to get along without side lights in the bedrooms. Then the center outlet in the kitchen goes. Next goes the bathroom switch. Finally the customer gets a job at about one-half the original figure, that isn't much of a job.

Next week Mr. Ownahouse buys a Toaster-Stove. If he could use it conveniently, he would add a percolator and a number of other appliances. His wife cannot use her iron without turning off her light. The result? One of two things—either Mr. Ownahouse gives up the use of electricity in disgust, using it only for light, or if he has abounding faith, he calls an electrician, not the reputable John T. Wiringmain, has the convenience outlets installed without reference to Underwriter's rules, and tries to be satisfied.

Who suffers when John T. skins down his figures? First of all, John T. suffers, because he has reduced the volume of his business and reduced the profits he ought to make.

Second, John T. suffers because Mr. Ownahouse blames him for not providing enough outlets.

Third, John T. suffers because he loses the possible sale of electrical appliances that would just fit the missing outlets.

Fourth, the customer suffers because he cannot avail himself of the electrical conveniences he should be able to use.

Fifth, the central station suffers because it loses the increased revenue without increased capital investment it ought to enjoy through Mr. Ownahouse's meter.

Sixth, the whole electrical industry suffers. It has received another black eye.

And who gains? Possibly the "disreputable" electrician.

Increase in Swiss Telephone Charges

According to Thurgauer Zeitung, the project of the Federal Council to increase the telephone rates provides that the annual charge shall be in proportion to the distance and to the number of subscribers. For a distance of 2 kilometers (1.24 miles) the cost will be 70 francs ($13.51) for less than 300 subscribers and 80 francs ($15.44) for 301 to 1,000 subscribers; for a distance of 3 kilometers (1.86 miles) the cost will be 100 francs ($19.30) for 1,000 to 5,000 customers. The rate for local conversations will be raised from 5 centimes (1 cent) to 10 centimes (2 cents). Rates for out-of-town conversations will also be raised. The increase of receipts which it is hoped will result from the new rates is estimated to be 9,000,000 francs ($1,737,000).

Badge of Honor for Service Flags

The following statement is issued by Grosvenor B. Clarkson, director of the United States Council of National Defense:

The War and Navy Departments having issued a citation to employers who give assurance that they will gladly take back their old employees who have served in the armed forces of the United States, it seems fitting that some symbol representing this attitude on their part should be placed upon the service flag.

The United States Council of National Defense, therefore, endorses the placing of the United States shield upon the red border, but no names of individuals or business firms shall appear anywhere upon the flag. Any employer who sends the required assurance to the War and Navy Departments through Colonel Arthur Woods, Chairman of the Council's Emergency Employment Committee for Soldiers and Sailors, Washington, D. C., can receive the citation, and as soon as the citation is received such employer is entitled to put the shield upon his flag.

The shield should appear upon the service flag in the following manner: If the service flag hangs downward, as in a window, the shield should be at the top; if the flag flies from a mast, the shield should be placed on the border nearest the mast. In both cases, the shield shall be right side up.

Loss on a Municipally Owned Car Line

The municipally owned street car line operating over the Tide Flats of Tacoma to the Todd shipbuilding plant is operating at a heavy loss. During the month of April the revenue was $1,000 short of the payroll alone and the monthly loss is estimated by Tacoma's commissioner of finance at approximately $5,000. One serious feature in connection with the situation is that in September the city must repay to the Federal Government $40,000 advanced by it for the construction of the line. The fund provided for the purpose now contains only $4,000 and with a monthly loss of $5,000, it is apparent that the line cannot be expected to meet the obligation from earnings.

Government and Public Works

THE National Federation of Construction Industries, in its fifth News Letter under date of May 24th, advocates as one of the most important steps to be taken by the Congress of the United States in the restoration of general business activity the provision that the National Government shall concentrate into the immediate future its program of the construction of public works, which would normally be extended over the next several years, in order to effect a quick general resumption of business, which would follow the stimulus given by large Government activities.

The Federation also presents a National Construction program, indicating its position relative to the transition of the American construction business from a war to a peace basis. The magnitude of the Construction Industry and the diversity and wide geographical distribution of the interests concerned gives the construction industry a pivotal position in its influence upon the return of general business to normal conditions. The Federation therefore advocates that the Federal Government, as well as state, county and municipal authorities, proceed generally with public work already authorized and that if necessary to complete such work, additional appropriation should be made for that purpose. It is recommended that the Government speedily complete river improvement projects already authorized, and that Congress provide for a comprehensive system of waterways with co-ordination of the services of waterways and railways. It is proposed that Congress should create a Federal Highway Commision, independent of present departments of the Government, composed of members from the different geographical sections of the country, to perform the executive functions of the Federal Government pertaining to highways, and that the Commission should report to Congress a plan for continued aid for state construction of highways in the period beyond 1921, to which time the provisions of existing Federal aid laws extend.

The Federation announces the creation of a Board of National Advisers, to be composed of Directors of the Federation, representatives of member associations, and other gentlemen selected because of their prominence in the business world. It has been decided that for the remainder of the current year the presidents of association members shall be requested to serve as representatives of their several associations and that the determination of how association members shall thereafter be selected shall be left to the next annual meeting of the Federation. Announcement of the names of National Advisers will be made beginning with the next News Letter and subsequent announcement will be made as the Advisers are selected.

The Federation advocates the building of USEFUL war memorials and has submitted to the several hundred construction associations of the United States the question whether a campaign should be inaugurated to build USEFUL war memorials.

A summary is given of Own Your Home Campaign and 84 other cities are reported as organizing such campaigns. One thousand four hundred and seventy-six other cities and towns have shown interest in the campaign in correspondence with the National Own Your Home Bureau in the U. S. Department of Labor.

Considerable attention is given to the question of Emergency Public Works and reprints are given of the Kenyon United States Emergency Public Works Bill presented during the last session of Congress and the Emergency Public Works Acts of Pennsylvania and California. In this connection, the Federation says: "In ordinary years of peace the amount of money spent annually in the United States for public works is said to be in the neighborhood of a Thousand Million Dollars. It has been proposed that as a nation we shall adopt the policy of spending nine-tenths of the Public Works appropriation currently and put aside the remaining one-tenth as a reserve to be used in recurrent periods of business depression and unemployment, which are said to have occurred on the average of once in ten years in this country since 1850."

An interesting summary is given of figures showing the relationship between the construction industry and American business as a whole. The data have been taken from various Government reports and emphasize the magnitude of the industry. In conclusion the observation is made that if the industry were operating on a hundred per cent basis, it would mean that two million additional men would be directly employed, without taking into consideration the added employment given to railroad crews, coal miners and other related industries.

Practical Training for Technical Men

The complete success of the army system of training technical men for positions requiring a high degree of specialization has attracted much attention. However, the methods used are not altogether new, as many of them have been used for a number of years by the Westinghouse Electric Manufacturing Company in training college graduates for its commercial and engineering departments, writes A. C. Forney. Briefly, the principles involved are the careful selection of well qualified men for definite positions and the training by intensive methods for such predetermined positions.

Emphasis is laid on the selection of men with the proper characteristics for the line of work they desire. Indication of these qualities is found in the college work and other miscellaneous activities of the technical graduate. For some types of work certain characteristics must predominate, and for others these particular characteristics are not so important. Personality, courage, tact and initiative are emphasized in the sales type of student. Mathematical ability, accuracy and analytical inclination indicate the engineering type. The basic qualities of character are considered rather than experience or skill. One point on which stress is laid is the necessity of an early determination of the kind of work desired, as a means of avoiding waste of time and in order to get the proper preparation for the ultimate position.

Specific intensive training is given for commercial, design, manufacturing and application engineering. The student is segregated for some particular branch as soon as he demonstrates his fitness and expresses a desire for this particular work. The radical difference in the experience afforded in the various shop sections, as well as the limited time available for each student, makes early segregation necessary. For instance, it is useless to have a graduate working on heating equipment or overhead line material when he is scheduled for sales in the marine machinery department.

The course covers a period of approximately twelve months, divided into shop experience and intensive study. During the first period of the course short assignments in different manufacturing section bearing a definite relation to the position in which the man will ultimately be placed. Weekly class conferences accompany this shop period to insure thoroughness in the shop experience, to give a knowledge of the developments of the immediate work in which the men are engaged and to study the features of the Company's product as a whole.

This shop training is followed by a short period of full time intensive study adapting the student to his particular permanent work. This is conducted under the immediate supervision of the department heads. For instance, students training for work in the engineering departments, spend the last three months of their course studying the salient features of Westinghouse design under the leadership of the Chief Engineer. Likewise the commercial students pass through a period of intensive study of business methods, advertising and the construction of Westinghouse apparatus from the selling point of view.

After completion of the intensive study period the student is taken into the regular organization of the Company in the department for which his entire training has been shaped to prepare him. The departmental requirements are known some time in advance and the number of men appointed to the course is carefully restricted to limits based on these requirements. The method of training more men than are needed has been found unsatisfactory. Every man now appointed to the course is selected and trained for some definite position. Quite a number of men are taken for training as managing operators for public utility corporations. Men are chosen not so much because they express a desire for a particular phase of work, but because they show training and ability of a higher capacity than the average.

The opportunities for work on problems of practical engineering application and commercial importance and of such association with men of broad business and engineering experience give to each student a basis for cultivation of whatever latent or active ability he may have. Continued contact with high standards in engineering ethics and business practice rarely fails to produce a favorable reaction. The preparation of these young men for positions of responsibility is a matter of vital importance to the company, dealing as it does with the man material for the future operation of the organization. The eminently successful system of "promotion from the ranks" to the higher positions makes it doubly important that the company and the young engineer each recognize the potentialities of the other and avail themselves of these opportunities to the fullest extent.

Radio Stations in Domingo and Haiti

The Navy Department announces that the naval radio stations at Santo Domingo City, Dominican Republic, and Port au Prince, Haiti, were opened May 1 to commercial service for points in the United States via the Naval Radio Station at Guantanamo, Cuba, and then via cable from Guantanamo to destination. The same routing will apply on traffic filed in the United States for delivery in the immediate vicinity of Port au Prince or Santo Domingo City.

The rates governing this traffic will be the usual cable rates between points in the United States and Guantanamo, plus $0.20 per word between Guantanamo and Port au Prince or Santo Domingo City. It is believed that this service will be of great value to American business interests.

Albert Brunt Returns to Holland

Albert Brunt, who for the past four years has been engineer in charge of the direct-current machine design section of the Industrial Engineering Department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, has resigned to return to Holland, his native country. Mr. Brunt was born in Woerden, Netherlands, November 6, 1883, and received a complete education in the schools and universities of that country. His technical training was received at the University of Delft, where he took the degree of mechanical engineer in 1905 and electrical engineer in

1906. For two years following this, he was employed in design work with electrical manufacturing companies on the continent.

In April, 1909, he came to America and entered the Engineering Department of the Westinghouse Company. Mr. Brunt was an active member of the A. I. E. E. and has prepared a number of interesting articles for technical papers on direct-current motors.

Do Not Know Costs of Municipal Plants

Mr. S. S. Kendall, a member of the Colorado Utilities Commission, says: "It is a notorious fact that very few cities and towns have the slightest conception as to what it costs them to build, operate and maintain a municipal utility plant. Possibly in some instances they don't care, but as a plain business proposition they should know whether it is being maintained partly from general revenue of the municipality. It is very natural, however, that city officials want to make as good a showing as possible and are only too willing to allow their successors to assume the burden of renewals to the property. The result is that in a few years not much value is left to the plant, for it is mostly junk."

Electricity on the Farm

Push a button out in the wheat field. Whirr! Away goes the threshing separator and a tawny stream of grain, worth $2.26 for every sixty pounds, comes running into the wagon. No smoke, no water or coal hauling, no danger of fire—it is the modern method out in the big wheat belt of Kansas, writes Charles Moreau Harger.

Eleven million acres of wheat are to be cut and threshed before the first of August. More than 150,000 men are to be busy from sunup to sundown—at 50 to 60 cents an hour "and found." It will be the biggest crop ever harvested in any State and will bring the farmers of Kansas some $400,000,000, or $250 for every person in the State.

Threading the farm country of the wheat belt are being extended long transmission lines of central power plants. One company with three connected power plants furnishes current to 53 towns and over 400 farms. The farmer lights his house and barn, pumps water, grinds feed, charges his motor car battery—and all for less than the city dweller pays for his house current alone. For miles in some counties every farmstead is wired.

When threshing time comes, instead of having a huge tractor engine, with engineer, coal shoveller and a team to bring coal and water or to haul gasolene or fuel oil—electricity does the work. From the central station is sent a motor wagon, equipped with motor, transformer and a half mile or more of cable. The cable is attached to the main transmission line and runs across the wheat field to the threshing scene, where the motor is stationed conveniently for the use of the separator. The belt from the motor to the separator is attached; the manager pushes a button or turns a switch and the big machine begins to hum. Into the gaping maw of the separator the pitchers throw the bundles and the harvest return is ready for the elevator—and $2 or more per bushel.

Last year the threshing of Western wheat cost the farmer at least 20 cents a bushel. The expense of labor and the charge of the threshers came high. This year where there is no electric motor it will be even higher. But the farms with electricity on tap have a cinch. The owners cooperate and buy a separator, moving it from farm to farm. The threshing season is but a few weeks long and the old-fashioned plan of "changing work" is revived to utilize the new idea.

The power company charges $1 an hour for use of the motor, transformer and attendant, with a charge for current running from 15 cents a kilowatt down to 5 cents, according to amount used. Last year when the first threshing by electricity was done the cost was determined through the experience of twenty-two farmers. The highest cost was 4.2 cents a bushel; the lowest 2 cents, covering the power furnished to the machine. Of course, the separator must be manned, and there is that expense added. However, the farmer finds his outgo materially cut down, and he has much more profit in his two dollar wheat. When, as is the case on some of the farms, 5,000 to 10,000 bushels of wheat are threshed a reduction of ten cents a bushel counts into a fair figure.

Wheat harvest will be followed closely by threshing. The machines will be working as soon as the bundles are in the shock. The use of electricity will reach further into the wheat belt this year and promises to revolutionize harvesting as the electric lines are more thickly scattered over the farm country. Hundreds of farmers are now on the waiting list to obtain the service and it is a matter of securing labor and material to make hundreds of miles of new extensions.

With a tractor to till the soil and pull the self binder, a motor car—and Kansas has more than 200,000 of them—to carry him to the field, an electric motor to run his threshing machine, and a motor truck to haul the grain to the market, the Kansas wheat farmer is getting his operations on a thoroughly businesslike basis.

An Electro-Magnet Signalling Device

An interesting electrical application, regarding which the war-time ban of secrecy has been but recently lifted, was the perfecting of an electro-magnetic signalling device whereby fog bound ships may determine their position and be warned away from dangerous shoals. This device enables the listening operator to determine not only the direction from which the call comes but the distance from which it is sent.

ELECTRICAL ENGINEERING

With Which is Incorporated the

SOUTHERN ELECTRICIAN and the ELECTRICAL AGE

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VOL. LIII JUNE, 1919 No. 6

NEARLY all of the states have taken definite steps towards opening land for settlement by returned soldiers, in accordance with the plans advocated and formulated by the Department of Labor. No less than twenty-four states have proposed or adopted definite legislation along the lines, while in sixteen other states committees have been appointed or other steps taken to carry out the scheme. The readjustment of affairs in this country to a peace basis will bring many changes, the full effect of which we cannot begin to foresee. Boys raised on the farm have had their first taste of city life and it cannot be doubted that many of them will wish to remain in the centers of population. On the other hand, there are thousands of city-bred lads who have been brought into splendid physical condition for the first time in their lives, and who have known what it is to live in the open air. Who can doubt that many of these will be glad to get close to nature on the farm, the ranch, or in the forests. It is essential that we should bring as many back to the soil as possible. By all means let there be farms for all who will cultivate them. We must increase our food supplies and at the same time it will be an excellent thing if we can lessen the congestion of population in our cities.

THREE-FOURTHS of the industrial workers in America are handicapped by lack of proper training in their respective tasks, according to the U. S. Training Service of the Department of Labor. The work of the service is to increase the efficiency of this "insufficient three-fourths," rather than to stimulate the output of the one-fourth already producing at a satisfactory rate, says a bulletin "Some Advantages of Industrial Training," now being distributed free by this branch of the government. Bringing about a big increase in output of the average plant, the Government contends, is wholly within the possibilities, if the following steps are taken: (1) A careful analytical survey of the operations in the plant to ascertain where existing methods can be improved; (2) the formulation of a definite program of training, either in a separate department or "on the floor" in direct conjunction with production; (3) the instruction of those workers who are most in need of it and (4) the upgrading of those in the next higher strata. A training department helps workers to help themselves. Another question of keen interest to the working man and the employer alike, taken up in this booklet, is the effect of training on labor turnover. It points out that the turnover for the country at large is at least 250 per cent., placing an annual burden of $1,250,000,000 on our manufacturing industries. Basing his claim on the experience of several score of plants where training has been installed, the author maintains that such instruction in a factory causes a big reduction in turnover. The trained employes can more readily find suitable work and are more easily retained in a plant. Training contributes to a better spirit among employes and develops better teamwork with the employers, according to this bulletin. It is one of a series, all of which can be had for the asking.

AT the last election in Cleveland, Mr. W. A. Stinchcomb, who is County Engineer of Cuyahoga County (in which Cleveland is situated), was candidate. This, and the fact that he is a fearless public servant, gives special interest to his paper on "The Engineer in Politics," presented at the last convention of the American Association of Engineers. Mr. Stinchcomb was unable to be present in person at the convention, on account of a case in court, but his paper will attract wide attention among the members. Of course Mr. Stinchcomb does not use the word "politics" in its partisan sense; his reference is purely to civic and governmental service. He says that in our cities practically all of our public problems are subject to scientific analysis. Is the subject one of developing the physical plan of the city, including the adequacy and location of its highways, the kind and strength of its pavements, the development of its park and recreation facilities, the working out of a proper drainage or the planning of its transportation facilities, either rail or water? Surely the engineer is best qualified to solve such problems. He is now called on for advice in these matters, and in Mr. Stinchcomb's opinion he should be the one to largely decide. In matters of public health as influenced by problems of sanitation such as sewage and garbage disposal, water supply and building and housing regulations, he is best qualified. On questions affecting the control of public utilities such as transportation, electric or gas supply and telephone service, his engineering training best fits him to bargain with the trained mind representing the public utility companies, and to know when the contract has been made that justice is done both the public and service corporation. As cities extend further into the realm of municipal ownership of these public utilities, his obligations to serve the public in an executive capacity in directing the management of such work increases and his fitness to serve grows. We have yet to learn in this country that the administration of our cities is purely a business job, and should require the same abilities and qualifications as the conducting of a great mercantile enterprise. We might take a lesson from Germany, where civic administration is made a regular profession, those who make a distinguished success being called from one job to another, precisely as is an eminent engineer. Mr. Stinchcomb has sounded a trumpet blast, and the discussion that will inevitably follow his paper will be welcome.

Warring on Misleading Advertising

As a result of plans which have just been perfected, the work which the Associated Advertising Clubs of the World have been doing for the prevention of unfair competition through misleading advertising is to be multiplied several times, says a bulletin which comes out of the Association's offices in New York City.

The plan calls for the raising of a special fund of $141,000 a year (on a three-year basis) and the selection of five prominent business men to act as trustees for the fund. These trustees are: F. A. Seiberling, president of the Goodyear Tire and Rubber Company, Akron; Festus J. Wade, president of the Mercantile Trust Company, St. Louis; S. C. Dobbs, vice-president of the Coco-Cola Company, Atlanta; David Kirschbaum, president of the A. B. Kirschbaum Company, manufacturing clothiers, Philadelphia; Henry L. Doherty, president of Henry L. Doherty & Company, investment bankers, New York.

Immediately following the signing of the armistice, the Executive Committee of the Advertising Association held a meeting in New York and approved a budget for the enlarged work, which had been prepared by Merle Sidener, chairman of the National Vigilance Committee. Soon thereafter, arrangements were made by the association for the services of Richard H. Lee, as special counsel in charge of investigations.

The bigger work will take four chief directions: (1) the establishment of a force of special investigators working out of the headquarters offices of the association in New York City; (2) intensive work for the establishment of additional local vigilance committees, this branch being under the supervision of William P. Green, who recently returned to the association from Washington; (3) the establishment of a bureau to do in foreign markets what has been done for the protection of trade in North America, and (4) intensified work in co-operation with various trade associations, representing important lines of business, toward the establishment of "standards of practice" by leaders in these various lines for the elimination of evil practices which have been allowed to grow up.

The last-named activity is particularly interesting, and especially so because the adoption of the idea as it applies to national and international problems, follows closely the use of such "standards" in several local communities.

Local vigilance committees of advertising clubs are organized and their work is guided under the direction of the international office in New York City, and it has been found that the adoption of such standards has tended to eliminate much misleading advertising before it is published, for there are many practices among local advertisers which have grown up through competition and which each advertiser would be glad to eliminate if others would.

Build Now!

Wages are paid for the creating of wealth. Wages are labor's share of the wealth it *has* produced, rather than a mortgage on wealth that it *will* produce. *Wealth depends upon construction*, and in the building field not only does the individual add to his personal wealth, but he adds to the assets of the Nation.

The United States now has more wealth than any other two nations combined. Every house built, every road constructed, every public building and improvement, is adding to that great accumulation of permanent wealth, making the Nation stronger and stronger.

A general, country-wide campaign of building, assuming reasonable intelligence is exercised, would do more than any other one thing to increase the permanent wealth of the Nation and the individual. While its permanent wealth is piling up—especially when it is in the nature of homes owned by individuals—a nation may have its perplexing problems, but there is nothing serious or dangerous in its industrial status.

The permanent wealth of the country is represented in homes, buildings, private and public construction work—is the Nation's reserve fund. As long as the reserve fund is growing the Nation is a Going Concern and in sound condition.

If you would add to your personal wealth and make the Nation sounder and stronger—BUILD NOW.

Recommends a Permanent Government Employment Bureau

Secretary of Labor Wilson has recommended to Congress the enactment of legislation creating a permanent public employment service for the United States. Inletters to Representative J. M. C. Smith, chairman of the House Committee on Labor, and to Senator Kenyon, chairman of the Senate Committee on Labor, he approved the general principles of a national public employment system unanimously agreed upon by representatives of the Governors of the States at the employment conference held last month in Washington, and transmitted an outline of a bill embodying those principles. The outline calls for the continuance of the United States Employment Service, developed during the war, as a permanent bureau in the Department of Labor and in charge of a director general appointed by the President, and a system of public employment offices, operated by the States and cooperating with the Federal Employment Service. The Federal Government would contribute funds to the States for the maintenance of their offices, which would work under standard rules and regulations prescribed by the United States Employment Service, the national service handling labor clearances between States, inspecting and gathering of information as to labor and employment conditions. At the conference which agreed upon this outline were representatives of thirty States, including nearly all the industrial States, and representatives of employers and labor.

Good Roads and Motor Transportation

"Along with the great national movement for better highways comes the question of weight of loads, speed and many other factors," says R. E. Fulton, vice-president of the International Motor Company. "In the solution of the matter, plain, ordinary common sense should prevail. Unimproved roads, in good weather when they are dry and sound, can stand a great deal of traffic with little or no damage. They can even bear tremendous loads if the width of the tire is sufficient. When these roads are solid, big steam traction engines, with thrashing machines or corn shellers, run over them with no damage; in fact, with benefit, as they act like rollers.

"Moderately improved roads likewise can stand much traffic in good weather. The big trouble with these roads is that they are not what can be called all year 'round roads. They should be improved to meet the normal requirements of traffic, so that full benefit may be derived from them at all times.

"The weight of the load should be determined on the basis of width of tires. Routes between large cities or important commercial and industrial centers serve an enormous tonnage, and the larger the units in which this tonnage is hauled the greater the economy of hauling. These routes are main arteries of traffic and anything which increases the cost of transportation on them is paid for by all the people, regardless of how far they may be from these main arteries. When it is taken into consideration that a 50 per cent. increase in the size of the unit hauled makes a 15 per cent. decrease in the cost of transportation, the matter becomes one of great economic importance with tonnage running up into the millions.

"On these roads the weight is fully taken care of by the 800-pound limit per inch width of tire. For every 800 pounds, an inch is added to the bearing surface of the tires. With the addition of a trailer the weight of the load can be doubled without doubling the strain on the road. You simply add to the wheel base. The load, while greater, is distributed over more wheels of proportionate tire width. A striking illustration of this is given by our roads. While heavy rolling stock, such as the big compound engines which are now used on our railroads, are very much heavier than the rolling stock of years ago, the weight per inch of bearing surface has not been greatly increased. This has been met by putting extra bearing surface under the weight. For instance, the big engines now have 16 driving wheels, whereas the early engines had only four.

"It would have been as sensible fifty years ago to have prohibited the use of locomotives larger than the little four-wheel drivers as it would be to today to limit the weight of the motor truck on any other basis than tire width, and the number of wheels under the weight, which in the case of our large locomotives gives several hundred per cent. greater hauling capacity with probably only 100 per cent. greater weight of rail. Without the development of the large locomotive and the increased size of railroad cars, freight rates would probably be double what they are now. If we set an artificial limit on motor trucks, we are handicapping what is fast becoming an important means of transportation, and adding to the cost of every article of food or clothing we use, and placing a generally greater economic burden on the country. We must build to carry the load."

American Association of Engineers

At the annual convention of the American Association of Engineers, held at the Hotel LaSalle, Chicago, the past month, the following officers were elected:

President, F. H. Newell; First Vice-Pres., W. W. DeBerard; Second Vice-Pres., T. A. Evans.

Auditing Committee: H. P. Gillette, Chairman; C. A. Gaensslen, T. J. Mullin.

Director to fill vacancy, C. H. Crawford.

Directors: W. W. K. Sparrow, Chicago; P. E. Harraun San Francisco; R. Burham, Chicago; F. D. Richards, Cleveland; A. A. Matthews, Tyler, Tex.; E. F. Collins, St. Louis.

Addresses were made by Prof. Bass, of the University of Minnesota; Fraser S. Keith, Secretary of the Engineering Institute of Canada; Col. Walter Dill Scott, and Harry A. Wheeler, past president of the United States Chamber of Commerce.

The specific recommendations made in the report of the Compensation Committee of the Chicago Chapter, elicited much favorable comment and were approved by resolution.

A New Cast Winding Rotor

A new type of rotor with cast winding which has been recently designed by the General Electric Company, Schenectady, N. Y., presents new features and improvements worthy of brief description. The bars and short-circuiting rings comprising the windings employ the same material and are cast in a single operation. With the windings thus made a solid unit, rigidity, durability and better balance is procured. The cast winding from an electrical point of view also insures uniform cross section and union between the bars and the end rings. This has become a factor in eliminating operating difficulties due to open circuiting of joints between bars and end rings. Holes bored radially through the cast end rings give effective ventilation for rotation in either direction. The new cast winding rotor is said to be especially effective on induction motors of the "squirrel cage" type.

Here and There in the Electrical Field

The Houston (Tex.) Engineers' Club and local members of the American Association of Engineers gave a dinner at the Rice Hotel on the evening of May 26 to Secretary Drayer, of A. A. E. Following the address by Mr. Drayer, in which he explained the principles of the association and the work it is doing, officers of the Houston Club asked for a proposal under which the club could become a part of the National Association. The Houston Club was organized about a year ago and now has a membership of nearly 100 out of an engineering population of 250 to 300. The President is O. G. McVea, City Engineer. Discussion following the address centered on licensing, in which J. M. Howe stated that an effort would be made to have a license law passed by the legislature at the special session in June. Major J. A. Rossiter suggested that the club direct the formation of a City Planning Commission. President McVea and others concurred and it was agreed to take up the furtherance of a city plan commission at the next regular meeting on June 12. Several predicted that Houston would have a population of 500,000 in ten years.

There will be a three-day convention of the Illuminating Engineering Society in Chicago the second or third week in October. Chicago was decided upon as the convention city this year as a result of an invitation extended by the Chicago section.

The Enid division of Oklahoma Gas & Electric Company is negotiation with the city officials of Kingfisher with the view of supplying the town's requirements of electric energy and also the large mills situated there which have been using their own power.

The Stockton, Cal., division of the Western States Gas & Electric Company has received application from the Sperry Flour Company for 450 horsepower in motors to operate their new Crown Mills. The company will also supply the Pacific Gas & Electric Company with an additional 150 horsepower in motors to operate their new pumping plant at Stockton.

The Sapulpa, Okla., Electric Company has secured contract with the local Board of Education covering the electric light and power requirements of the $300,000 high school now being constructed. It is anticipated that approximately 100 horsepower in motors will be required, and about 15 kilowatts for lighting.

Twenty-five farmers living between Hartford and Wall Lake, S. D., have signed an agreement with the Hartford Light & Power Company to secure electric current for light and power on their farms. The Harford Light & Power Company secures its current from the Northern States Power Company.

The Railroad Commission of California has just handed down a decision which increases the gas and electric rates of the San Diego Consolidated Gas & Electric Company approximately 10 per cent. The decision, which is effective as of May 1st, amounts to a general revision of the company's rates.

The Commercial Department of the Arkansas Valley Railway Light & Power Company is conducting a series of campaigns on electric household devices. A recent electric washing machine campaign in Pueblo, Col., resulted in the sale of 18 machines and prospects for many more. An electric vacuum cleaner campaign is now in progress and later another campaign will be opened on the small labor-saving appliances. In a recent week local contractors soliciting in co-operation with the campaigns Commercial department secured orders for wiring 52 already-built houses.

The St. Paul Chapter of the American Association of Engineers is now the Twin City Chapter and holds alternate meetings in Minneapolis and St. Paul. The Twin City Chapter has now nearly 300 members. On September 5, 1917, when the petition for a chapter charter was sent to national headquarters, there were but twenty-two members. Recent officers elected for the Twin City Chapter are: President, F. K. Bennett, Principle Assistant Engineer M. & St. L. R. R.; First Vice-President, W. S. Irwin, Office Manager Eastern Dist. Great Northern Railway, St. Paul; Second Vice-President, A. V. Duncanson, Cost Engineer, City of Minneapolis; Secretary, R. C. Smith, Assistant Engineer M. & St. L. R. R., Minneapolis; Treasurer, E. W. Bolmgren, Assistant Engineer C. M. & St. P. R. R., Minneapolis; Assistants to Secretary, Hardy Bryan and Arthur L. Rosenthal.

Three new appartment buildings now under construction in Minneapolis will install 137 electric ranges, orders having recently been placed.

Managers of the properties of Northern States Power Company met with the general officers and executives in a two-day business conference at Minneapolis, May 15 and 16. A feature of the program was a paper by H. E. Young, sales manager, on the systematic efforts necessary to build up and maintain public good will.

Excavations have been completed and the forms set for the foundation of the $300,000 addition to Northern States Power Company's power plant at Sioux Falls, S. D. A new 3,000 kilowatt generator will be installed.

The Bradley-Ford Company, Cicero, Ill., have announced that their Bradley funeral cars for 1919 will be equipped with Westinghouse starting motors and lighting generators. The motor is a 6-volt machine which drives the engine fly-wheel by means of a screw pinion shaft. It is started by means of a foot operated switch. The generator is of the third brush type, delivers current at 6.5 volts, and is driven from the timing gears.

The St. Louis Chapter of the American Association of Engineers was elected on May 14 as a member of the Associated Engineering Societies of St. Louis. The Associated Societies approved unanimously the schedule for the city employees adopted by the St. Louis Chapter of A. A. E. and its Municipal Section, which was approved by the national convention of the American Association on May 12.

The following officers have been elected by the New York Chapter of the American Association of Engineers: President, Alexander Potter, Civil Engineer, 50 Church St.; First Vice-Pres., J. C. Patterson, Prin. Asst. Engr. Erie R. R., 50 Church St.; Second Vice-Pres., Maurice Griest, Asst. to Chief Engr. Public Service Com.; Treasurer, Hugh C. Jackson, Civil Engr., 552 W. 14th St., New York City; Secretary, E. B. Miller, 294 Henry St., Brooklyn, N. Y.

Direct Current Armature Windings

By Jacob Gintz, Jr.

SIMPLEX SINGLY RE-ENTRANT WINDINGS

All direct current armature windings come under two common heads; namely, Lap or Parallel windings and Wave or Series windings. These are again divided into some minor types known as follows: Simplex windings, duplex windings, triplex windings, etc.; singly re-entrant windings, doubly re-entrant windings, triply re-entrant windings, etc.

The meanings of the above terms are as follows:

Any winding in which there are as many circuits as there are poles and requiring as many brushes as poles for successful operation is called lap or parallel winding.

Any winding in which there are but two circuits regardless the number of poles or brushes is called wave or series winding.

A winding which is wound with one wire in hand is called a simplex winding.

A winding which is wound with two wires in hand, or where two simplex windings are placed on the same armature, is called a duplex winding.

A winding which is wound with three wires in hand or where three simplex are placed on the same armature is called a triplex winding.

A winding which encircles the armature once and then closes on itself is called a singly re-entrant winding. Any number of coils may be used in this style of winding.

A winding which encircles the armature twice and then closes on itself is called a doubly re-entrant winding. In this style of winding only an odd number of coils can be used.

A winding which encircles the armature three times and then closes on itself is called a triply re-entrant winding. In this style of winding only an odd number of coils, which are not a multiple of three, may be used.

Ring wound armatures are not used in any of the modern motors or generators so this article will be devoted entirely to the discussion of drum wound armatures.

The windings that are placed on drum wound armatures have their coils placed so that while one side is acting under a north pole the other side is acting under a south pole. From this it will be seen that for each turn of wire in a coil there will be two active sides or conductors. By a conductor we

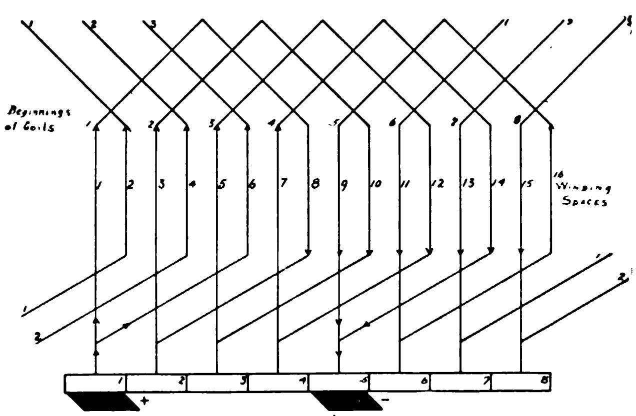

Fig. 1.

refer to that part of a turn which is in the slot of the armature, cuts lines of force and produce an electro motive force.

The distance or part of the armature circumference that a coil spreads is known as the coil spread or coil pitch. This distance is expressed in a certain number of winding spaces. A winding space may be represented by an entire slot or by only a fractional part of a slot; this depends entirely on the number of coils in the winding and the number of slots in the armature core. If there are half as many coils as there are slots in the armature, there will be but one coil side per slot, and it is called a one layer winding and each slot will be considered as one winding space. If the number of coils and the number of slots are equal, there will be two coil sides per slot, and it is called a two layer winding and each slot will then represent two winding spaces

The following are the symbols and their meanings that will be used in the various formulae in connection with the above mentioned windings.

Yb—Coil pitch expressed in a number of winding spaces. If it is an even number it must be made an odd number by + or — 1.

Yf—Front pitch which is the distance expressed in a number of winding spaces from the end of one coil to the beginning of the next.

Yr—Resultant pitch, which is two winding spaces in a singly re-entrant winding; four winding spaces in a doubly re-entrant winding; six winding spaces in a triply re-entrant winding, etc.

C—Whole number of coils in the winding.

A—Number of pairs of armature circuits.

P—Number of pairs of poles.

The following are the two formulae used in any drum winding:

$$1.\quad Yb = \frac{C \pm A}{P}$$

$$2.\quad Yf = Yb \pm Yr$$

In formula No. 1 if the + value of A is used it is called the long pitch and the use of the — value of A is called the short pitch. In formula No. 2 the use of the + value of Yr will result in a left-hand winding in which the beginning of coil 2 will be to the left of the beginning of coil 1; and the use of the — value of Yr will result in a right-hand winding in which the beginning of coil 2 is to the right of the beginning of coil 1.

The first windings to be treated will be of the lap or parallel type of the various classes and styles mentioned above. For the first winding assume a winding of the simplex singly re-entrant lap wound type for a 2-pole armature having 8 coils and one layer or one coil side per slot. There are two methods of showing a winding diagram; one is known as a working drawing and the other a development. By applying the above two formulae the winding diagrams 1 and 2 will be worked out.

As stated in the problem, there are to be 8 coils in the winding, with one layer or coil side per slot. The number of slots required in the armature are found as follows:

$$\text{Number of slots in armature} = \frac{\text{No. of coils x 2}}{\text{No. of coil sides per slot}} = \frac{8 \times 2}{1} = 16 \text{ slots in armature.}$$

By using formula No. 1 the spread or coil pitch will be found. The numeral values of the different symbols are as follows:

$$C = 8,\ P = 1,\ A = 1;\ \text{then } Yb = \frac{C \pm A}{P} = \frac{8 \pm 1}{1} = 9 \text{ or } 7$$

winding spaces for the value of Yb. By using formula No. 2 the front pitch will be found:

$$Yf = Yb \pm Yr = 9 \pm 2 = 11 \text{ or } 7 \text{ and}$$
$$7 \pm 2 = 9 \text{ or } 5 \text{ for}$$

the value of Yf. By examining the above results it will be seen that there are four different ways or steps by which this armature can be wound: First, $Yb = 9$, $Yf = 11$; second, $Yb = 9$, $Yf = 7$; third, $Yb = 7$, $Yf = 9$; fourth, $Yb = 7$, $Yf = 5$. Since all four windings are possible and work equally well it will be up to the winder to use a little judgment, and the winding which can be used to the best advantage is the fourth, where $Yb = 7$ and $Yf = 5$. In this winding the least amount of material will be used in winding and this in turn will reduce the cost of manufacture or winding.

Fig. 1 is the development of the above winding, and the following is the winding and connecting table, using Yb as 7 and Yf as 5 winding spaces:

WINDING TABLE

Coil No.	Wound in Spaces No.	In Slots No.
1	1 and 8	1 and 8
2	3 " 10	3 " 10
3	5 " 12	5 " 12
4	7 " 14	7 " 14
5	9 " 16	9 " 16
6	11 " 2	11 " 2
7	13 " 4	13 " 4
8	15 " 6	15 " 6

When all 8 coils have been placed in the armature according to the above table, the winder is then ready to connect the winding to the commutator. The number of bars in the commutator must be equal to the number of active coils in the winding; so, for this reason, there will be 8 bars in the commutator to which the above winding will be connected.

Before a winder can make the proper connections between the commutator bars and the winding, he must know how the brushes are going to be set in relation to the pole pieces. The usual position of the brushes is that they are set center between the pole tips or center off the pole. The rules to be followed are as follows:

When the brushes are set center between the pole tips the beginning lead of each coil will be connected to the commutator bar straight out in front of the slot in which the coil begins.

When the brushes are set center off the pole the beginning lead of each coil will be connected to the commutator bar which is 90 electrical degrees to the right or left of straight away.

The reason for these connections is that the coils will be commutated at the proper time; that is when they are in their neutral position. Figs. 2 and 3 will illustrate these connections and brush positions.

Assume that the brushes are set center between the pole tips the connections for the winding in Fig. 1 are made as follows:

CONNECTING TABLE

Beginning of Coil No.	Connection to Bar No.	End of Coil No.	Connected to Bar No.
1	1	1	2
2	2	2	3
3	3	3	4
4	4	4	5
5	5	5	6
6	6	6	7
7	7	7	8
8	8	8	1

Fig. 4 is the end view or working drawing of the same winding as Fig. 1.

The next step is to find how far the brushes will be spaced apart. This is found by the following formula:

$$\text{Spacing of brushes} = \frac{\text{No. of Com. Bars}}{\text{No. of Poles}}$$

$$\text{which would be } \frac{8}{2} = 4 \text{ bars}$$

as the brush spacing for the winding in Fig. 1; then by placing one brush at commutator bar No. 1, the next brush would be placed on the fourth bar away or bar No. 5. They may be called negative and positive at will.

Assume that this armature is that belonging to a motor, the current will enter the winding through the positive brush and leave through the negative brush. By following the indicating arrow points through the winding it will be seen that the winding is divided into two paths or circuits and that each path or circuit contains 4 coils in series. If the reader will make a careful study of the foregoing he should have very little trouble with the following windings.

The next winding to be discussed will be that of a 2-pole simplex singly re-entrant lap winding having 16 coils, 2 coil sides per slot.

To find the number of slots in the armature to receive 16 coils at 2 coil sides per slot use the following:

$$\text{No. of slots} = \frac{\text{No. of coils} \times 2}{\text{No. of coil sides per slot}} = \frac{16 \times 2}{2} = 16$$

By following the rules as laid down above for lap winding the spread of the coil is found as follows:

$$C = 16,\ P = 1,\ A = 1;\ \text{then } Yb = \frac{C \pm A}{P} = \frac{16 \pm 1}{1} = 17 \text{ or } 15$$

and

$$Yf = Yb \pm Yr = 17 \pm 2 = 19 \text{ or } 15, \text{ or } 15 \pm 2 = 17 \text{ or } 13.$$

As previously explained, there are at least four possible windings for each armature; the same holds true in this case. The winding which is preferred will be the one in which Yb

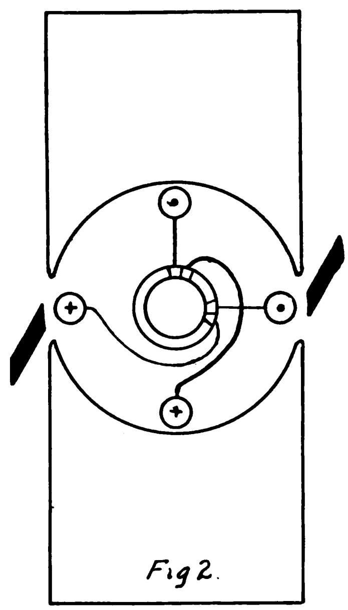

Fig 2.

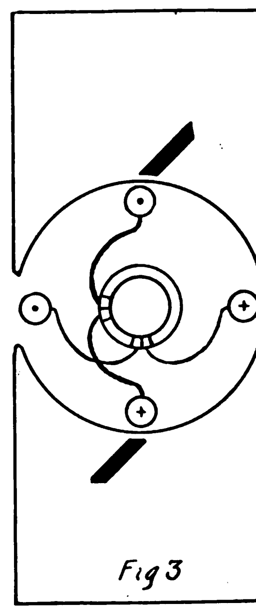

Fig 3

= 15 and Yf = 13. These values will be used in constructing Figs. 5 and 6.

The winding table for Fig. 5 is as follows:

Coil No.	Wound in Spaces No.	In Slots No.
1	1 and 16	1 and 8
2	3 " 18	2 " 9
3	5 " 20	3 " 10
4	7 " 22	4 " 11
5	9 " 24	5 " 12
6	11 " 26	6 " 13
7	13 " 28	7 " 14
8	15 " 30	8 " 15
9	17 " 32	9 " 16
10	19 " 2	10 " 1
11	21 " 4	11 " 2
12	23 " 6	12 " 3
13	25 " 8	13 " 4
14	27 " 10	14 " 5
15	29 " 12	15 " 6
16	31 " 14	16 " 7

When all coils are placed according to the above table they are then connected to the commutator bars. Assume the brushes are set center off pole as in Fig. 3, then the connections are made as follows:

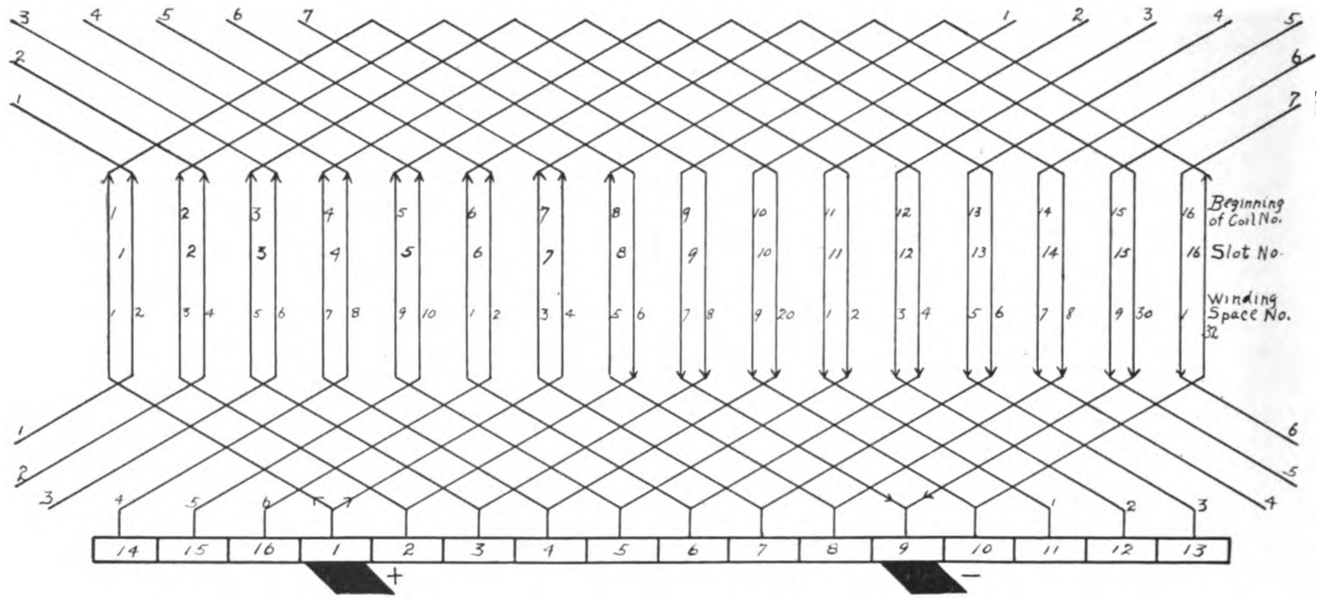

Fig 5.

The first step is to line up the commutator to find which bar is straight in front of any given slot This is done as follows: Take a piece of string, place it over the center of a slot, pass it out over the commutator and down over the center of the centering hole in the end of the shaft; the bar the string rest on will be called No. 1 Fig. 6.

To find the number of bars to be counted to the right or

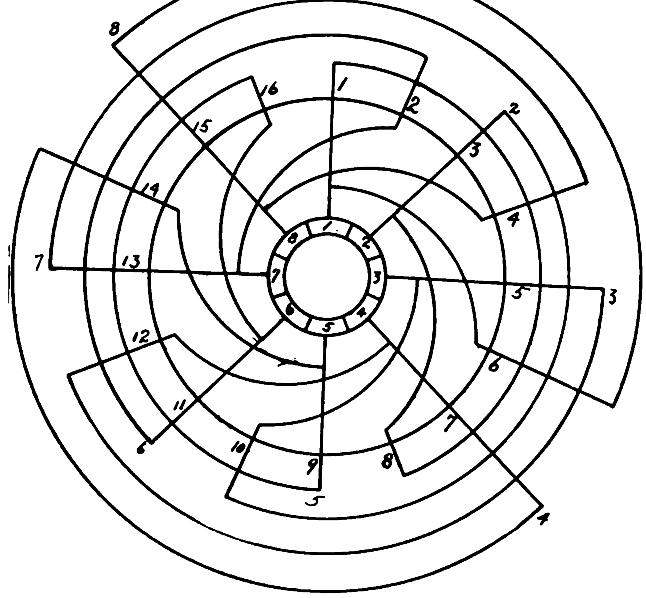

Fig.4.

left to swing the leads 90 electrical degrees, use the following formula:

$$\text{No. of bars equal 90 elec. degrees} = \frac{\text{No. of Com. Bars}}{2 \times \text{No. of poles}}$$

$$\text{which would be } \frac{16}{2 \times 2} = 4 \text{ bars}$$

in this winding. Should the above result be a mixed number, say 4½ bars, it would be increased to the next higher whole

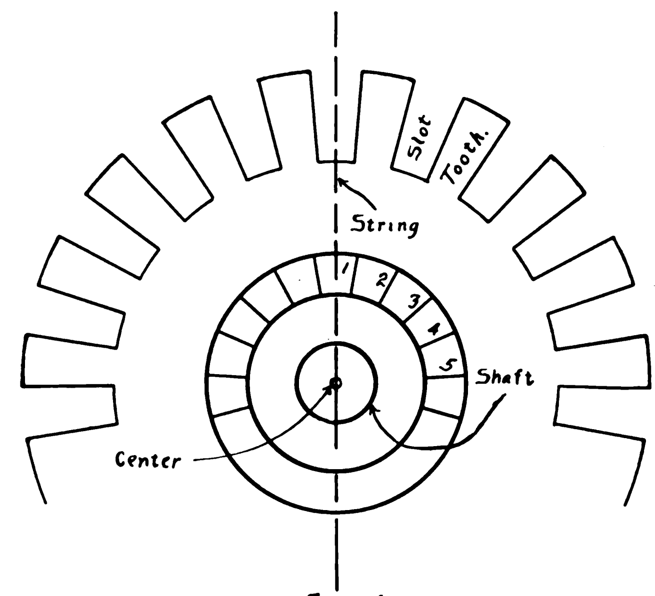

Fig. 6.

number or 5. This holds true regardless of the size of the fraction.

By following this rule the winding will be connected as shown by the following table:

Coil No. beg.	Con. to bar No.	End of coil	Con. to bar No.
1	1	1	2
2	2	2	3
3	3	3	4
4	4	4	5
5	5	5	6
6	6	6	7
7	7	7	8
8	8	8	9
9	9	9	10
10	10	10	11
11	11	11	12
12	12	12	13
13	13	13	14
14	14	14	15
15	15	15	16
16	16	16	1

When all the connections have been made according to the above table the spacing of brushes is as follows:

$$\frac{\text{No. of com. bars}}{\text{No. of poles}} = \frac{16}{2} = 8 \text{ bars}$$

One brush may be placed at any bar and the other on the eighth bar away from it. Assume that this is the winding on the armature of a generator, the current will enter the windings through the negative brush and leave through the positive brush, and by following the arrow points it will be seen that one-half or 8 coils are in series in each path or circuit. Fig. 7 is the working drawing or end view of the same winding.

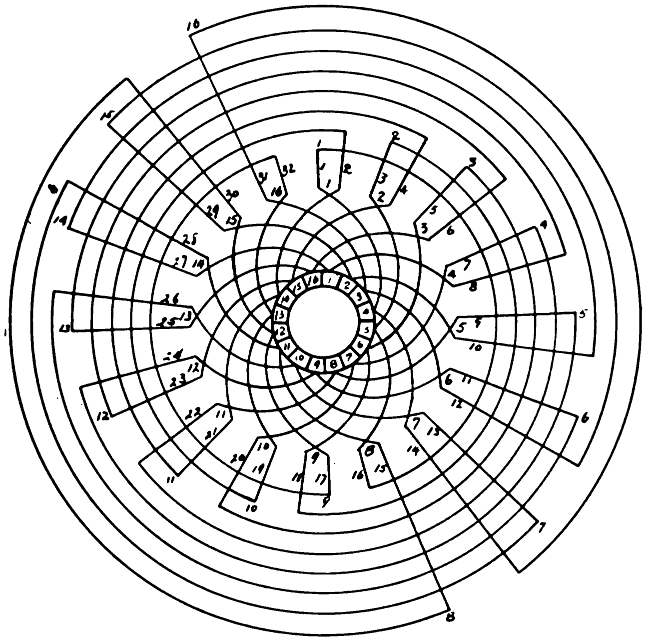

Fig 7.

The next winding to be discussed will be a 4-pole simplex singly re-entrant lap winding 16 coils; 2 coil sides per slot. Fig. 8.

The number of slots required in the armature will be the same as in the previous problem as the number of coils in the winding and the number of coil sides per slot are the same.

To find the numeral values of Yb and Yf use the following: $C = 16$; $P = 2$; $A = 2$. (This being a 4-pole winding there

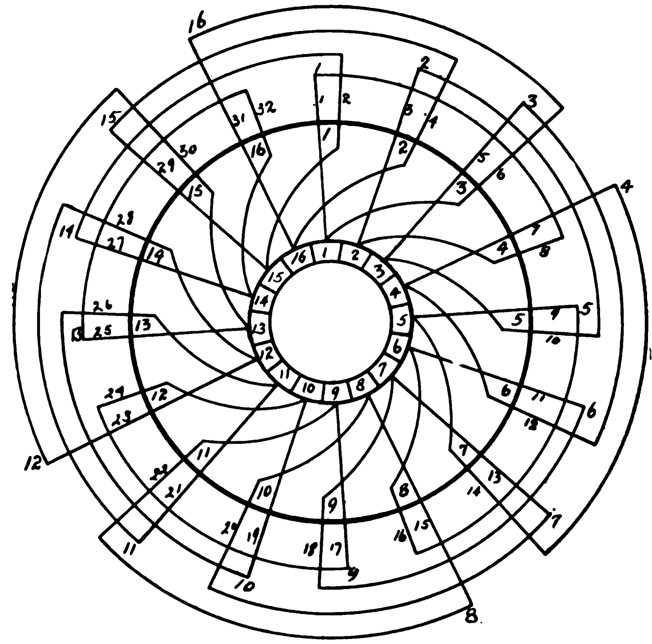

Fig. 9.

will be two pair of poles also two pair of circuits through the winding when connected, hence $P = 2$; $A = 2$.)

$$Yb = \frac{C \pm A}{P} = \frac{16 \pm 2}{2} = \frac{18 \text{ or } 14}{2} = 9 \text{ or } 7.$$

$$Yf = Yb \pm Yr = 9 \pm 2 = 11 \text{ or } 7 \text{ and}$$
$$7 \pm 2 = 9 \text{ or } 5.$$

By the same method as above explained $Yb = 7$ and $Yf = 5$ will be used.

The following winding table will show the location of the

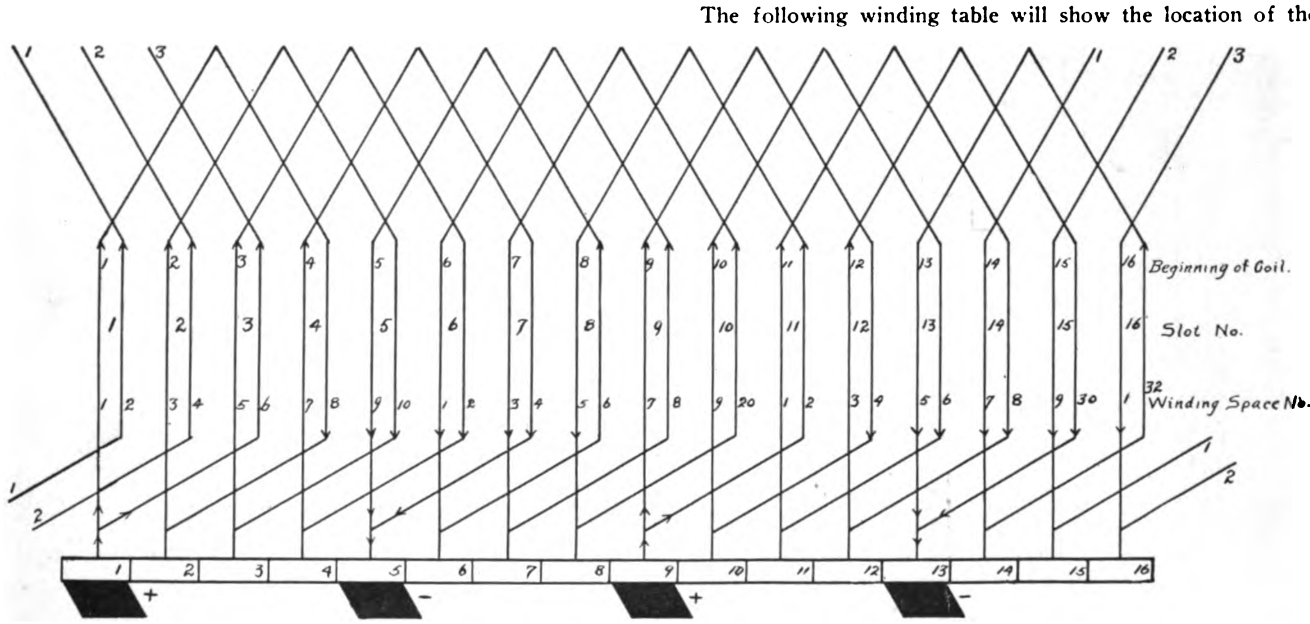

Fig. 8.

coil in the slot also the number of the winding space it occupies:

Coil No.	Wound in spaces No.	In slots No.
1	1 and 8	1 and 4
2	3 " 10	1 " 5
3	5 " 12	3 " 6
4	7 " 14	4 " 7
5	9 " 16	5 " 8
6	11 " 18	6 " 9
7	13 " 20	7 " 10
8	15 " 22	8 " 11
9	17 " 24	9 " 12
10	19 " 26	10 " 13
11	21 " 28	11 " 14
12	23 " 30	12 " 15
13	25 " 32	13 " 16
14	27 " 2	14 " 1
15	29 " 4	15 " 2
16	31 " 6	16 " 3

When all coils are placed the next step is to connect the winding to the commutator bars. Assume that the brushes

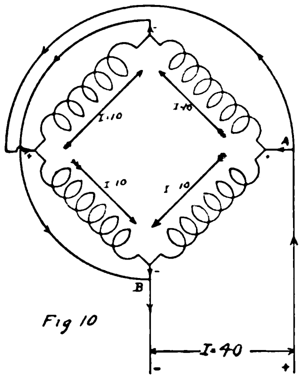

Fig 10

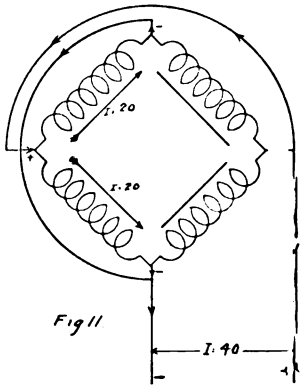

Fig 11

are set center between the pole tips, the connections are made as shown in the table:

Coil No.	Beg. of coil to bar No.	End of coil to bar No.
1	1	2
2	2	3
3	3	4
4	4	5
5	5	6
6	6	7
7	7	8
8	8	9
9	9	10
10	10	11
11	11	12
12	12	13
13	13	14
14	14	15
15	15	16
16	16	1

On this winding for successful operation it will require four brushes. The spacing of brushes will be found as follows:

$$\frac{\text{No. of bars}}{\text{No. of poles}} = \frac{16}{4} = 4 \text{ bars.}$$

Set one brush on bar No. 1 and on the fourth bar away or No. 5 place brush No. 2, on the fourth from here, or bar No. 9, place the third brush; and the fourth from here, or bar No. 13, place the fourth brush. Call the first and third brushes positive and the second and fourth brushes the negative. Assume this winding to be on the armature of a motor, the current will enter through the positive brushes and devide into two pair or four paths or circuits through the winding. By following the arrow points these circuits can be followed out.

It was stated previously that in all lap windings it is necessary to have as many brushes as poles in order to have successful operation. Figs. 10, 11 and 12 will illustrate how the current is equally divided when the proper number of brushes are used; what will happen if only three brushes on a 4-pole machine make contact; and also what happens if only two brushes in a 4-pole machine make contact.

Fig. 10 shows a 4-pole winding carrying a load of 40 amperes. This amount of current reaches point A, where the feeder connects to the bus bar which connects both positive brushes. The current of 40 amperes divides at point A and 20 amperes will flow to each positive brush. All circuits through the armature winding have approximately the same resistance, so for this reason the current as it enters the arma-

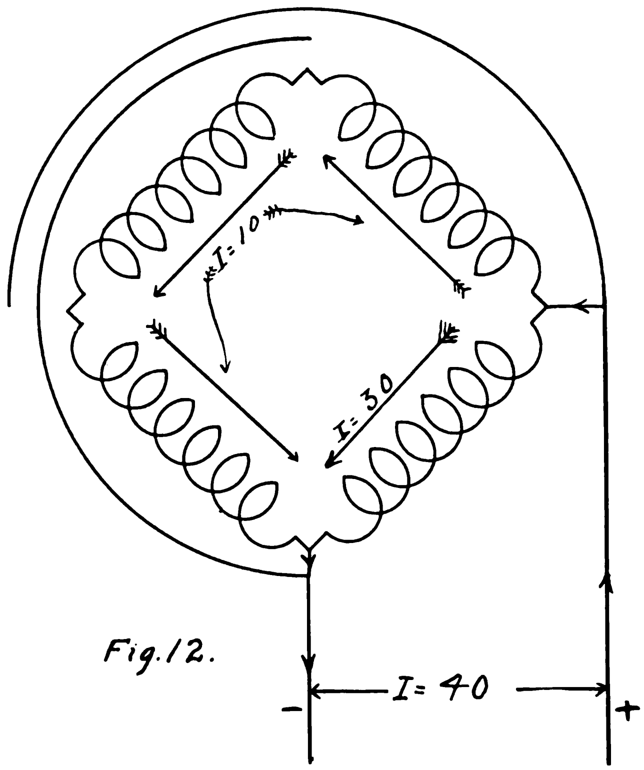

Fig. 12.

ture winding again divides and 10 amperes flow through each circuit of the winding. This shows that the current carried by the machine is equally divided between the various circuits, uniting again at point B and flowing back on the circuit through the negative brush.

Fig. 11 shows the same armature winding with one of the positive brushes removed. The machine is still driving the same load, consequently 40 amperes still flow, but the internal dividing of the current has changed.

The current having but one positive brush through which to enter the windings will flow as follows:

Owing to the opposition of induced counter electro motive forces in two of the circuits the current will divide into two parts and 20 amperes will flow through the two circuits as indicated in Fig. 11. This shows that by the removal of one brush, either negative or positive, the winding of this machine will be overloaded by 100 per cent., which will cause the winding to heat intensely, and if kept in operation burn out the armature winding.

Fig. 12 shows the extreme condition of a 4-pole winding having one pair of brushes removed (one negative and one positive brush). The load driven by the machine is unchanged, but the flow of the current through the internal circuits of the wind is very much out of proportion, as will be seen from Fig. 12.

The current entering the armature winding through the positive brush divides in to but two paths; one path has one-quarter of the winding in series, while the other path has three-fourth of the winding in series. This will cause the current to divide unequally according to the resistance of the circuits; then the amount of current that would flow through the circuit with one-quarter of the winding in series would be three times as great as the current in the circuit with three-fourths of the winding in series. The current would then be divided as follows:

30 amperes in one circuit and 10 amperes in the other circuit. It will then be seen that the removal of one pair of brushes in a 4-pole lap winding will overload the winding by 200 per cent.

On very large machines, of say 12 poles upwards, one brush may be removed at a time for renewal or cleaning without danger, since the larger the number of brushes the smaller the percentage of overload becomes.

New York Electrical Society

At the regular meeting of the New York Electrical Society, held in the Engineering Society Building, on May 26, Mr. A. M. Nicolson, of the research laboratory of the Western Electric Company, gave an illustrated lecture on "Speaking Crystals." The remarkable researches which made it possible to utilize common crystals for transmitting speech, music and sound, were explained and demonstrated. The members present listened through special receivers to music electrically transmitted without the aid of a battery, and with no other source of electricity than that of a crystal of Rochelle salts. Mr. E. B. Craft, assistant chief engineer of the Western Electric Company, gave a lecture, illustrated with lantern slides and motion pictures, of "War Developments in Electrical Communication—on Land and Sea and in the Air."

Personal

G. W. Milliken, superintendent of the La Junta, Col., division of the Arkansas Valley Railway Light & Power Company, has been elected a member of the local school board.

Mr. Harlan H. Edwards, member of American Association of Engineers, left his position with the Highway Laboratory of the University of Illinois and has been appointed City Engineer and Superintendent of Streets of Danville, Ill. This city has let a contract for a new garbage incinerator plant for immediate construction.

Captain A. A. Brown, of the Headquarters Company, 32d Division, U. S. A., formerly new business manager of the St. Paul division of Northern States Power Company, is at Camp Custer, Mich., and expects to be honorably discharged soon.

J. C. Rockwell has been promoted from local general manager to vice-president of the Manila Electric Railroad & Light Company, Manila, Philippine Islands, in charge of the general Philippine affairs of that company. This property is under the operating management of the J. G. White Management Corporation, New York, N. Y. Mr. Rockwell was graduated in 1904 from Cornell University with the degree of mechanical engineer. Following his graduation he engaged in track construction work. In 1906 he became superintendent of transportation of the Syracuse (N. Y.) Lake Shore & Northern Railroad Company. He was appointed general superintendent in 1909 of the Charleston (W. Va.) Interurban Railroad Company, and the following year was elected general manager of this company. In 1911 he joined the operating organization of the J. G. White Management Corporation, New York, N. Y., and was assigned to the Manila Electric Railroad & Light Company as manager of the light and power department. He was made general manager of that company in the early part of 1918.

H. H. Crowell, a vice-president of the Michigan Railway Company and the Consumers Power Company, who has represented the Commonwealth Power Railway & Light Company's interests for the last eight years, has been elected a vice-president of the Electric Bond & Share Company to fill the vacancy recently created by the death of George E. Claflin. Mr. Crowell has been identified with the electrical industry since 1889, when he entered the service of the Thomson-Houston Electric Company. Later he was New York State agent of the Thomson-Houston Motor Company and assistant New York State manager of the Thomson-Houston Electric Company until the organization of the General Electric Company, in 1893. He was manager of the Syracuse and Buffalo offices of the General Electric Company until 1906, when he became chief engineer of the Commission of Gas and Electricity of New York State and later of the Public Service Commission, Second District. Since 1911 he has been with the Commonwealth Power Railway & Light Company properties in Michigan. Mr. Crowell is a member of the National Committee on Public Utility Conditions, which has represented the public utilities in Washington during the war.

Obituary Notes

Harry Marshall Norton, secretary and treasurer of the Norton Electrical Instrument Company, of Manchester, Conn., died recently. He was widely known and highly respected in the electrical industry.

Foreign Trade Opportunities

The Bureau of Foreign and Domestic Commerce list the following inquiries from abroad for electrical goods and supplies. Particulars can be had by addressing the Bureau and mentioning the number given:

29,255.—Domestic lighting plants, such as acetylene and electric, and mining machinery are required by a man from Colombia who will soon arrive in this country for the purchase of same. References are given.

29,258.—The director of the equipment section of the naval aviation service of a European country desires to purchase electrically driven machine tools, for metal and wood, and to be used for hand drills, hand grinders, etc. This machinery is needed for the maintenance of the equipment of the service, and for the construction of new equipment. Catalogues, prices, and general information should be forwarded. Correspondence may be in English.

29,263.—Exclusive representation is desired by a company in India for the sale of electrical goods, motor cycles, motors, dynamos, electrical lighting sets, etc. It is requested that triplicate sets of catalogues, price lists, and samples where necessary, be forwarded. References.

29,266.—A manufacturing firm in Norway wish to purchase machinery to be used in an automobile factory. Drilling machines, milling machines, lathes, motors, frames, axles and starter equipment are required. Quotations should be given f.o.b. New York. Payment, cash against documents. References.

29,286.—The manager of a general business agency in Spain wishes to purchase electric sky signs. Correspondence may be in English. Reference.

29,325.—A firm in Belgium wishes to purchase material for central heating and ventilating installations, such as boilers, radiators, pipes, valves, ventilators, dust aspirators (vacuum), electrical automatic pumps and disinfection apparatus cleaners; and also to secure an agency or purchase mechanical laundry equipment, steam kitchens, refrigerator and ice-machinery lifts and vacuum cleaners. Correspondence may be in English. References.

29,335.—The president of a firm in this country, who is about to make a trip to Cuba and South and Central America, desires to secures agencies for the sale of electrical supplies and dynamos. References.

29,369.—Electric heating and cooking appliances, electric light fittings, electric wire, electroplaters, are required by a firm in New Zealand. Agencies will also be accepted. Quotations should be given f.o.b. port of shipment. Terms, cash against documents under New York letter of credit. References.

29,414.—A company in India desires to be placed in communication with firms, with a view to securing representation for the sale of electrical supplies. References.

29,434.—Electrical materials for railways are required by a man in Portugal. An agency is also desired. Terms of payment, letter of credit in New York. Correspondence may be in English. References.

29,452.—Electrical supplies of all kinds, electrical cables, etc., are desired by a firm in Norway. Quotations should be given f.o.b. American port of shipment. Terms, cash against documents. Reference.

29,517.—A firm in the Philippines having a branch office in this country desires to represent manufacturers for the sale of electrical appliances. References.

29,536.—A Government engineer in Peru desires to receive catalogues from manufacturers of all kinds of structural material used in the construction of public buildings and works, such as electrical fixtures, ornamental electric street lights. He desires these catalogues as soon as possible as all purchases will be made upon his recommendation.

29,542.—A merchant in Italy wishes to purchase or secure an agency for the sale of medical and dental equipment, electrical equipment, etc. Terms, payment on receipt of goods. Correspondence may be in English. References.

Trade Notes

During the past month, the Robbins & Myers Company, of Springfield, O., has purchased five and one-half acres of ground and all the factory buildings of the James Leffel Water Wheel Company, adjoining the Robbins & Myers plant at Lagonda. Immediately upon the James Leffel Company vacating its present factory and office buildings in Lagonda, the Robbins & Myers Company will assume possession, and will increase its force from 3,000 to over 5,000. The present Leffel factory buildings will be used for the time being, although the Robbins & Myers Company has under contemplation entire reconstruction of the buildings, connecting them with R. & M. plants Nos. 1 and 2 in what will be one of the largest factory buildings in Ohio under one roof, with facilities to accommodate more than 6,000 employees. This will give the company 98,000 feet of floor space. By the expansion made possible under the deal, the Robbins & Myers Company will indisputably become the world's largest exclusive manufacturer of electric fans and motors. Originating with a small casting foundry in 1878, under the ownership of Chandler Robbins and James A. Myers, the Robbins & Myers Company has experienced remarkable growth. In 1887, C. F. McGilvray, president of the company, and also president of the city commission, joined the firm as superintendent. In 1898, with a force of barely more than 200, the firm entered the electrical field, manufacturing ceiling fans and later desk and bracket fans. In 1899 it built its first power motors. The year following James A. Myers, H. E. Myers and C. F. McGilvray purchased the interests of Chandler Robbins and continued the firm as the Robbins & Myers Company. The purchase from John W. Bookwalter of the old rake factory in 1899 formed the nucleus for the present R. & M. main plant, which was reconstructed in 1907. The complete destruction of the R. & M. foundry in 1914 resulted in erection of Plant Two the following year. Plant Three, in the Shuey building, was acquired in 1918, and the new warehouse was also built last year. With the retirement in 1915 of H. E. Myers, the official personnel of the company became C. F. McGilvray, president; Wilbur J. Myers, vice-president, and Warren A. Myers, secretary. In 1917 H. E. Freeman joined the company as treasurer.

Paul W. Koch & Company, of Chicago, announce that they have opened Pacific Coast offices at the following addresses: No. 114 San Fernando Building, Los Angeles, Cal.; No. 324 Rialto Building, San Francisco, Cal., and No. 342 Sherlock Building, Portland, Ore.

L. V. Estes, Inc., industrial engineers and accountants, for a number of years located in the McCormick Building, have removed their offices to the Century Building, 202 South State Street, Chicago, Ill., where they occupy the entire 15th floor.

The Thordarson Electric Manufacturing Company, Chicago, announce that the demand for electrical toys and transformers has broken all previous records. "Orders for toy transformers are coming in at such a rate as to tax our capacity. We are increasing our space and facilities to meet the demand. We therefore urge you to place your orders at once so as to avoid disappointment. In many sections of the country it was impossible to secure toy transformers for Christmas trade last year."

The Cummings Electric Supply Company, of San Antonio. Tex., incorporated on March 13th and are conducting a strictly wholesale electrical supply business. Mr. J. G. Cummings, who is president and general manager of the company, has been engaged in the electrical business for over twenty years, in both the jobbing and constructing end. The company will carry complete stocks in San Antonio and this is the first strictly wholesale electrical supply house to be established in this territory. The company will cover South Texas and old Mexico. The next nearest jobbing points are Dallas and Houston, approximately 300 miles away. The Cummings Company are distributors for Safety Insulated Wire and Cable, Appleton Electric Company's Unilets, Arrow Electric Company's wiring devices, Buckeye Mazda lamps, Benjamin Electric Company and numerous other standard lines of material.

The Matthews Engineering Company, of Sandusky, O., have added to their line of full automatic lighting plants, which heretofore has consisted of 1, 2, 5 and 15 kilowatt plants, a new size known as their "Little Husky." It carries a 300 watt continuous rating on the generator. This plant is made in the 32-volt type, same as their 1 kw. plant, their argument being that even for so small a plant as this the limitations of a lower voltage make it most undesirable for the practical applications that a 15-light plant will obtain. This plant is the simplest possible kind of a direct connection of a generator to an engine. The generator frame and engine crank case are cast integral. The engine is a 4-cycle water-cooled type, 2-in. bore, 3-in. stroke. The plant is guaranteed to have 35 per cent. overload capacity. A 60-ampere hour Willard glass cell storage battery is used with the plant. Main bearings are 1 3/16-in. diameter, 2-in. long. Connecting rod 1-in. diameter and 1¾-in. long. The ignition is from a 32-volt spark coil, and breaker is mounted on the end of the cam shaft. The coil is mounted on the end plate of the crank case. The armature is the standard laminated drum type, hand wound, with closed slots for retaining the windings. It is impregnated with Bakelite varnish and baked. This is the first announcement that has been made of any lighting plant of this size and type.

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ELECTRICAL ENGINEERING

A Monthly Journal for All Interested in the Practical Application of Electricity
Published at 258 Broadway, New York

THE COMING YEAR

THE Convention at Atlantic City, in its large and representative attendance, and in the enthusiasm and optimism manifested, furnishes an admirable index of what may be expected in the development of the Electrical Industry in the immediate future.

The present issue of **Electrical Engineering** shows what has been accomplished in many and diversified fields.

An illustrated article on **"Electricity in the Largest Hotel in the World"** tells of novel applications of power to the service of guests, both in ways that are apparent to all and in others that are "behind the scenes."

The New Electric Generating Station at Denver is a great plant recently completed and this is illustrated and described by T. O. Kennedy and H. C. Kerr.

A Novel City Substation, by Roy E. Kline, tells how the difficulties in establishing a power plant on a narrow city lot in a residence section of fashionable New York were met and overcome.

Direct Current Armature Winding, by Jacob Gintz, Jr., is a practical and technical article on an important subject, illustrated with many diagrams.

Are Your Old Transformers Eating Up Profits?

Tests recently made on a large distribution network show that transformers built a few years ago have so much higher iron losses than modern ones that handsome savings can be made by replacing and junking the "old-timers."

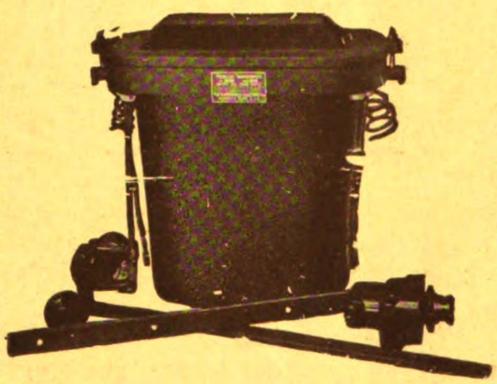
For instance, if a new 5 kva. transformer is substituted for one ten years old the saving in power will pay a 16% return on the additional capital investment. The iron used in early days aged so as to increase losses by 30 to 50%—a condition which has been removed by the use of silicon steel. Before deciding on your construction program, find out how many "profit-eaters" are on your lines. The field test is easily and cheaply made. Two men with a wattmeter can do it quickly by removing the primary fuses and reading the no-load losses from the secondary side. By comparing these with the guaranteed figures in the "Peerless" catalog, you can tell how many watts you are losing. Knowing your power cost, it's easy to see what you can save by installing

	Iron Loss	
Age (years)	5 kva. (watts)	10 kva. (watts)
1-4	40	70
4-5	50	82
5-6	50	85
6-9	60	100
9-11	85	132
11-19	95	167

Data on Transformers of Varying Ages, 2200 to 220/110 Volts

PEERLESS TRANSFORMERS

Their silicon steel cores show practically no increase in losses—that means they will not "grow old" in service; no need to replace them except for accidents, or a growth of load.



The cool running of **"Peerless"** Transformers on no-load means that they have a greater reserve capacity during the short daily lighting peak. Their core type of construction aids the circulation of cooling oil and is better able to withstand the shock of lightning surges.

"Peerless" Transformers in sizes up to 10 kw. are contained in plain cast-iron cases, with pole-mounting hangers and primary cutouts furnished. Above 10 kw. the cases are of corrugated cast iron or sheet steel with all seams welded.

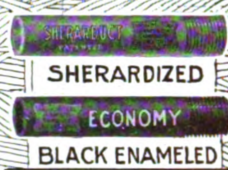
You can't afford distribution failures—that means "Order Peerless."

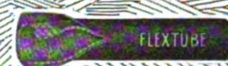
The Enterprise Electric Company

Warren, Ohio

"Transformers of all kinds for all purposes"

NATIONAL PRODUCTS





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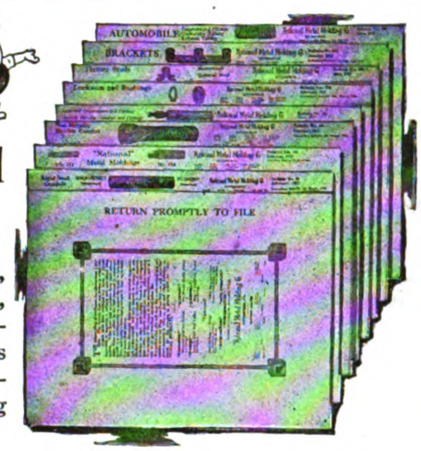
Interwoven — Seamless — Non-Collapsible. Inseparable and Double Compounded. Easy to fish and every foot of every coil can be used
Write for Bulletin 151

For Your Files

Complete data on Electrical Conduits and Fittings



A separate bulletin on each of our various lines, each bound in a standard correspondence folder, suitably indexed for convenient filing, either according to the name of the manufacturer or the materials listed. A system which permits the filing of correspondence, quotations, etc., in the folder listing the materials to which such may refer.

Any or all of the bulletins listed will be sent promptly on request

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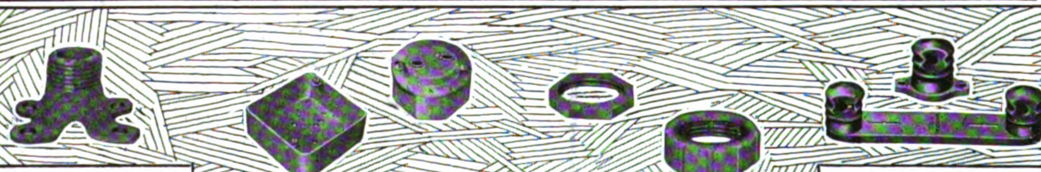
1108 Fulton Building, Pittsburgh, Pa.

Atlanta, Boston, Buffalo, Buenos Aires, Chicago, Dallas, Denver, Detroit, Havana, Los Angeles, Manila, New York, Paris, Philadelphia, Portland, Salt Lake City, San Francisco, Seattle, St. Louis

CANADIAN DISTRIBUTORS: CANADIAN GENERAL ELECTRIC CO., LIMITED 419



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Sherardized Stamped Steel. Hollow Stems. Stronger, and yet lighter, than any other stud on the market.
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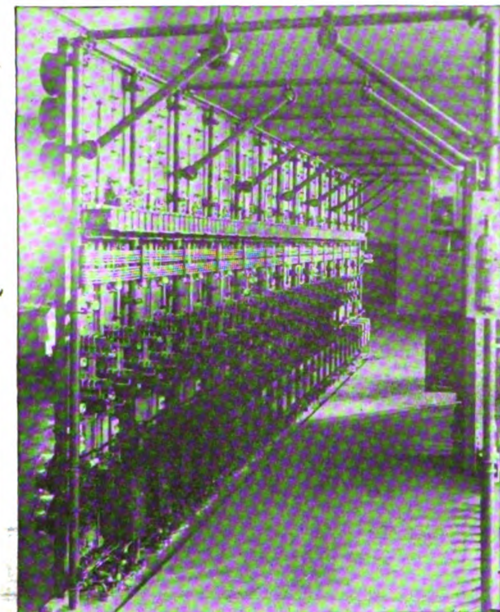
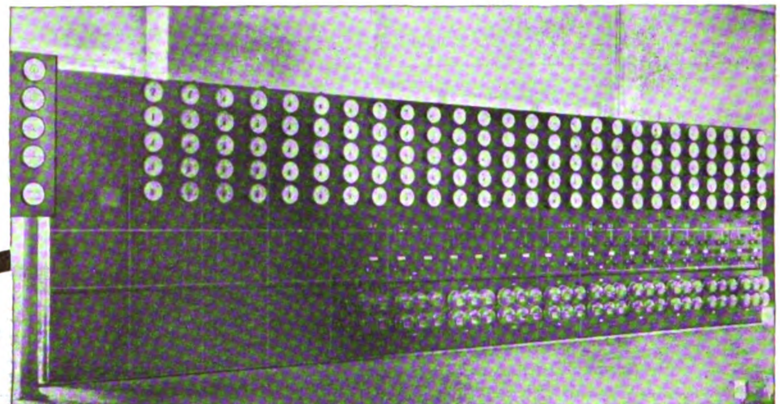
BRACKETS
Complete with insulators. Sherardized Bases. Wires run straight through. No Tie-Wires necessary.
Write for Bulletin 602

Westinghouse

Switch Gear in Cincinnati



Rear View of Main 13,200-Volt Feeder Board Showing Graphic Meter Panels to rear.



Main 13,200-Volt Feeder Board.-Each of the 14 Panels controls Two 300 ampere, 3-Phase, 13,200 Volt Circuits. Each panel also controls Four 600 ampere Electrically operated Type E-6 Oil Circuit Breakers.

WESTINGHOUSE ELECTRIC

The Union Gas & Electric Company's West End Power House in Cincinnati is one of the most modern in the country.

The initial equipment consists of two 31,250 kv-a 13,200 volt, 3-phase, 60 cycle turbine generators with exciters, and three 1,800 kv-a, 13,200/600 volt station auxiliary transformers; twenty-four 300 ampere, 13,200 volt out-going feeders and thirty 600 volt auxiliary feeders. Ultimate equipment will include 250,000 kv-a in turbine generator units.

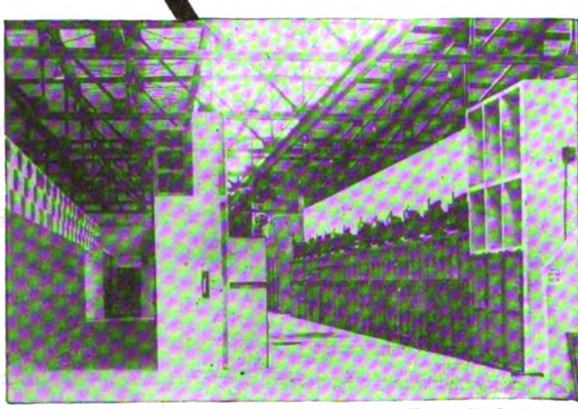
Sargent & Lundy, Consulting Engineers, designed and supervised the installation of the complete station equipment.

Representative of the magnitude of this switch gear (Westinghouse throughout) are the sixty, Type E-6; twelve Type O-2; six 2,400 ampere, multipole Type F-3, and fifty-four Type F-2 Oil Circuit Breakers, together with the four-section control desk, illustrated and a total of approximately 47 panels of control boards.

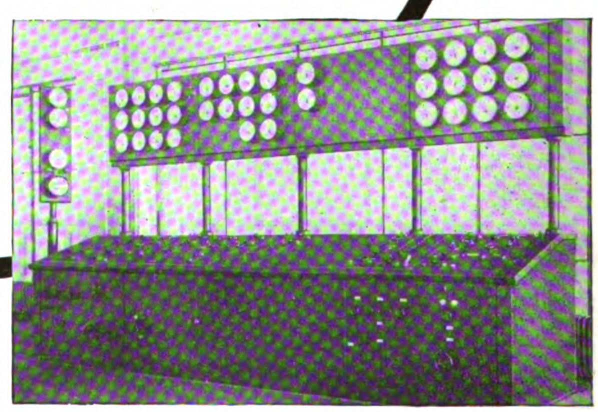
Westinghouse Electric & Manufacturing Company

East Pittsburgh, Pa.

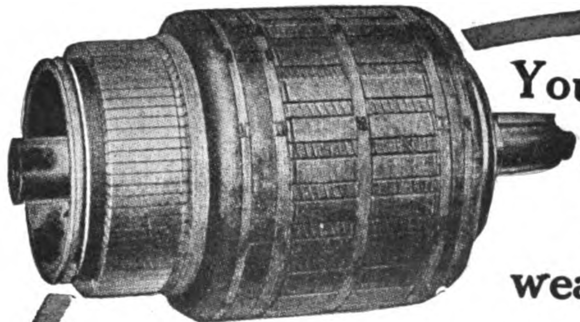
Sales Offices in All Large American Cities



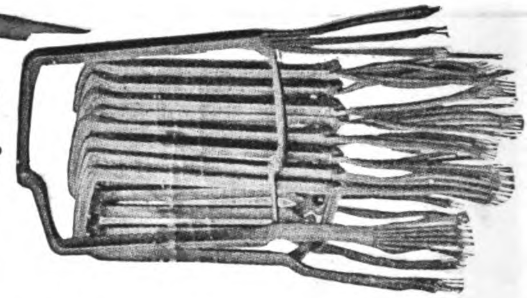
Main 13,200-Volt Type O-2 and Type E-6 Oil Circuit Breakers and Bus Construction.



Main Control Desk.



Your Motor is no stronger than its weakest coil



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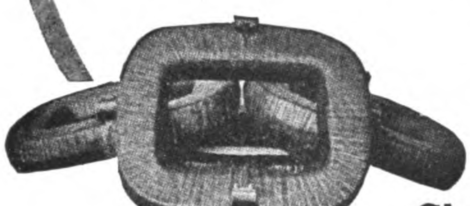

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THE NATIONAL AUTHORITY FOR TWENTY-FOUR YEARS

THE 1919 EDITION

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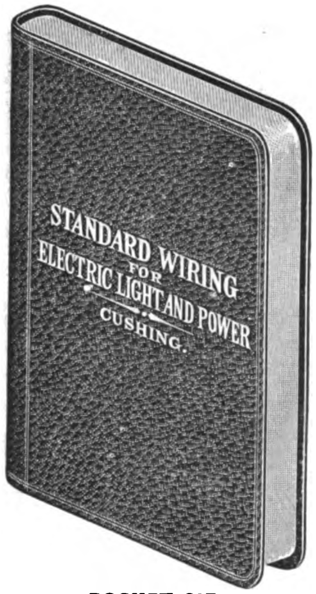
TELLS YOU HOW



POCKET SIZE
LEATHER COVER

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