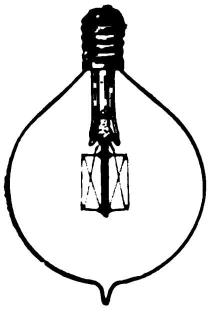
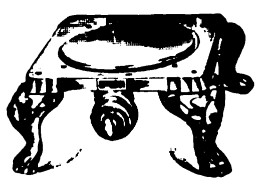
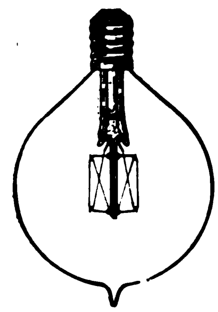
Electrical
VGA

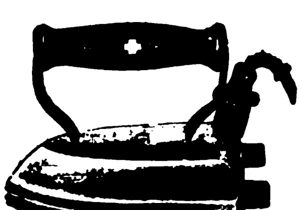
Electrical Engineering







WIRE YOUR HOME.—Those who endured the privations brought about by the recent cold snap and lack of fuel know now what a boon to mankind is modern electric service. Their more thoughtful and forehanded neighbors have told them that electric service spells light to see by when the gas mains chill and the pressure goes down; it spells warm rooms to live and dress in, warm water to wash in, warm beds to sleep in, and warm foods to eat and drink when the coal bin is empty and no coal offering for delivery. ¶ The judicious placing of a few electric heaters saved many a water pipe from freezing, bursting and flooding. ¶ Electric service wires don't freeze and burst; they don't lower the pressure when chilled; installed in a house equipped with lamps and heating and cooking devices they insure comfort and freedom from suffering and expense in all weathers. ¶ Call the electrical contractor today to wire your home. Ask the central station to connect you to its mains. Then seek the electrical manufacturer and dealer and equip your home with all the electrical devices that spell light and heat. ¶ WIRE YOUR HOME.



Electrical Engineering

Incorporating Electrical Age and Southern Electrician
ISSUED MONTHLY BY TECHNICAL JOURNAL CO., INC.
1642 Woolworth Bldg., New York
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GEO. A. WARDLAW, Editor

Volume 51 JANUARY 1918 Number 1

In This Issue:

Other Items of Interest:

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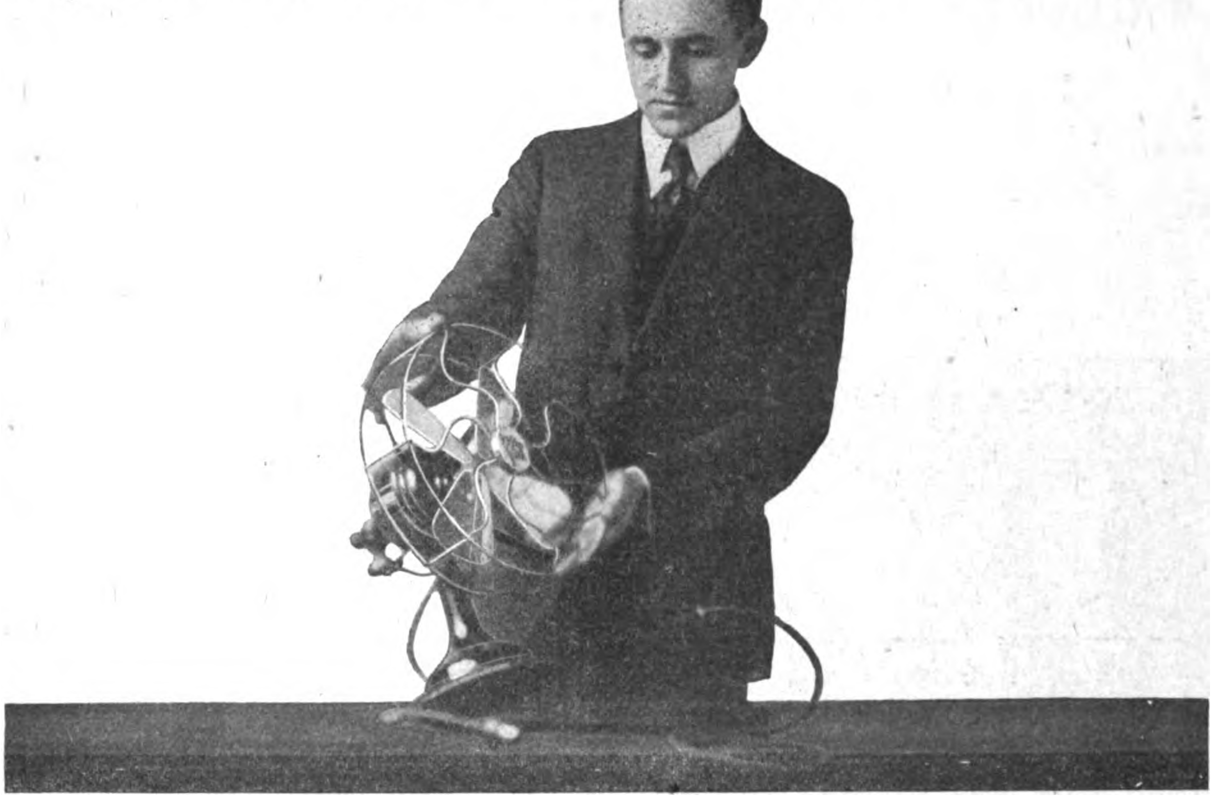
Robbins & Myers Fans



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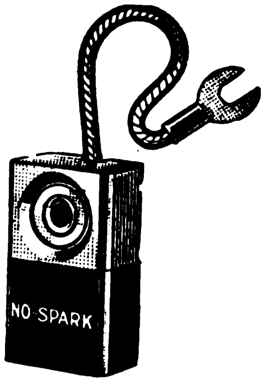

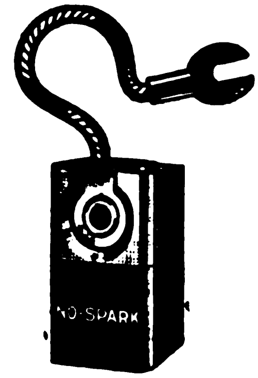

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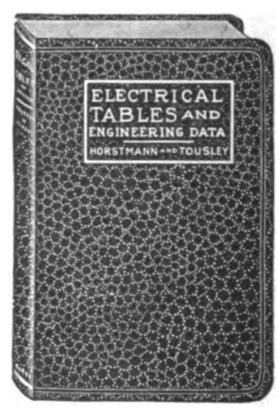

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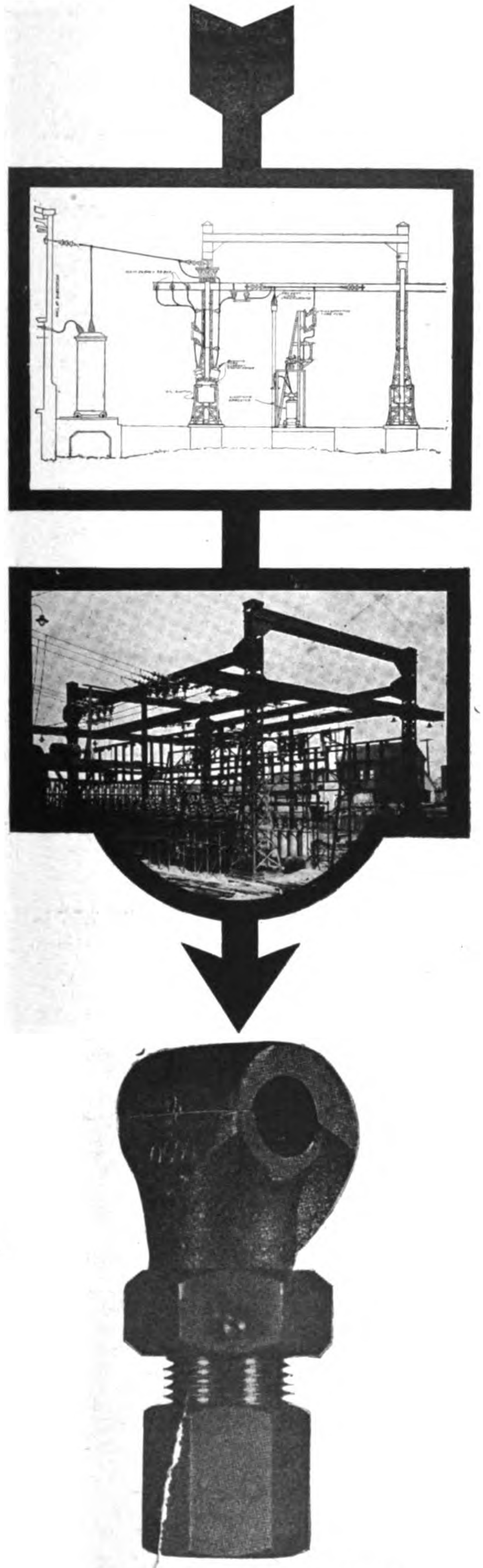

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Electrical Engineering

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

Technical Journal Company, Inc., New York

Vol. 51 **JANUARY 1918** **No. 1**

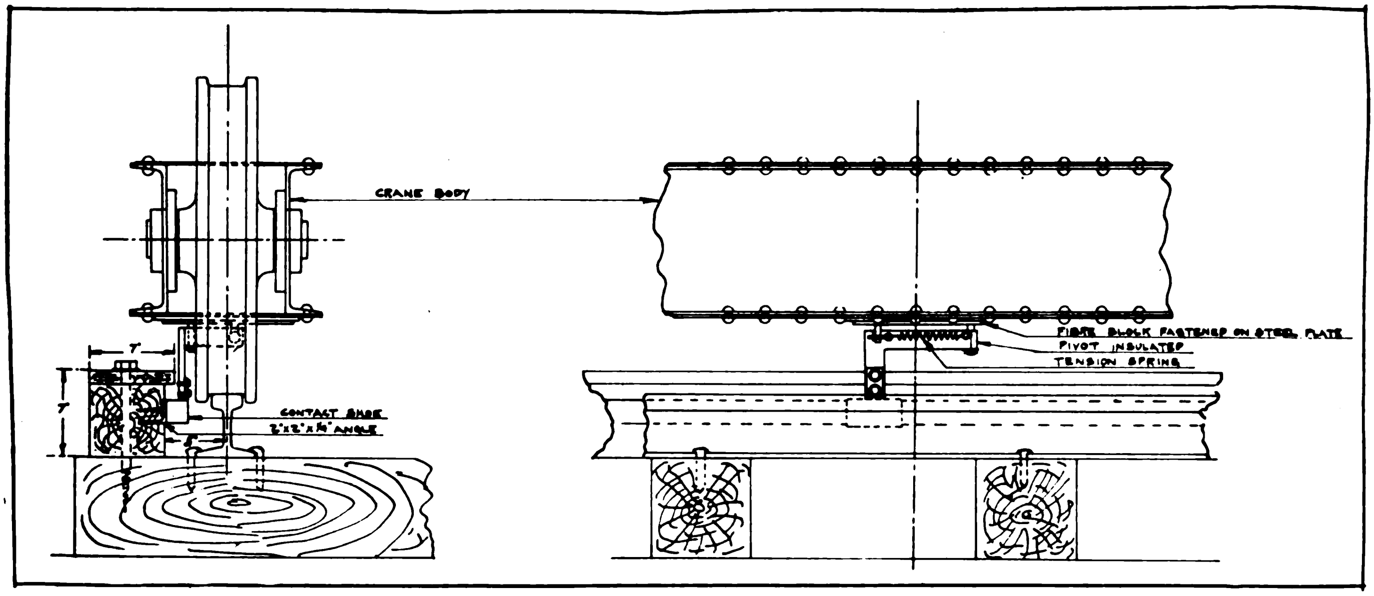
ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

By H. A. Hornor, Electrical Engineer

The fifth installment of Mr. Hornor's story, the last that has to do with the shipyard itself, takes up in detail the supplying of current to cranes, lighting fixtures and reflectors, lighting both temporary and permanent, and miscellaneous applications of electricity. A summary is added, containing approximate cost of isolated plants, wiring, fixtures, and motor equipments for machine tools. In succeeding installments the author will discuss electricity on the ship itself.

Supplying Current to Cranes

The accepted method of supplying current to overhead cranes is by means of trolley wires held on brackets secured to the building. Although there are many ways in which this may be done, by far the best method is to "sweat" the copper trolley wire into the bracket at intervals, making it a permanent job. Then the collector on the crane may be either a trolley wheel or sliding shoe. One of the old methods was to support the trolley wire loosely and pick it up with the sliding shoe as the crane moved. This method has been found dangerous and expensive in practice, for if the trolley wire burns off or is mechanically broken it falls to the ground and may do great damage. Even if it does no injury it generally means an entirely new trolley line. The methods are a little more varied for gantry crane trolley lines and much more difficult, as both the questions of mechanical protection and good insulation arise.

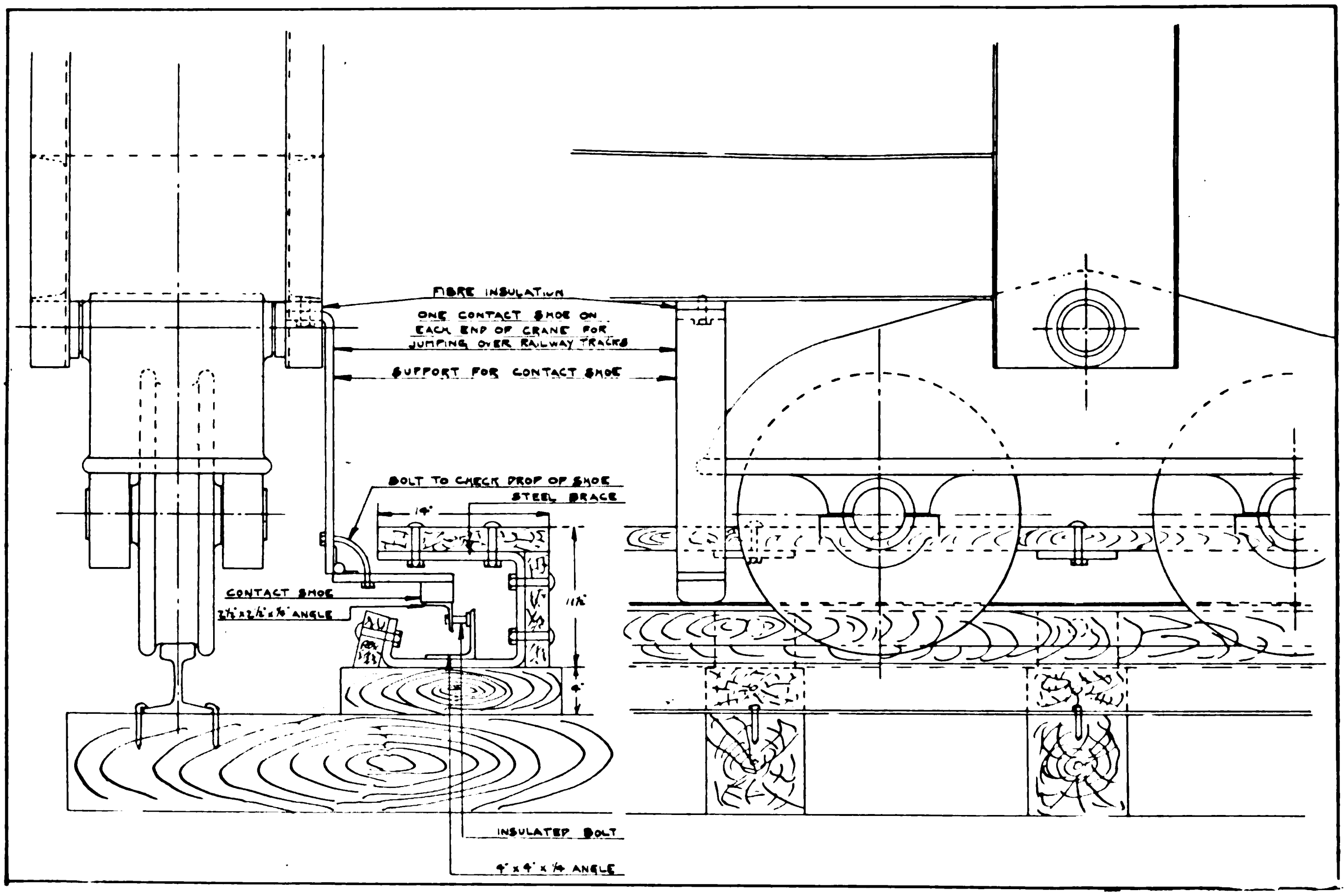


Method of conducting current to small gantry crane. New York Shipbuilding Co., Camden, N. J.

A method for small gantries using a piece of timber 7in. x 7 in.

with a small steel angle set into it is shown in the accompany sketch. This sketch shows only one side of the circuit, the other side being an exact duplicate. In situations where the entire circuit must be carried on one side the same method may be used by raising one conductor over the other or placing them side by side. This has given good service. Another sketch shows the method of conducting current to a large gantry crane. After looking at these sketches it may seem that here was an opportunity for the satisfactory operation of a surface contact system. This system has been very much developed recently and appears to be suitable. Its introduction is probably only withheld because of the first cost of installation which it is understood is rather high. Of the systems illustrated it must be said that little or no trouble is experienced, however likely it may appear that such would be the case.

on the hoist motor, thus stopping further upward movement and at the same time placing the knife blade in contact with opposite jaws which maintain the lowering circuit intact. For this reason the operator may now lower his block and load, but cannot again hoist until he crawls out from his cage on to the trolley and manually resets the switch. He can make no adjustments. After the operator has unintentionally done this a couple of times he soon becomes attentive enough not to repeat it. The advantages of this particular type of limit switch cannot be overstated. An example of the saving of cables is illustrated in one case where the records showed forty to fifty cables a year were replaced, or approximately one new cable a year for each crane installed. After this limit switch was mounted on all cranes nine or ten years ago the records show no cables broken down due to over-travel of the hoist. There



Method of conducting current to large gantry crane. New York Shipbuilding Co., Camden, N. J.

The Hoist Block

Although over-travel of the hoist block is dangerous in that a serious accident may result either when lifting a load or with an empty hook there is also a further consideration—the breakage of cables, which results not only in a loss of time but also in a renewal of the cable. Cables are very expensive. The crane builder usually provides a device for the purpose of limiting the upward travel of the block, and there are almost as many designs as there are crane manufacturers. The desired function of this protective mechanism is to make it impossible for the operator to tamper with it and not put severe limitations on the operation of the hoist with a long sling or some large piece of material. The accompanying illustrations show a type of limit switch which completely fulfills this specification. A near view is also shown, likewise the device mounted on the trolley of a 10-ton crane. The knife blade is held in the hoisting position by a latch against a heavy spring. The threaded stud is moved by the gear attached directly to the main hoisting gear. When the runner on the threaded stud releases the latch, the spring instantly opens the hoisting circuit which sets the brake

comes to mind the reduction of accidents but of these data there is no record. It can be assumed, however, that those in responsible charge of the thousand of men working beneath these cranes are greatly relieved from anxiety.

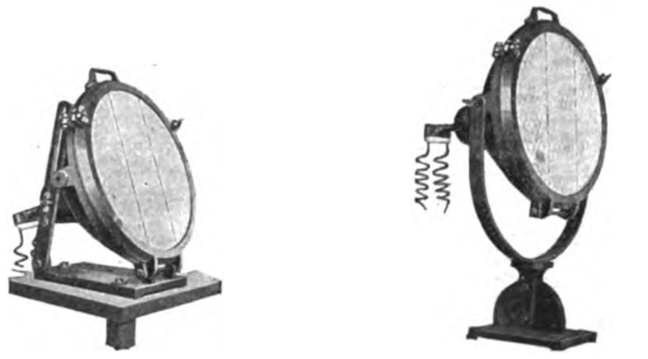
The Lifting Magnet

In certain operations the way is entirely clear of men and the work to be done can be handled economically by the lifting magnet. This is especially true in the general store department. One of the regular duties of this department is the sorting of plates. These plates arrive in the yard on flat cars and are unmarked. It is the function of the general storekeeper to mark this material for the contract (ship) for which it is to be used and then stack these plates together. A pair of rectangular lifting magnets of about 7½ tons capacity is suspended from the crane hook, or hooks in case of a double trolley crane, and then lowered on a pile of plates either in the railway car or on the ground. This pair of magnets will lift about three or four quarter-inch plates, and by the quick action of the switch the crane operator becomes skillful enough to drop off one plate

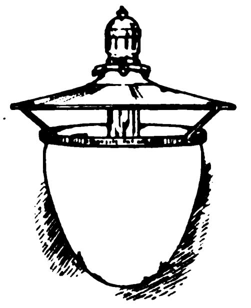
SOME OF THE LIGHTING FIXTURES USED IN MODERN SHIPYARDS

Type SDX projector with numbering box. Crouse-Hinds Co., Syracuse, N. Y.

Type SDY projector. Crouse-Hinds Co., Syracuse, N. Y.



Searchlight for shipyard use. George Cutter Co., South Bend, Ind.



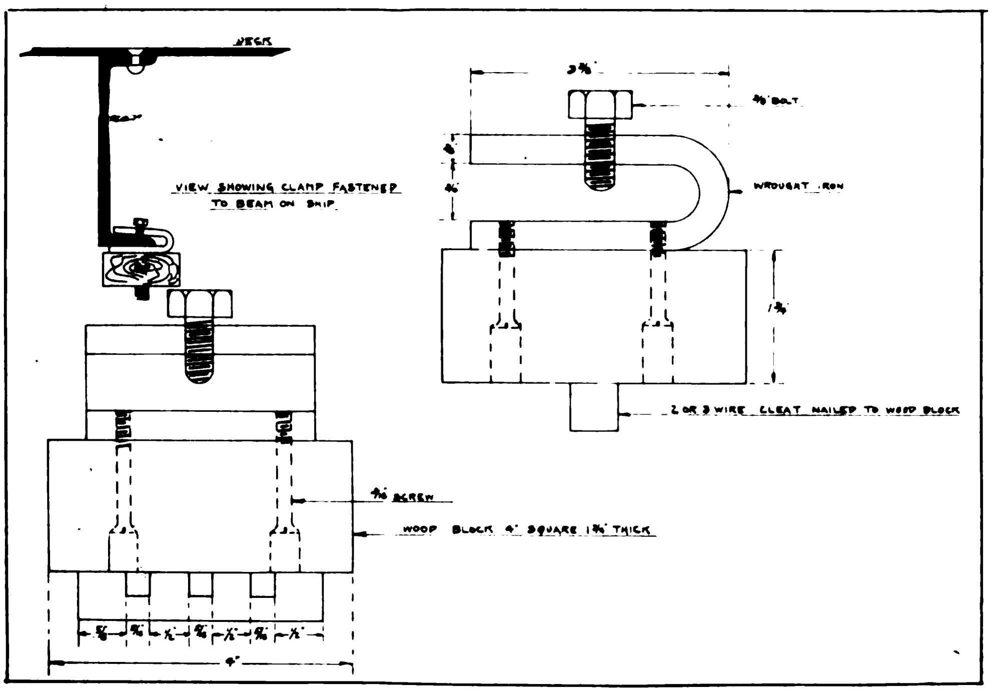
Stransky-lite fixture No. 10. Stransky Mfg. Co., Inc., 337 N. 11th Street, Philadelphia, Pa.

Four of the lighting fixture shades for shipyard use made by Harvey Hubbell, Bridgeport, Conn.

at a time. Such an operation, or indeed the use of magnets at all, could not be thought of except in a place devoted to just such work, as the magnet depends upon the continuous supply of electric current, and failure of this for any reason would cause a serious accident if handled over men or machinery. Another application of the magnet in shipyards is that of handling "scrap material." Such wastage is usually of steel, but in various shapes such as punchings, curlings, bits of plate, etc., and as the market price of this material fluctuates it becomes important to pile the scrap until a proper time arrives to sell it. Circuits are arranged in the yard so that one or more of the steam locomotive cranes may hook on the magnet, plug in the portable wire, and load a railway car. This operation, like that in the general store department, was previously man-handled, requiring usually about 12 or 15 men.

Storage Battery Locomotive

Before passing to a consideration of the lighting system a word should be said about the storage battery locomotive and its absence from general shipyard practice. One of the recent yards has in operation a small storage battery locomotive, and its use has caused orders to be placed for more; but the larger and older yards do not seem to realize the benefits of this apparatus, although in other industrial fields it has more than proved its reliability and economy. As previously stated, and no doubt now fully established, electricity plays a large part in the equipment of any shipyard, therefore the current necessary to charge a storage battery is always available and in this case appears simply as a transformation of energy. As a matter of fact, from the electrical engineers' point of view the shipyard that makes its own power the charging of storage batteries at night really costs nothing. In the first place a certain amount of current must be generated at night for night lighting and in busy times also for power. This requires the same size of machine that was running all day, but with a much lighter load. To take off of this generator the small wattage needed to charge a few batteries could not be discovered in the coal consumption by the most elaborate methods of testing. Perhaps this added load at night might increase the generator efficiency, as such apparatus is usually less efficient at loads lower than full load. If this happened to be so it could be said that the storage batteries were charged without cost. As to the labor connected with the charging process, any plant that has to work at night provides a man for looking after the electric apparatus used at night. Usually this man is not fully employed, and a part of his time could be used for this purpose prof-



Support for semi-permanent temporary wires for use on ships under construction. New York Shipbuilding Co., Camden, N. J.

itably. It is believed that the usefulness of the electric locomotive will be increased when, as suggested above, a design is made that will include some form of hoisting device, as such apparatus no doubt will make a greater appeal to those directly concerned in the increase of production in shipyards.

Lighting System

So many shops, often necessarily crowded, make artificial lighting a requirement at all times. In northeastern latitudes the working hours fall in winter to a dark period in the morning and late afternoon. At such times there is a peak lighting load. Even in extreme southern localities there would still be dark places in the shops and the ships under construction. Af-

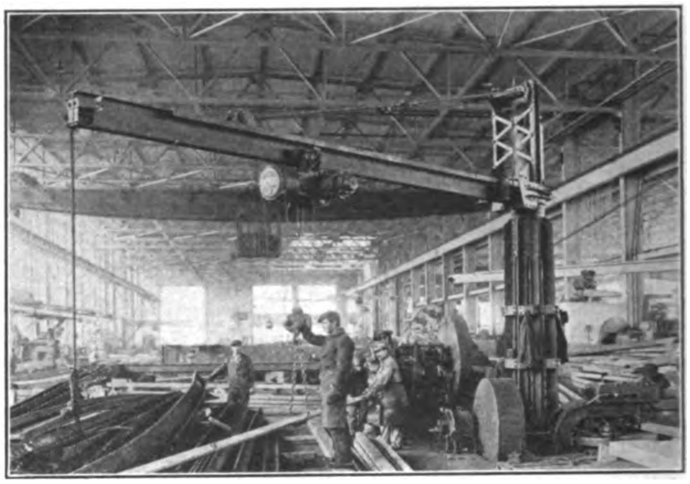
Two-motor hoist on jib crane—not a square foot that is not covered by a crane. Fore River Shipbuilding Corp., Quincy, Mass.

ter the keel plating is started, the frames set, and the shell plating bolted into place the compartments of the ship begin to take shape and, even if the ship is building in the open, few stray beams of daylight fall into the interior. This is intensified as the decks are laid and the hatch frames set in place. Then the ship structure becomes dangerous as well as unworkable, and artificial light plays the role of a great safety factor. Thus it comes about that the ship structure must be lighted as the work progresses. This type of lighting is commonly called "temporary lighting" because all the material used is torn out of the vessel when completed and the nature of the construction must be such that this may be accomplished with as little destruction of the wiring as well as injury to the hull. Thus the subject of lighting divides itself into two main divisions, permanent lighting and temporary lighting.

Permanent Lighting

The illumination problem is one of large spaces. If the shipyard is designed for covered sheds over the building ways the proportions of each building will be approximately 100 ft. wide, 700 ft. long, and 100 ft. high. These are the largest spaces. But the machine shop, boiler shop, and plate and angle shop, present more of a problem although of smaller size. The addition of machinery in these spaces requires a more careful study of the problem. General lighting with overhead lamps and either low lamps or portable lights at the machines is usually the solution.

Historically, the shipyards started their electric lighting with the Edison carbon filament lamp. Upon the introduction of the old carbon arc lamp, the incandescent lamp was discarded. As



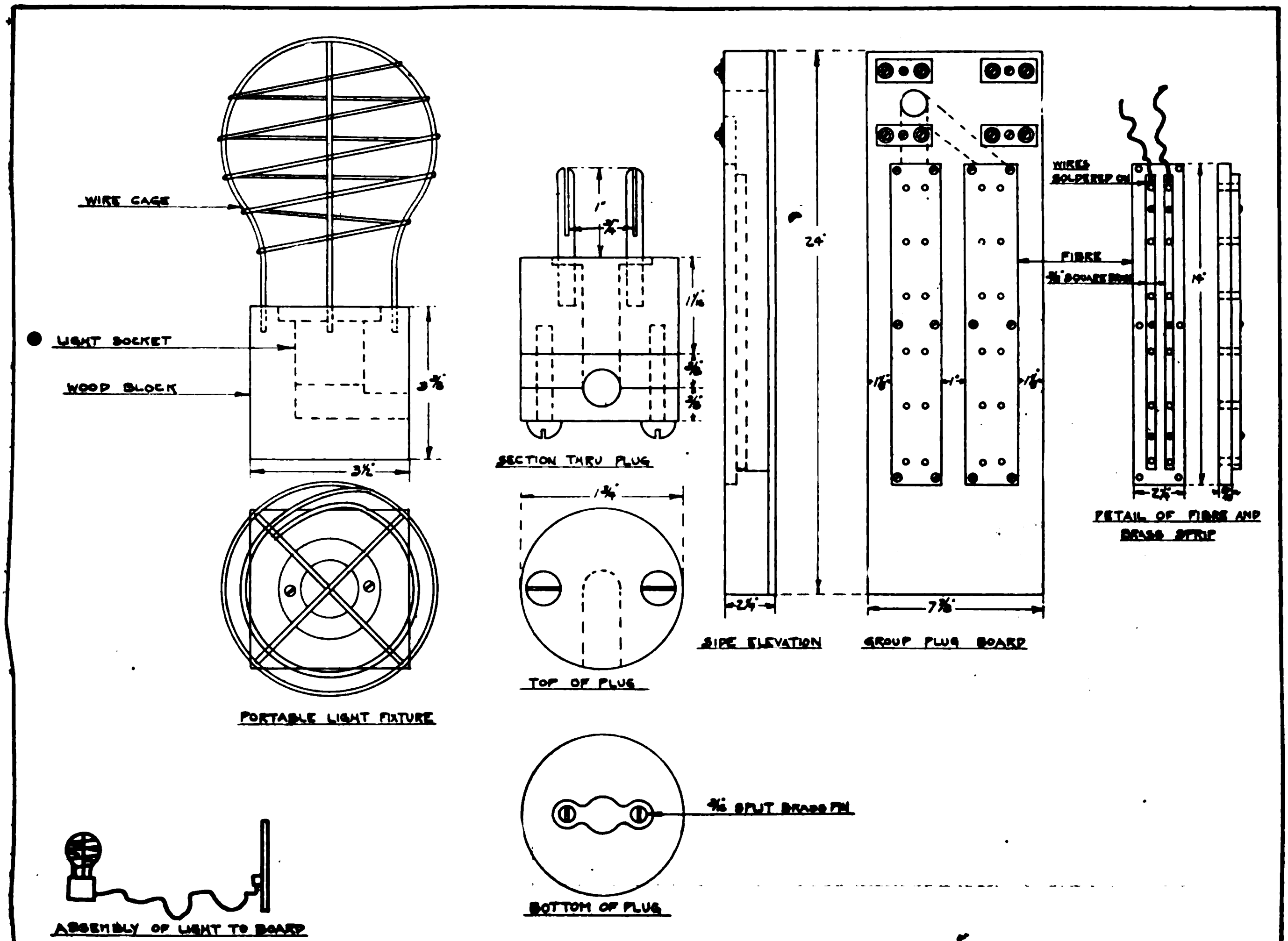
Self-supporting bracket crane, 3 tons, serving a heavy punch used for punching deck beams and ship frames. Fore River Shipbuiding Corp., Quincy, Mass.

the arc lamp was developed up to the flame arc lamp with impregnated carbons this type was used. Now that the tungsten filament incandescent lamp of high candle power has become generally commercial, it in turn replaces all types of arc lamps. The use of 220 volts which so admirably fits the conditions for the power system becomes a nuisance for the lighting system. In the early introduction of 220 volts it was thought that a multiple arc lamp for parallel operation on 220 volts would be a successful lighting unit. This hope fell far short of the reality, and it was but a short trial that turned the illuminating engineer against it. Everyone recommended the use of 110-volt arc lamps, two in series on 220 volts. This required the attachment on each lamp of a cut-out resistance; that is, a resistance that would automatically come into the circuit when one of the two lamps was extinguished for any reason, thus compensating for the lamp that was out. Although this was a compromise of some value it did not fully cover the case when the lamps were widely separated, as the extinguishing of one lamp might cause a stoppage of work or present a dangerous condition.

It was thought also that there was a future for the 220-volt incandescent lamp, and this voltage being much off the standard of house service would prevent the stealing of lamps. Further hope in the development of the 220-volt incandescent lamp remained almost up to the present time because of the general use of this voltage in many countries of Europe. This expectation is now altogether shattered, and recommendations from those who are recognized leaders in investigational work recur to the exigency of two 110-volt lamps in series, or the use of a balancer set on direct current, or a balancing coil on alternating current. Their reasons briefly stated are: lower cost of 110-volt lamps, higher efficiency of 110-volt lamps, superior service performance of 110-volt lamps.

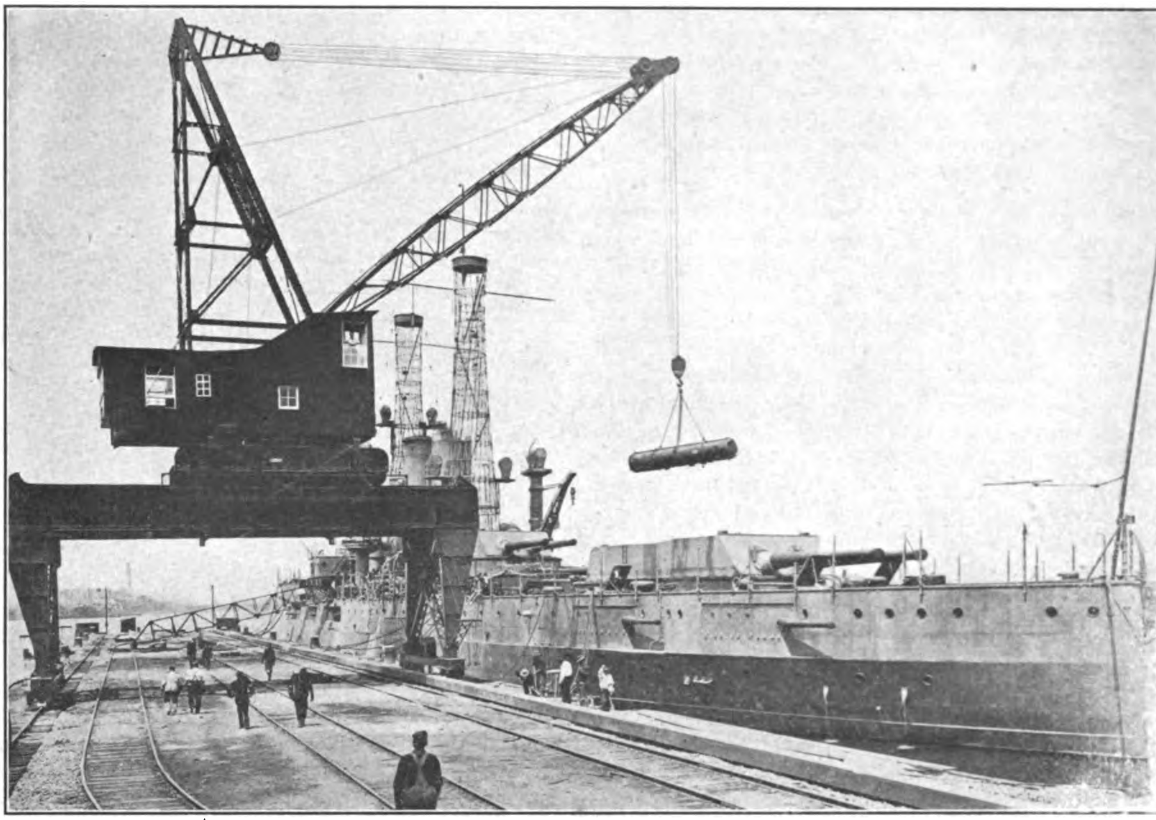
This whole question is fully covered in an excellent bulletin issued by the Engineering Department of the National Lamp Works of the General Electric Co. This bulletin shows that the 220-volt lamp costs 20 percent. more than the 110-volt lamp; that they give "only about 90 percent. of the light which corresponding sizes of the lower voltage lamps give . . . ". The concluding sentence of this article really settles the matter for the practical man. It is as follows: "Lamps of 110-125 volt class compose at present approximately 85 percent. of the output of mazda lamp factories, exclusive of miniature lamps, as compared with a figure of less than 7 percent. in the case of 220-250 volt lamps; hence, emergency demands may be more readily satisfied." This is certainly conclusive in every sense. It was natural that the tungsten lamp would drive the carbon lamp out of the market, and now the 110-volt mazda finishes all discussion with the 220-volt lamp. As in alternating current a genius is needed to solve the practical problem of a frequency that will satisfy both a lighting and power load, so here in direct current lighting a genius is needed to furnish the compromise voltage.

The manufacturer of reflectors for use with the various high-powered tungsten units has well studied the illuminating problems and he produces a fixture that in every way is suitable for the lighting of the shipyard. The question of clusters versus single units arises. If the series method is adopted a good compromise is the four-light cluster, so that in the event of one lamp burning out there remain two lights to guard against a shut down or danger. Outdoor fixtures designed fully to protect the connections from dampness and to shed the rain water or melting snow; indoor fixtures which in some designs are simply modifications or omissions from the outdoor type; fixtures with reflectors placed at every conceivable degree from zero to a great circle, throwing the rays of light in any wished for direction—these comprise, with many more attractive designs, the stock which the fixture manufacturer offers to the shipbuilder. Many of the designs embody easy means of adapting the proper reflector for change in size of lamp, as for instance, a range of from 300 watts to 1000 watts. This permits, if the wiring is heavy enough, materially to increase the lighting in a shop in the event that the initial installation proves unsatisfactory, or vice versa. Another feature that is usually pro-

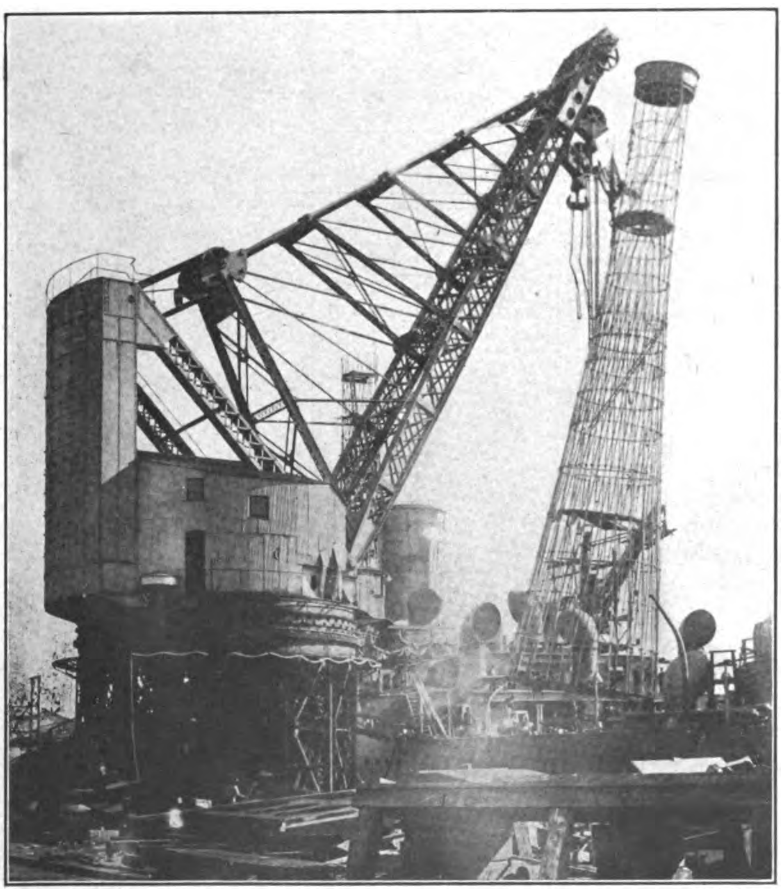


Temporary lighting portables and plugging-in board. New York Shipbuilding Co., Camden, N. J.

vided is that the fixture is made independent of the permanent wiring of the building so if it is desired to change the size, or type of lighting unit, this may be done at no great expense for rewiring.



Gantry crane in yard of New York Shipbuilding Co., Camden, N. J.



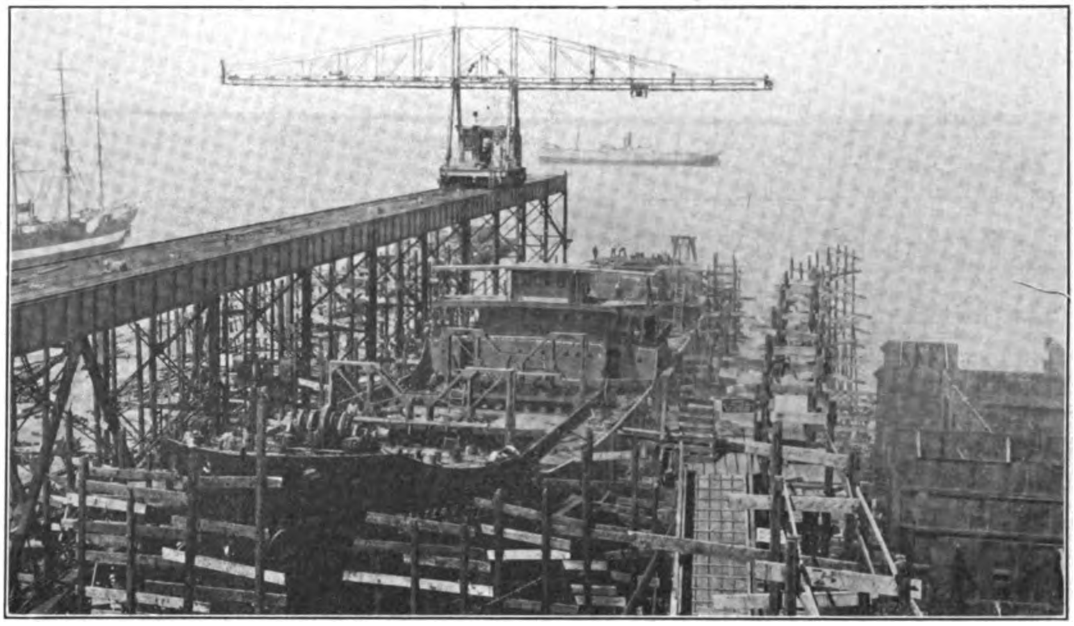
Putting complete assembled military cage mast on board battleship by means of Hercules crane. Hercules crane, 150 tons, 70 tons with boom extended. New York Shipbuilding Co., Camden, N. J.

Temporary Lighting

As soon as the keel blocks are laid for the construction of the ship, an electric circuit is carried down the whole length of the ways on these wooden supports. The construction is a simple porcelain knob and the wire drawn up taut at each end. Plugging-in boards, which consist of a block of maple wood into which are sunk flush sockets to any desired number, usually 12, enclosed fuses on the mains, are connected at intervals all along the line. This is the beginning of the temporary electric service for the ship. This whole work is conducted by a separate group of men whose duties are solely to look after the temporary lighting needs of the various workmen on the ship. Each workman is equipped with a portable lamp and plug which he keeps in his tool chest. If he breaks the incandescent lamp he merely goes to the compartment of the ship where the temporary lighting man furnishes him with a new lamp, or an entire new portable if that is in bad condition. The portable lamp outfit consists of a molded water-proof composition (pressed mica) socket with a galvanized iron guard, a plug and about 50 ft. of portable wire.

After many years of practical trial the best portable wire on the market for this particularly hard service has been found to be, two No. 18 B. & S. wires covered with 1-32 in. flexible wound with Packinghouse cord. The trade name is "Packinghouse cord." This material must stand the shock of heavy walking upon, of abrasion against sharp edges of steel plates, and sustain itself against the blow of a falling piece of steel. It must live up to reliability when the ship is exposed to rain, hail, or snow, and if left in a pool of water all night must be quite able to function properly the next morning.

In the ship proper, as the beams are bolted up the other temporary looking wires assume the appearance of permanency. This is only appearance, for a ship at any stage of construction could be stripped of all temporary wiring in a few hours. The cut on page 25 shows how this is accomplished. A casting is made, or a piece of plate bent, to slide over the heel of a channel beam or bulb angle beam. To this attachment is screwed a wood block upon which the wiring is carried. This whole device is secured by a screw bolt to the heel of the beams and the wires are strung along both sides of the deck on each deck. As in the line, on the keel blocks at desired intervals plugging-in boards are tapped from these mains and the workmen derive their electric supply from these boards.



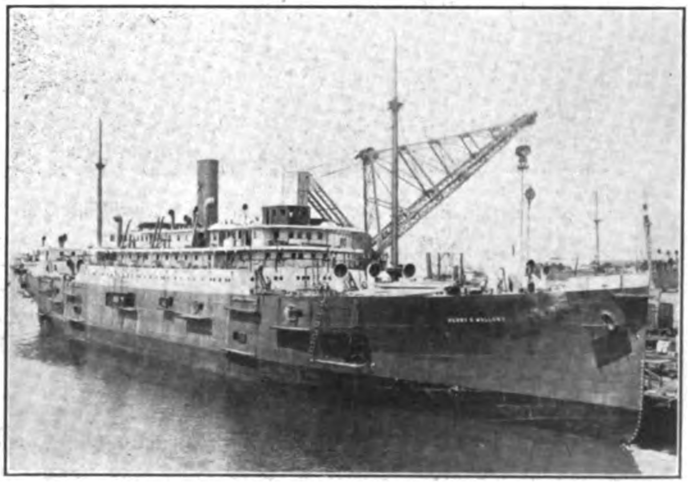
Ship during construction, showing double arm crane on trestle. Newport News Shipbuilding Co., Newport News, Va.

Everything went very well with this system of temporary lighting on ships under construction using 220-volt lamps and with protective fuses on the mains at their one point of distribution. When the shipbuilder started to build oil tankers, or ships equipped to burn oil under the boilers, a condition arose at the finishing stage that compelled a complete change in the methods previously employed. When such vessels arrive at the state which permits the filling of the fuel oil tanks it becomes imperative to change the type of portable to one that encloses the incandescent bulb. This resembles, and in fact is, the type used for the permanent electric equipment on board ship and is known as a watertight hand portable. Besides the glass globe which encases the lamp bulb it also has a brass guard around the globe. Each individual lamp on the semi-permanent temporary lines must be protected by an enclosed fuse, and every precaution taken to insure against an open spark or arc. The fuel oil in itself is not dangerous, but the gas mixing with the atmosphere is unknown in proportions and therefore cannot be depended upon not to explode, especially if ignition is added to its already unstable condition.

The same question as in the permanent lighting of the plant comes into notice; namely, the use of the 110-volt lamps. Already some of the shipyards have provided themselves with small balancer sets which may temporarily be placed on board the ship under construction. This again is a precaution necessary to take on vessels having anything to do with oil, for it has been observed in practice that without any apparent reason the 220-volt lamp explodes. This is dangerous enough for the individual workman, but more serious when the whole ship with many men may be seriously hurt. This unlooked for characteristic of the 220-volt lamp is accredited to a deficiency in the quantity and quality of potash which enters into the manufacture of glass for bulbs. In the 220-volt lamps full pressure exists between the first and last strands of the filament, and this will produce a current transfer through the air left in the bulb. It is stated that this is more severe in the case of direct current, which is now under discussion, and an arc will form which "travels rapidly toward the base of the lamp and ruptures the stem." This latter action of the 220-volt lamp is cited to show that normally this lamp is dangerous even if the ingredients of the glass were correct.

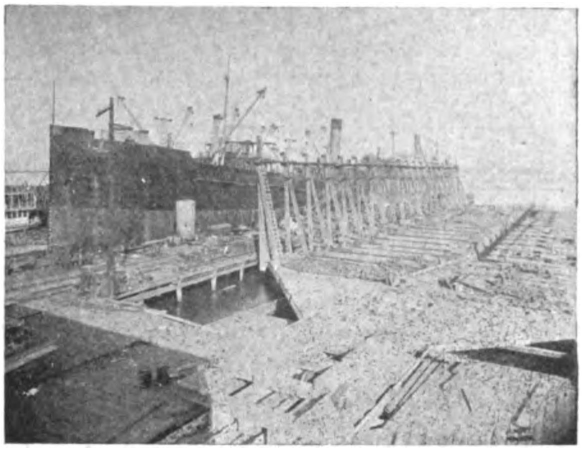
Much ingenuity is expressed by those interested in temporary lighting clusters. Two examples are shown in the annexed cuts. This type has been jocularly named the "tin pail type." It has answered all the requisite requirements that the designer had in view. The handles of the familiar culinary utensil make excellent hooks for supporting the cluster in any desired position. Herewith is shown another device that gives good results even when placed in serious competition with its professional brother, the flood-lighting unit.

Many men who are not followers of the lighting developments of the last five years fear to work on the construction of a ship by night. To those who have a knowledge of improved lighting methods there is not let nor hindrance. To be sure,



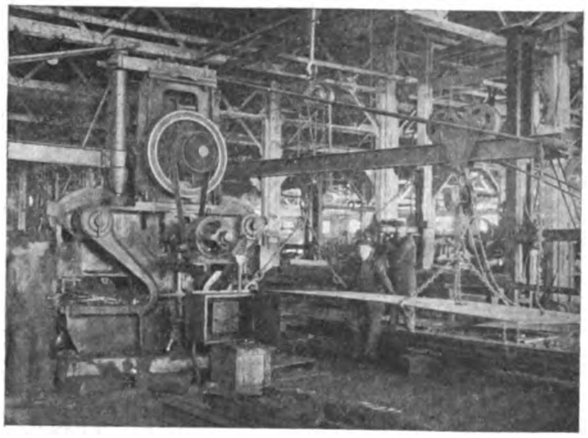
Steamship "Henry R. Mallory" during construction, Hercules crane in background. Newport News Shipbuilding & Dry Dock Co., Newport News, Va.

night work on such a steel structure appears dangerous, but the interior is well lighted by day and work could not be done except by artificial light. If the ship is building under a shed sufficient light can be provided with little expense to answer all questions of risk to those workmen employed on the outside of the ship. Due to the nearness of the scaffolding it is difficult, if



Marine Railroad. Ships undergoing repairs. Standard Shipbuilding Corp., Shooters Island, N. Y.

not dangerous, to throw flood-lighting on the sides of the vessel, because these powerful units would have to be too close if placed inside the scaffolding and would create too deep shadows if located outside of the scaffolding. But something might be gained by locating the floodlights high, and throwing the light down along the sides of the ship, or locating them down on the ground and throwing the light upward. If the ship is built in the open it is probably provided with some type of crane, or cranes, and lights located on apparatus will aid in the general illumination on the exterior. This question has been practically investigated recently and the results are very gratifying. Some large tungsten units, 500-watt and 1000-watt lamps, have been permanently mounted on the gantry crane which spans the ship,



Motor operated punch and shear. Standard Shipbuilding Corp., Shooters Island, N. Y.

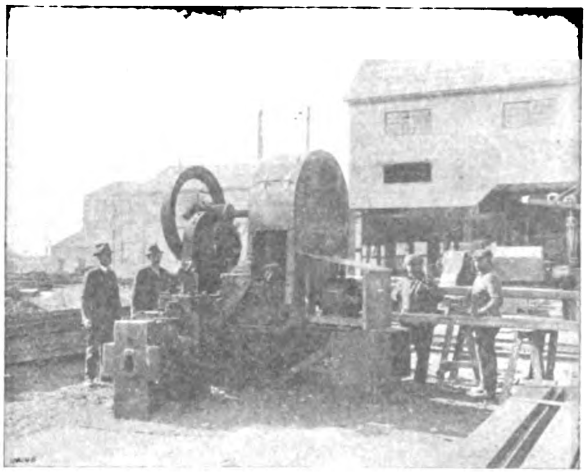
and in addition flooded-lights and clusters are used on the exterior. There is no change necessary in the interior lighting as used by day. The owners, or managers, of shipyards who wish to speed up the construction of ships by working all night only need turn to the illuminating engineer.

Miscellaneous Applications

There are a number of systems using electricity which can hardly fall in the broad classification of either the power or lighting systems. They are all in the nature of call bell systems or telephone systems; that is to say, applications requiring small wiring. They have their importance nevertheless and often are a great necessity. Thus most of the shipyards are equipped with a fire alarm system. There are a number of well designed methods on the market. The installation work is usually done with cables and the general functioning is planned for safety. The energy is small, and so may be handled by some type of wet cell, or other source of energy not dependent upon the main power. The signals may be sent to any desired point where the general alarm may be sounded, as for example the power house where the alarm may be given by blowing a sufficient number of blasts on the steam whistle.

Call bells operating on annunciators are regularly installed in the main office. On this system will be additional connections for signals for the night watchman, etc. Of course such a system includes besides the regulation push buttons for call-boys, also a system for stenographers and special calls for secretaries, etc.

As such a plant is spread out over a large territory it is necessary to provide watchmen for night guard duty. Those men in turn have to be watched. There is provided a system whereby the watchmen on their different beats record their time on a dial clock provided with a chart which may be examined by the superintendent every day, and in the case of fire or accident gives evidence as to the time the event



Motor operated punch. Standard Shipbuilding Corp., Shooters Island, N. Y.

took place. As in the case of the firm alarm, there are numerous systems on the market, any one of which will satisfactorily perform this function.

As to the telephone: some shipyards probably retain a local system of telephones; but to-day the large telephone companies are pleased to sell transmission of intelligence just as the central stations like to sell transmission of power. Arrangements can be made so that the telephone company installs the local telephones and provides a branch central. This system will be maintained by them. It then becomes a case of annual rental for the shipbuilder. The manufacturer of telephone material is ready on the other hand to sell satisfactory apparatus of various designs if a privately owned local system is desired.

The making of blueprints for tracings is an important item in the main office of the shipyard. This work must be very quickly done so as not to delay the work in the yard for want of instructions. In recent years there has been much development in blue printing machines using artificial light. The unreliability of sunlight puts this method out of consideration in a shipyard of any size. These blueprint machines use arc lamps for the source of rays for printing, and by means of a motor automatically revolve the drawing to be printed in the rays of the arc lamps. The negative blueprint is further rolled into a tank of water, drained off and drawn before a bank of electrical heaters. In this manner the attendant merely feeds the machine with tracing and blueprint paper and it comes out the other side a finished

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work of installing a rail bond is performed with the same efficiency as by a rail bonding outfit weighing twenty times as much. The apparatus consists of a rheostat weighing about 200 lb. and a welder weighing about 65 lb. These may be carried by convenient handles, or a single wheel placed under the rheostat will permit of its being wheeled along the track; but the most convenient way of handling the outfit has been found to be that of mounting the parts on a four-wheeled lorry and this may be run along the tracks from one point to another as desired. This arrangement permits the use of two welders, one mounted on either side so that work on either track may be done without the necessity of shifting the apparatus from one side to the other as required where only one welder is available.

This entire combination may be readily lifted from the track by two men to permit the passage of cars. The portable welder is opearted from the trolley wire direct, working at any voltage from 150 to 600, which takes care of the extreme fluctuation in line voltage which may be met in the field.

By the use of this outfit an electrically welded bond is obtained with a contact having an initial high conductivity and one which it is claimed will not depreciate because of the elements or like exposure. In obtaining this union between the rail and the bond neither arc nor flame strikes the parts, and thus the danger of injury to the bond, the rail and the eyes of the operator is avoided. Instead, a heated block of graphite presses against the bond terminal and makes the union of the metals. The apparatus is held in position for service by a yoke placed over the head of the rail and a chain and hook fastened to the opposite rail. This holds the welder in a tilted position so that a portion of its weight presses against the bond. Two hand wheels on the framework are provided to adjust the tilt and vertical position so that the surface of the graphite will come into plane contact with the bond terminal.—*Scientific American.*

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NEW YORK LIGHTING RATE

Appearing before the Public Service Commission late last month J. W. Lieb, vice-president and general manager of the New York Edison Co. told the commissioners that the New York Edison Co. is willing to continue to charge for electrical energy at the present rate of 7 cents a kilowatt-hour for at least the next six months. By that time the company will be able to say, in view of climbing prices for labor and materials, whether or not it is losing money at the 7-cent rate for light.

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NIAGARA FALLS PLANTS TAKEN OVER

To assure an adequate supply of electric power for establishments engaged in war work at Niagara Falls and Buffalo the Federal Government on December 28, requisitioned the electric power produced, imported and distributed by the Niagara Falls Power Company, the Hydraluic Power Company of Niagara Falls, and the Cliff Electrical Distributing Company.

Canadian demands that approximately 100,000 hp of energy imported from the Canadian side should be applied exclusively to war work were said to have been a determining factor in the Government's decision to requisition all power.

Operation of mills is not expected to be affected materially by the new order, as readjustment of the power supply had been effected previously by representatives of the War Industries Board in conference with the Buffalo manufacturers.

Approximately 110 factories not working directly on war contracts will curtail their electric power requirements somewhat and will use power at times when munitions factories are making their smallest demand. They also will substitute steam for electricity as much as possible.

INDUCTIVE INTERFERENCE TESTS

With the presentation of its final report dated September 28, 1917, the Joint Committee on Inductive Interference, which has been investigating for the past five years, under the auspices of the California Railroad Commission, the disturbances in communication circuits caused by induction from neighboring power circuits, announces the conclusion of its work. A preliminary report was rendered by the Committee in 1914. Besides a discussion of technical features of the problem, rules were recommended to the California commission, to regulate the practices of companies operating power and communication lines in proximity to each other. The report just issued includes a review of the basic principles, comprising a simple statement of the nature of the subject, a summary of the facts established or agreed upon, and a concise statement of the guiding principles for the prevention of interference. Also recommendadations for revised rules to govern the design, construction and operation of power and communication lines and associated apparatus, to prevent or mitigate inductive interference, followed by explanatory comments.

Under a sub-committee on tests, experimental investigations were conducted upon several long parallels involving a 22,000 volt, three phase, 60 cycle system isolated from ground, and a three phase, 60 cycle system with lines of 22,000, 33,000, and 55,000 volts, having grounded neutrals at one or more points, with long distance telephone, telegraph and railway signal lines. Most of these tests were made at Morgan Hill, Salinas and Santa Cruz, with the aid of a rather elaborate field laboratory, many of the tests being conducted with the power lines in normal operation.

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COAL SHORTAGE AFFECTS POWER

Due to lack of coal, a number of power companies in various parts of the country have been compelled to shut off the supply of electric power to a large number of industrial establishments. In the middle of December the coal situation in Cleveland, Ohio, was such as to compel a temporary shut down of a portion of the plant of the Cleveland Electric Illuminating Co. Somewhat similar conditions prevailed at Columbus, Hamilton, Springfield, and Toledo. So serious were the conditions that Governor Cox, of Ohio, took the matter into his own hands and threatened to commandeer some of the coal from the Ohio coal fields that was consigned to the Northwest. In doing this he ran against the U. S. Government coal authorities, resulting in some animated messages over the telephone and telegraph wires. The situation is somewhat better at this writing but no power houses in that part of the country, or elsewhere for that matter, are overstocked with fuel. Power house managers are hopeful that the pooling plan adopted by the coal operators and the taking over of the railroads by the United States Government will save further fuel shortage. Conditions in Ohio were reflected in Baltimore, Pittsburgh, and throughout New England.

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WAR TIME UTILITY RATES

The Appalachian Power Company has been authorized by the Public Service Commission of West Virgina to make a 20 percent, surcharge to net bills for electricity served to customers having a connected load of 50 hp. or more. The rate increase became effective on December 1, 1917, and is to extend to January 1, 1919, or the further order of the commission. The Appalachian Power Company serves a large amount of power to the coal mines in the Pocahontas field.

At Fargo, North Dakota, The Union Light, Heat & Power Company has announced a 10 percent. war emergency surcharge to be added to electric and gas bills after January 1, 1918.

Red River Power Company, Grand Forks, N. D., has announced a war surcharge of 10 percent. to be added to electric light, power and gas bills until costs of materials and supplies again become normal.

Western States Gas & Electric Company, Eureka Division, has made application to the Railroad Commission of California for an increase in gas rates at Eureka for the period of the war owing to the high price of oil used in the manufacture of gas.

Olympia Gas Company, a subsidiary of Tacoma Gas Company, has been authorized by the Public Service Commission of Washington, to place in effect a higher rate schedule effective as of December 7, 1917.

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REWARD FOR GOOD SERVICE

The Danbury & Bethel (Conn.) Gas & Electric Light Company has started a bonus scheme for the fireman which is reported to be very promising. The coal is weighed over each eight-hour shift and the electric output is also noted. Shifts are changed every month so that a cycle is completed every three months. The bonus is distributed at the end of each cycle to the fireman who has the lowest fuel consumption per kilowatt hour and also to the fireman having the next best record.

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FROSTLESS WINDOWS

To remove frost from show windows place an electric fan in position so that a warm breeze may be directed against that part of the window which has been decorated by Jack Frost. If there is a radiator in the store, just inside the window, place the fan so as to have the breeze pass over the radiator. The heat waves radiated by the heater will be propelled by the waves from the fan against the window pane and remove the frosted decorations in a few moments.

W. T. Estlick.

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LAMPS INCREASE 10 PERCENT.

On January 1 the prices of mazda and graphitized filament incandescent lamps were increased an average of about 10 percent. As an offset the 60-watt gas-filled lamps were reduced from 36 to 35 cents each. With a few exceptions, such as gas-filled and vacuum type lamps, prices of minature lamps were also advanced.

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MOTOR BEARINGS AND FLASHLIGHTS

When on your oiling rounds take a pocket flashlight with you. You will find it indispensable. It enables you to see at a glance the amount and condition of the oil in each motor bearing. It prevents waste from overflow. You can see when the oil gets gritty and dirty, and when it should be replaced. The regular use of this simple device for this purpose will save a lot of time and oil.

W. T. Estlick.

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MOTOR TROUBLE

A two-pole, 25-cycle repulsion-induction motor when idle would start up and run until the mechanism which lifts the brushes and short-circuits the commutator acted. It would then slow down until the brushes were again on the commutator, and repeat the performance. The trouble was found to be due to both poles being connected for the same polarity. It operated as a repulsion motor, but as the poles "bucked," each other, it would not operate as an induction motor.

C. C. SCHUDER.

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UNUSUAL METER TROUBLE

A mercury meter of the d. c. type was found to run at only a small fraction of its proper speed on full load, and it did not creep when the load was removed. It was finally found to have an open potential circuit. It was compounded, to compensate for the drooping characteristic at full load, and was running as a compound motor would with an open shunt field—with reduced torque.

C. C. SCHUDER.

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THE COPPER MARKET

For the first time in many months it may confidently be said that the uncertainties and perplexities of the copper situation have largely disappeared. During November there was a decided change for the better. The needs of the Government for the near future seem to be better known, though we have seen no authorized statement of quantities. The fact, however, is apparent because producers are releasing copper more freely for deliveries on old contracts. We hear they are accepting no orders for spot copper but are booking contracts for delivery during the first quarter of 1918. This indicates a better feeling regarding supply which is no doubt largely due to the clearing up of the labor situation, and to the fact that there is reason to hope that strikes will not—at least for the duration of the war—seriously reduce production.

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CENTRAL STATION NEWS

The Oregon Power Company recently completed an extension of its transmission system from Marshfield to Coquille, Oregon, which has heretofore been supplied electrically by the company's local steam-electric plant. Arrangements are now being made to extend the company's lines from Coquille to Myrtle Point—another heretofore isolated part of the company's system. These improvements will connect all of the company's operations into one unit and make possible operating economies in which the public will share by means of a rate reduction just announced.

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The transmission line from Claremont to Windsor, Vt., is being brought directly into the Claremont sub-station. Heretofore it has tapped the Claremont-Cavendish line 5 miles from Claremont. This will enable the company to give better service to the National Acme Mfg. Co., also to have better service on the Claremont-Cavendish line. The National Acme Mfg. Co. uses about 322,000 kw-hr. per month.

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The new dam and hydroelectric plant to be constructed at the Tugalo site in Georgia by the Georgia Railway & Power Co. will be a 48,000-kilowatt development. The Tallulah Falls plant, when its sixth unit is completed, will produce 72,000 kilowatts.

This company is beginning surveys and other preliminary work on the big storage reservoir at Burton, 13 miles above the Mathis reservoir, which supplies Tallulah Falls. It will hold three times the amount of water held by the Mathis lake, and a dam 700 ft. long and 100 ft. high must be built at its foot.

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The Minneapolis division of the Northern States Power Company has accepted a power contract from the Minneapolis Steel and Machinery Company amounting to 6,500 hp. during the continuance of the war. The latter company is operating a large part of its plant at the present time on a 24-hour a day basis. The power company has been supplying 2,500 hp. to the machinery company, and the additional contract will bring the total demand from this one factory to 9,000 hp.

EDITORIAL

THE END OF THE YEAR

For the first time since the electrical industry was started in this country, a year has passed without some epochal invention or marked change in the design of electrical apparatus. Wartime conditions are responsible for this unusual state of affairs, all our manufacturers being so much engrossed in meeting extraordinary demands for standard electrical products that development work has been marking time. Never have the manufacturers been so busy; never have they been so far behind on orders; never have they paid out so much in wages and bonuses; never have they had such gross sales. In the effort to speed up munition production, motors, lamps, and accessory apparatus have been installed in factories that have heretofore resisted all efforts properly to motorize and illuminate them. Under great pressure, their orders for war time products taxing them beyond capacity, these factories have called on the electrical industry to help them out. They knew where to go for help in time of need, for a factory effectively motorized and lighted is a factory ready for any emergency within the limits of its physical capacity. All their energies engaged in manufacturing standard apparatus, our electrical works have adhered closely to the production and delivery of such apparatus. During the last twelvemonth, then, the electrical industry has given scant attention to research and invention, but has devoted its intelligence and energy to maximum output and minimum delay in delivery.

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RHEOSTAT ECONOMY

Many persons, not excluding some engineers who ought to know better, have a wrong conception regarding the saving of power when rheostats are inserted in a circuit containing a lamp or a motor. An important use of rheostats for saving power is in connection with theatre dimmers. No steam engineer in charge of a power plant ever doubts the effect on his engine load when a bank of lamps is dimmed by the use of a rheostat. In this instance the effect on the prime mover is unmistakable. Nevertheless it is often said that in applying rheostates to dim lamps or to slow down motors the power that doesn't appear in the lamps or the motors is "used up in the resistor, appearing as heat." This isn't even a half-truth, which sometimes passes for the real article. How much of a truth it is in the case of an individual incandescent lamp whose illuminating quality is regulated by connecting it in series with one or more resistors may be discovered by scanning the story in this issue on the turning down of such lamps. Here arithmetic in its simplest form serves to demonstrate just how the wattage in circuits containing a lamp in series with one or more resistors is reduced in those cases where the actual resistance thrown in is one, two, three, or more times the resistance of the lamp itself. It is merely an intelligent appreciation of ohm's law. Prevailing misconception regarding these energy and money savers is not due entirely to stupidity on the part of the layman or to wrong-headedness on the part of the engineer; it is due chiefly to the inability of the manufacturers of such devices to explain them clearly, to picture their method of operating in attractive and understandable verbal garb. Like the professors of mathematics at college, they take too much for granted, assuming that what it has taken them forty years to acquire should be mastered by the untutored and inexperienced in ten minutes. They pay a fine compliment to the intelligence of the neophyte but they don't help him to understand.

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INSTALL A MOTOR

If men are scarce and work is waiting for both men and material, why not increase the supply of material and make up for the dearth of labor by installing motor drive? A small motor operating continuously will, when properly applied, do as much work as thirty men working on eight-hour shifts. If all our industries were motorized, the calling of workmen to the Colors would have but little effect on the output. In many cases the output would be greatly increased by substituting motor power for man power, regardless of the shortage in workmen. Release the men for service, install the motor, and turn on the juice! Then see that the factory is properly lighted at night. The right kind of fixture equipped with the right kind of reflector and located at the right place will do its share in winning the war.

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WHO GETS IT ALL?

Though the "Give Something Electrical This Xmas" campaign was a success, it played only a minor part in the gift-giving pastime during the holiday season just closed. Efficient, useful electrical appliances can't compete for popular favor with a fad when that fad takes a non-electrical form. No amount of publicity, either in the guise of seductive phrases printed in red and green and distributed with great energy, or in carrying an illuminated transparency behind a brass band down a crowded street, can divert the public from its inherent tendency to follow a fad. Anyone with half an eye who travels in even a small radius can see what the fad is this season—it is knitting. Those who knit must have bags to carry their tools and stuff in, so last Christmas was given over pretty generally, not to "something electrical" but to knitting-bags. All the women are carrying beflowered knitting-bags—you see these bags everywhere. And the women knit and knit and knit, for our soldiers and our sailors. So far, so good. To knit sweaters and mufflers and socks one must have yarn, even if it has to be got gratis from the Red Cross. Much of it has to be got in this way because the yarners, or whatever name it is the yarn manufacturers go by, have taken it on themselves to boost the price so high that well-intentioned, self-sacrificing women of ordinary means can no longer afford to buy it. Yarn that used to cost about a dollar and a half a pound is now selling at four dollars and a quarter a pound! Somebody must be profiteering at a great rate, taking advantage of the unselfishness of the boys in service and those at home who are anxious for their physical well being, to swell their fortunes! Why, one may be permitted to ask, is this allowed to go on? The homemade knitting industry has grown so huge and so profitable to somebody that the appointment of a Yarn Administrator is not so much of a joke as it seems. When the electrical industry is unselfishly bending all its energies to do its bit to help with the war, when it is willing to keep it rates for service at pre-war levels, or at only slight increases in the way of surcharges—just enough to meet part way the increated cost of labor and materials—it is not captious criticism or envy that impels it to ask that others be restrained by the Government from taking advantage of a situation that should demand all that a man has of loyalty and patriotism.

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THEY ALSO SAVE WHO ONLY SCRIMP AND SCRAPE

When the first Liberty Loan was launched, the cry was heard quite frequently, that this is not a thrifty nation and that the Continental peoples have outstripped us in the practical application of individual savings to national finances. True, at the beginning of this war, when our export balance reflected in increased billions our prosperity, we showed little disposition to imitate the careful Frenchman. But those who complained in the early months of 1917, on the eve of the first Liberty Loan, of our unwillingness to save have forgotten what this nation did when put to the test in the days of the Revolution and the days of the Civil War. From the time of Joseph, when the forcible contrast of the lean years and the overflowing granaries brought home to the people the value of saving, nations have known how to make use of this primeval instinct. It is no new and strange practice, then, that the American people must adopt if they are going to win this war. There is no national aversion to thrift. The first two Liberty Loan campaigns proved incontestably that the American people know how to "save and serve." That they will continue in this self-sacrificing, forward-gazing spirit is not to be doubted. They have heard and heeded the President:

"Let every man and every woman assume the duty of careful, provident use and expenditure as a public duty, as a dictate of patriotism which no one can now expect ever to be excused or forgiven for ignoring."

Our war bills, growing heavier as the climax of the world contest draws nearer, cannot be met, however, by the same measure of thrift that characterized the first months. The United States must reach and surpass the mark set in France and Great Britain. In England, one bank alone, the London City and Midland, reports that its depositors applied for $451,198,000 on the last war loan, or considerably more than one-half the amount standing to their credit. This may give an insight into the compelling pressure of patriotism upon all classes of persons in England, for the London City and Midland reaches all social ranks. It must not be supposed that these English subscribers drew all their half-billion from the bank in order to pay for their bonds. Such a step would have resulted in grave trouble. This tremendous total could not have been lent to the Government without the most extraordinary thrift and self-denial.

In a war which is taxing the capacity of every nation engaged thrift becomes the indispensible prerequisite of victory.

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THIS IS EFFICIENCY

Via the telephone route, the distance from New York to San Francisco is about 3,400 miles. At 435 pounds to a mile, a two-wire telephone circuit contains close to 3,000,000 pounds of copper. Without auxiliary aid, a circuit such as this and having an average frequency of 800 periods per second would deliver at the receiving end only about one fifty-billionth of the energy originating at the transmitting end. Due to mechanical limitations in transmitters and receivers, if a telephone line fail to deliver between one-hundredth and one-thousandth of the energy sent out by the transmitter that line is, as such things are looked at nowadays, unworkable. By placing loading coils at suitable intervals, about 8 miles in this case, or 400 such coils in all, the energy delivered at the receiver is increased to one-millionth of that sent out by the transmitter. This is an increase of 50,000 percent! Supplementing the loading coils by equipping the circuit with what are known as telephone repeaters—this device is analgous to a relay in a telegraph circuit, and feeds new energy into the line—causes the energy delivered to be further increased to one-eightieth of that sent out by the transmitter. Compared with the original delivery of one fifty-billionth of the energy sent out, the simple expedient of inserting loading coils and repeaters at suitable places in the circuit has increased the efficiency of transmission 625,000,000 percent! If increase in efficiency could be pictured in degree by distance, the increase in this case would represent about 1,300 round trips to the moon. This almost incomprehensible increase is due solely to the products of the research laboratory and the shop as applied by the engineer. And still there are some so dull-witted as to claim that engineering discovery and development reached its climax two decades ago.

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ELECTRICITY THE INFALLIBLE

During the recent severe cold snap the only utility that didn't peter out was electric service. Further comment would be superfluous.

EXTRACTING NITROGEN FROM THE AIR BY ELECTRIC POWER

By E. Kilburn Scott, Consulting Engineer, London

(Continued from page 47, December issue)

High tension three-phase current is supplied to the three electrodes, and when the furnace is in operation a mass of flame fills the inverted conical space. The conical shape is an advantage, because a large part of the air passing through the furnace is enabled to come in contact with the flame. It will be readily seen that when air issues from a pipe it spreads out in all directions, and therefore the single flame of a single phase furnace is not so good a shape as the conical flame of a three-phase arc furnace.

Figs. 6, 7, 8, and 9 are diagrams of connections of the four types of furnaces, and it will readily be seen that the simplest form with fewest electrodes is Fig. 9.

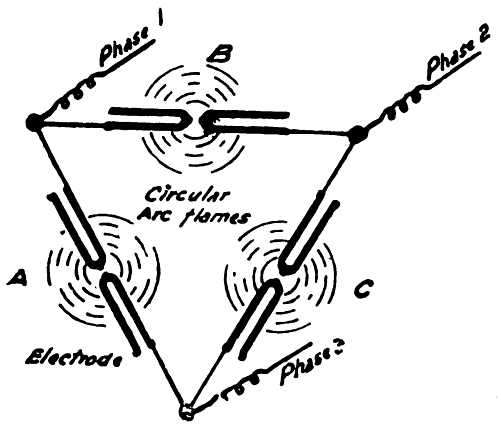

Fig. 6—Birkeland-Eyde, three single phase furnaces connected in delta, with six electrodes, all to adjust and all at high pressure giving three separate flat flames.

Combining three arc flames together gives a balanced load, and balancing is important from the point of view of supply and regulation of power. The engineer of a large power company operating abroad said that a feature of my furnace which most appealed to him was that it must work with all three phases or not at all. It appears that he had had considerable trouble due to unbalancing, set up by one consumer using single-phase furnaces and affecting the supply to other consumers. In a three-phase furnace continuity of working is also assured, because current is always flowing in one or other of the phases, and this appears to be a considerable advantage in enabling the arcs to maintain one another. In a single-phase furnace there are two zero points in each period of the alternating current, when no current flows.

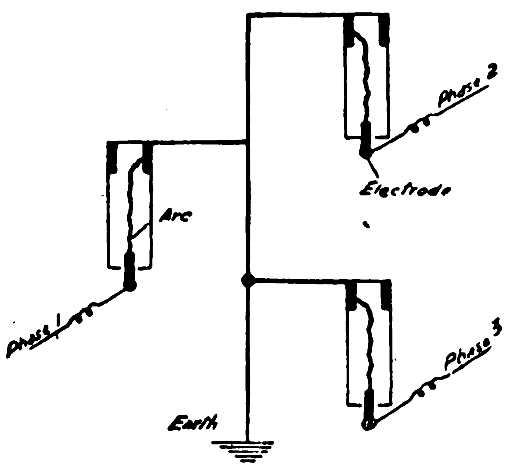

Fig. 7—Schonherr-Hessberger three single phase furnaces connected in star, with six electrodes, three to adjust and three at high pressure, giving three separate rod-like arcs.

A combined three-arc flame is hotter than if the same energy were expended in three separate single-phase furnaces, because the radiation losses are much less, and in a given time there are three times as many arcs. A 30 percent. increase above 3,200 degrees Centigrade increases the theoretical yield by over 225 percent.

A three-phase furnace requires only three electrodes, and there is thus a minimum of insulation where they pass through the furnace walls. The connections for the supply of electricity, and of cooling water, are simple. In all electric furnaces the cooling water for the electrodes is supplied through short lengths of tubes made of insulated material.

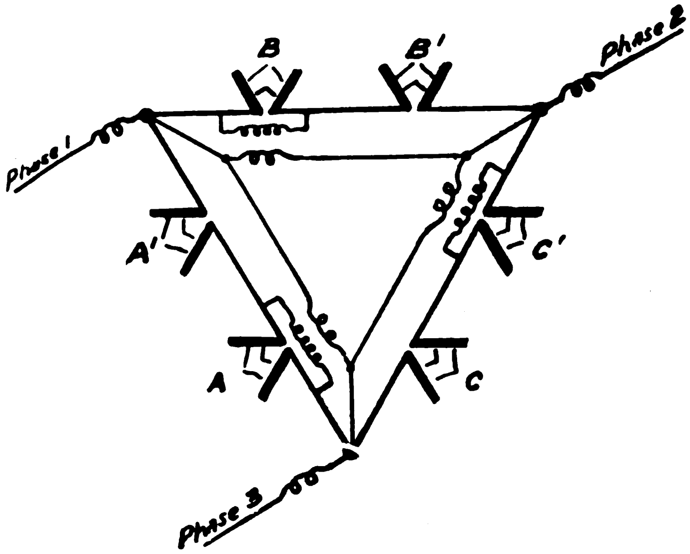

Fig. 8—Pauling, six single phase furnaces two in series connected delta, with twelve electrodes, all to adjust and all at high pressure, giving six separate flat flames.

For the reason that any furnace cannot have less than two electrodes it will be seen that three single-phase furnaces must have at least twice as many electrodes as my three phase furnace. Each Pauling furnace requires four. (See Fig. 8.) The electrodes of my furnace are made of ordinary flat steel plates, which are easy and cheap to renew. They are supported on hollow iron castings, through which cooling water circulates.

There is very little firebrick in this furnace, which is a great advantage, because it is thus very robust and can be easily made gas tight. This absence of firebrick is a great advantage from the point of view of intermittent working, because there are no difficulties due to expansion and contraction of firebrick. The question of intermittent working is important in this country, because electric power can usually be purchased more cheaply if the supplier has the right to cut off current during a portion of each day. One great advantage which electric furnaces for fixation of nitrogen have over those of other kinds is that the furnace is very like an arc lamp, and can be switched on or off at any time.

Electric furnaces for manufacture of ferro alloys, carbide of calcium, etc., having baths of molten metal or other material which must be kept molten, are not suitable for intermittent working.

Starting the Arc Flames

The single phase furnaces used abroad are started in much the same way as an arc lamp is started; namely, by approaching the electrodes together until the air gap is sufficiently narrow for the applied voltage to jump across, the electrodes being then withdrawn to the correct distance.

The adjustments have to be carefully made, and as all nitrogen fixation furnaces work with high tension alternating current, it will be readily appreciated that adjusting the electrodes when current is on is somewhat dangerous, especially as in some furnaces the furnace attendants have to make constant adjustments for wear and tear.

In this furnace I do away with three adjustments by starting the arc flames with pilot or trigger sparks. A steel wire placed about midway between the points of the three electrodes, just above the air pipe, is connected to a high frequency apparatus similar to that used in wireless work. When this apparatus is set in operation streams of sparks are made to pass from the wire to the electrodes, and thus break down the air dielectric. To start the furnace, air is first turned on, then the main three phase supply is switched on to the electrodes, and finally an ordinary tumbler switch starts the high frequency pilot or trigger sparks.

This is indicated in the diagram of connections (Fig. 10), which shows the experimental apparatus.

This method of starting is a great convenience because the electrodes can be placed at the most suitable distance apart for the air supply, and they do not require further adjustment. It has also the advantage that a lower alternating current pressure can be used, and it tends to high electrical efficiency because the whole of the alternating current wave is used.

If trigger sparks are not used the voltage has to rise to a certain value before the current begins to flow, and as there are two zero points to each cycle, this causes a loss. I estimate that in the single-phase furnace about one-sixth of the alternating current wave is wasted as compared with my furnace.

Boiler.

When air passes through an electric arc the nitrogen and oxygen combine together to form nitric oxide, and the chemical reaction being reversible it is most important to chill the gas as quickly as possible. The success of any furnace depends very largely on this quick quenching or cooling. With the single-phase furnaces employed on the Continent it is effected by blowing excess air through the furnace. I employ some excess air, but have also the boiler which forms the roof to act as a quick cooling zone.

I daresay that boilers would have been applied directly to single-phase furnaces in Norway if it could have been done, but the designs are not suitable. Such boilers as are used are therefore installed some distance away from the furnaces, and merely used for raising steam for evaporation of the products, etc.

By placing a boiler immediately over my furnace I obtain effective cooling by reason of the latent heat of steam, and at the same time the steam raised can be used for generating electric power. The combination can therefore work regeneratively, and I estimate the gain from this at over 10%.

Where there is plenty of water power which would otherwise run to waste, regenerative working may not be advantageous, more especially if steam prime movers have to be specially installed, but in this country generating plant is usually driven by steam, and it is therefore only necessary to connect up a steam pipe.

In order to understand why a boiler can work successfully in such a position I ought to mention that a *blown* arc flame is quite different from the arc which one sees at, say a switch contact or on the commutator of a dynamo. A blown arc flame has three zones. The lowest is brightly luminous, bluish, and carries the current. The middle zone is broader, and is bluish green, and the topmost one is freely luminous and brownish in color. These colors are given with platinum electrodes, and, of course, with steel or copper the colors are different.

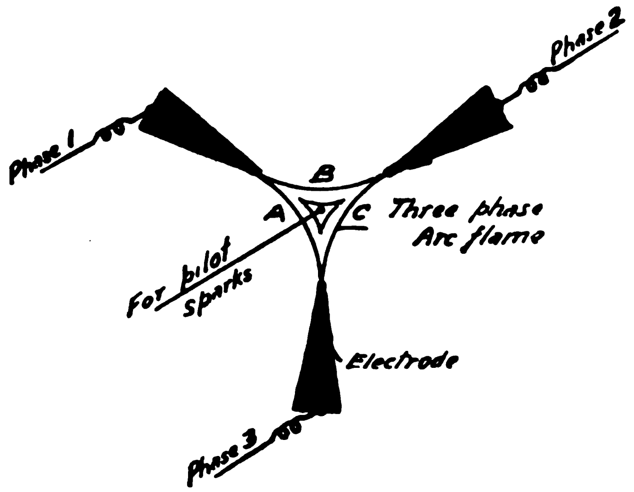

Fig. 9—Kilburn Scott, one three phase furnace connected delta-star, three electrodes, none to adjust, giving one large conical shaped flame.

During the tests with an experimental furnace I discovered that I could safely lower my boiler until the top of the arc flames entered the tubes. So far as the boiler was concerned the flame acted in just the same way as any ordinary flame burning to carbon dioxide. By reason of the nature of a three-phase circuit the centre of the arc flame forms the neutral point, and as the boiler is connected to earth, and the neutral point of the three-phase system is also earthed, there is no trouble with electrical connections.

There is no effect on the metal of the boiler, because nitric oxide does not attack metal. Nitrogen peroxide may do if moisture is also present, but the peroxide does not begin to form until the temperature is below 600 degrees Centigrade, and even then it is slow.

In the Notodden plant in Norway the gases from the various furnaces are collected and carried by a flue to a cooling device consisting of aluminum tubes over which water flows. The gases, which by that time have arrived at a temperature of about 500 degrees centigrade, pass through a boiler, where the temperature is lowered to about 200 degrees centigrade, and then, after further cooling, go into the oxidation tower.

It will thus be seen that the gases enter the boiler at a temperature when they are able to form nitric acid, if moisture is present. I have not heard that they have any difficulties, but I would point out that from the point of view of action on metal it is, if anything, much safer to use the boiler *directly* on the furnace where the gas is still in the *nitric oxide* stage.

Method of Working

To change the nitric oxide made in the furnace into nitric acid a certain amount of chemical plant is necessary. The usual procedure is first to pass the gases through a heat exchanger in order to preheat the fresh air entering the furnace.

As the gases cool down nitrogen peroxide begins to form, and this is expedited by passing the gases into a large tower through which they can circulate slowly. When they are at a low enough temperature they are drawn from the oxidation tower into the first of a series of acid absorption towers. These have the usual tower fillings so as to allow the gas and liquor to pass freely, and at the same time bring them into does not need to be pure. By working on a closed cycle only comparatively small and cheap oxygen-making plant is sufficient.

As a matter of fact, several industries operating in this country give oxygen as a by-product; for example, the electrolytic manufacture of hydrogen for aircraft, and for densifying oils and fats. Lever Bros. make hydrogen by the Knowles electrolytic method for the latter purpose.

The closed cycle has the further advantage that any gases

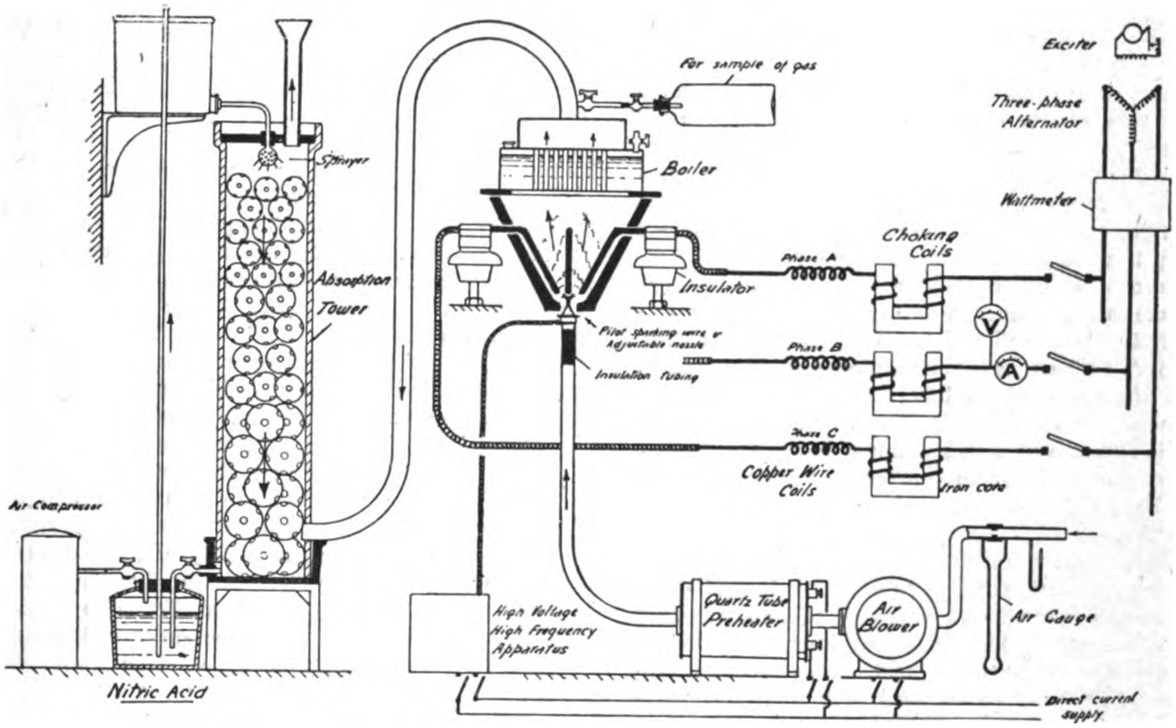

Fig. 10—Diagram of electrical connections for Kilburn Scott three phase furance, showing choke coils and high frequency circuitfor pilot sparks to start the arc flames.

intimate contact. The gases travel up these towers in succession.

The various parts of the plant are shown in Fig. 11, and the arrows indicate the route of the gases, etc.

Pure water is supplied at top of the last tower, and combines with the nitrogen peroxide to form nitrous and nitric acids. The nitrous acid being unstable in an aqueous solution forms into more nitric acid and nitric oxide, and this nitric oxide again changes to nitrogen peroxide, and so on.

The dilute nitric acid which runs out at the bottom of the last tower, which may be assumed to be at about 5 percent. strength, is then transferred to the top of the next tower, where it meets with stronger gas, and there makes stronger acid. It passes from tower to tower on the contra flow principle, gaining strength at each one, until it reaches, say, 33 percent., which is sufficient for the manufacture of ammonium nitrate and fertilizers.

After leaving the acid absorption towers, a certain amount of gas still remains, and this is absorbed by sodium carbonate or milk of lime to form a solution of nitrate and nitrite, or it can be absorbed by caustic soda to form sodium nitrite.

In the plants on the Continent the air from the last tower is allowed to escape, but I prefer to bring it back to the furnace, and work on a closed cycle. I do this because I can thus enrich the air passing into the furnace with oxygen, and thus materially increase the yield.

In ordinary air the nitrogen is about 79 percent., the oxygen 21 percent. By making the mixture in about equal quantities the increase of yield is about 20 percent. above that given by ordinary air. Even if only 10 percent. it would be worth doing, because it should be noted that the oxygen a small amount of make-up oxygen is required, therefore a

not taken up after passing through the absorption towers pass through the furnace again instead of being wasted into the atmosphere. I do not anticipate any difficulties on account of small amount of moisture that may be carried over from the absorption towers, because Sir J. J. Thomson, of Cambridge, has shown that chemical reactions are facilitated by the presence of nuclei, and a little moisture should therefore be advantageous.

It has been noticed on the Continent that the yields vary at different periods of the year, and that may be due to variations of moisture in the air.

Fig. 12 is a complete lay-out of a plant to make nitric acid. It shows six absorption towers, but this number is not essential. The Gaillard type of tower can be used.

Nitric Acid

The products of nitric acid are very numerous. Among them the following may be mentioned:

Nitrate of lime is used as a fertilizer.

Phosphate of ammonia is used as a fertilizer.

Nitrate of soda is used as a fertilizer.

Nitrate of ammonia is used for high explosives, for shells, hand grenades, etc. It is also used for mining explosives.

Nitrate of potassium is used for gunpowder.

Nitrate of silver is used for photography, silvering and pharmacy.

Nitrate of aluminum is used for mordant dyes.

Nitrate of strontium is used for fire works.

Nitrate of barium is used for fire works and for the manufacture of peroxide of barium, oxide of barium and hydrogen peroxide.

Nitro glycerine is used for dynamite and nitro-gelatine.

Nitro cellulose is used for gun-cotton, cordite, and all smokeless powders, also for making incandescent lamp filaments, artificial silk, and for celluloid.

There are in addition the nitrification products obtained by the distillation of coal tar, such as:

Nitro-benzol.
Tri-nitro-tuluol.
Nitro-napthalene.
Picric acid.
Indigo.

Nitric acid is also used to make sulphuric acid and aqua regia, etc.

Naturally the most important of the above compounds at the present time are the explosives. These explosives are of two kinds:

First.—Propellant explosives, or smokeless powders, such as cordite, which are used for filling the cartridges.

Second.—High explosives or burster charges, which are used for filling torpedos, shells, grenades, bombs, etc.

The best known is picric acid* or lyddite, but another which has come into prominence during the war in tri-nitro-toluol (generally written T.N.T.). The soldiers call this "Jack Johnson," because when it explodes it gives off a large amount of uncombined carbon.

Ammonium nitrate mixed with T.N.T. is used for filling shells and it is also mixed with aluminum powder to form a mixture called ammonal, which is used for filling grenades and bombs. Before the war ammonal was largely used as a mining explosive.

To make ammonium nitrate, the nitric acid need only be about 33 percent. strength, whereas to make picric acid about 60 percent. strength is required. For nitro cellulose the acid has to be concentrated, which is easily done by removing the water by means of sulphuric acid. It is important to note that when sulphuric acid is used in this way for concentrating it can be recovered again, whereas when it is used for treating Chili nitrate the acid is lost.

In ordinary peace times there is a considerable demand for nitric acid for making propellant explosives, such as cordite, but not much demand for high explosives, because firing practice is usually carried out with what are called "plugged shells." On the other hand, when we are in a state of war, the demand for high explosives in phenomenal, and even those accustomed to such statistics have been staggered by the demands of this war.

*Picric Acid is also employed as a yellow dye for silk and wool.

Ammonium Nitrate

This has been used as a principal constituent of mining explosives, because it is safer to handle and to carry.*

The Austrians and Russians appear to have been the first to use it for war purposes, and it will be remembered that Austrian explosives assisted materially in reducing the Belgian forts at the beginning of the war.

At that time very little ammonium nitrate was used by the Allies, whereas now many high explosives contain this compound, and the price has risen very considerably. When the sudden demand arose in the country there was practically no plant for its manufacture, because we had relied almost entirely on Norway for supplies. Now the demand is being met by various chemical processes from Chili nitrate, and for this enormous quantities of sulphuric acid are required.

Now that Norway is unable to get ammonia solutions from this country, the ammonia is being made by treating calcium cyanamide with superheated steam. Calcium cyanamide is also an electric furnace product, made at Odda from calcium carbide and pure nitrogen. The coke for the carbide is supplied from England.

One method of manufacturing ammonium nitrate at Notodden is to run the dilute nitric acid from the absorption towers into a closed iron tank containing 25 percent. ammonia solution. Acid is added slowly to a large volume of liquor, and an agitator mixes them together, the heat of combination being carried off by cooling coils as well as by a draught of air. The addition of acid is continued until nearly all the ammonia is taken up, leaving a slightly alkaline reaction.

The ammonia nitrate solution is run through a filter into vacuum pans where exaporation is effected by steam coils under a pressure of 20 mm. of mercury. When nearly all the water has been evaporated the solution passes into long troughs slightly inclined, and subjected to a rocking motion. The nitrate forms into small crystals with no enclosure of liquor, and what remains of the liquor drains off. The crystals are dried in a hydro extractor. There are no losses on the products, and the ammonium nitrate produced is pure.

(*To be continued*)

*In this country ammonium nitrate explosives are carried on the railways at considerably above the highest rate, just as if they were as dangerous as dynamite. On the Continent, however, such explosives are carried at ordinary rates, and that had a good deal to do with their coming into general use more quickly than with us.

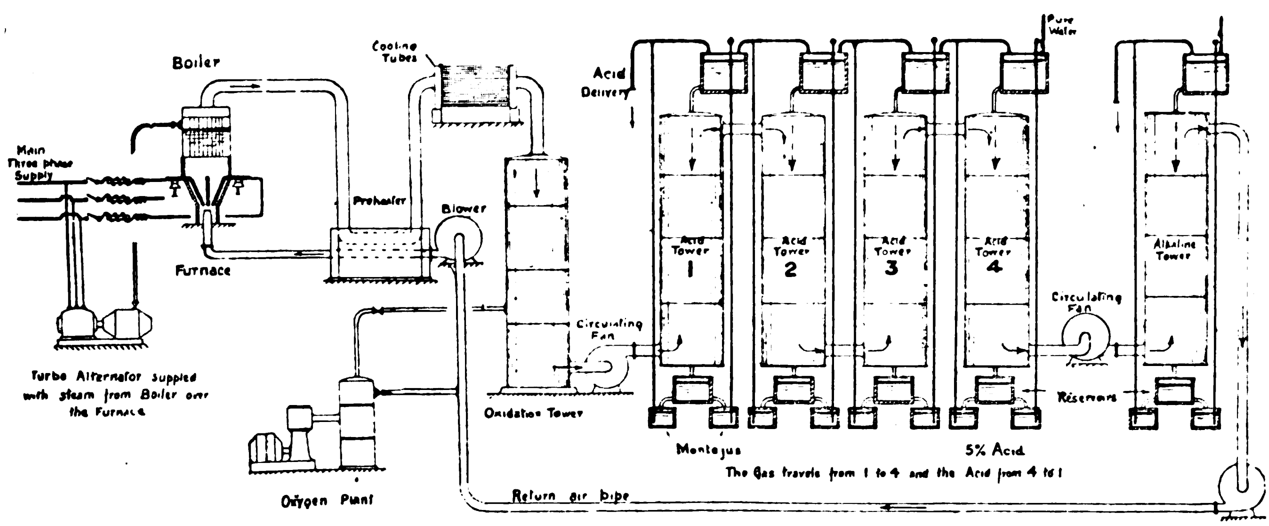

Fig. 11—Layout of complete plant for manufacture of nitric acid and sodium nitrite, etc., with Kilburn Scott furnace working regeneratively and the piping arranged to give a closed cycle, also provision for equal quantity of oxygen and nitrogen.

THE DESIGN OF A 110-VOLT 500-WATT ELECTRIC GENERATOR

By T. Schutter

(*Continued from page 49, December issue.*)

The radiating surface (RS) is considered as the area of the cylindrical surface as well as the area of each end of the armature and is found as follows:

$(D \times \pi \times L) + ((D^2 \times 0.7854) \times 2)$ where

D = Diameter of armature.

$\pi = 3.1416$.

L = Length of armature, then

$4 \times 3.1416 \times 2) + [(4^2 \times .7854) \times 2] = 52$ sq. in. then the temperature rise will be

$$T = \frac{75 \times 46}{52} = 66^\circ F.$$

This temperature rise is well within the safe limit. Cotton insulation, such as is used on the wire used for winding an armature, when heated to an excess of 170 or 180°F will gradually begin to char and if continued at this temperature will finally break down due to a short circuit. In this instance the total temperature of the armature under consideration is 66° + 75° = 141° F.

Fig. 8 shows a detailed construction of the armature, communtator, and brush rigging.

The armature winding is going to be of the lap type, as all two-pole windings can only be of this type. In Fig. 9 is shown the development of the winding for this armature.

The coil or winding pitch was found by the formula

$$\frac{c + a}{P} = Y$$

where c = whole number of coils in the winding.
a = Number of pair of armature circuits.
P = Number of pairs of poles.
Y = Coil pitch.

The following is the winding table which will give the location of each coil in the armature. As previously explained there will be two coils or two winding spaces per slot:

Coil No.	In winding spaces No.	Which are in slots No.
1	1 and 18	1 and 9
2	3 and 20	2 and 10
3	5 and 22	3 and 11
4	7 and 24	4 and 12
5	9 and 26	5 and 13
6	11 and 28	6 and 14
7	13 and 30	7 and 15
8	15 and 32	8 and 16
9	17 and 34	9 and 17
10	19 and 36	10 and 18
11	21 and 2	11 and 1
12	23 and 4	12 and 2
13	25 and 6	13 and 3
14	27 and 8	14 and 4
15	29 and 10	15 and 5
16	31 and 12	16 and 6
17	33 and 14	17 and 7
18	35 and 16	18 and 8

And to connect the winding to the commutator, commutator bar No. 1 is considered as the bar directly in front of the slot in which coil No. 1 begins, and the connecting table is as follows:

Beginning of coil No.	To bar No.	The end 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	17
17	17	18
18	18	1

Fig. 11 shows the detail and dimensions of the field frame. The armature is 4 in. in diameter and the air gap between the armature and the pole pieces should be about 3/32 in., which will make the bore of the pole pieces 4 3/16 in. in diameter.

The pole pieces on a bipolar machine should not cover less than 60% and not more than 80%. The amount of the armature covered by the pole pieces in this machine is 75%. In large machines of the multi-polar type the pole pieces should cover not more than 60% and not less than 50% of the armature circumference, so as to avoid an excess amount of magnetic leakage.

To find the area per pole piece

$$\left(\frac{D \times \pi \times 0.75}{2}\right) \times L \text{ where}$$

D = Diameter of bore.
$\pi = 3.1416$.
0.75 = Percentage of armature covered by pole pieces.
2 = 2 Pole machine.
L = Length of pole parallel to armature.

$$\text{Then } \left(\frac{4\ 3/16 \times 3.1416 \times 0.75}{2}\right) \times 2 = 9.6 \text{ sq. in.}$$

The area of the pole face is the same as the area of the air gap between the armature and poles.

The field cores on which the field coils are placed are 4 in. long and 2 in. parallel to the armature shaft or 4 in. × 2 in. = 8 sq. in.

The frame of the machine is 1¼ in. thick and 4 in. parallel with the armature shaft, or 4 in × 1¼ in. = 5 sq. in.

The cross-sectional area of the armature below the slots as shown in Fig. 7 is 1¼ in + 1¼ in. × 2 in. = 5 sq. in. The area of the number of teeth in the armature covered by poles is 75% of 18 teeth, or 13.5 teeth covered by both poles; then $\frac{13.5}{2} = 6.7$ teeth covered per pole. The average width per tooth in Fig. 6, is 5/16 in. and 2 in. long, or 5/8 sq. in. Then the area of 6.7 teeth is 6.7 + 5/8 = 4.2 sq. in.

The density per square inch in the field cores is found as follows:

$$B = \frac{\phi}{a} \text{ where}$$

B = Density or lines of force per sq. in.
ϕ = Total number of lines of force.
a = Area in square inches.

To find the number of ampere turns (IT) it will require to maintain the required flux density in the air gap.

$$IT = \frac{B \times L}{3.192} \text{ where}$$

IT = Number of ampere turns required.
B = Density per sq. in. in air gap.
L = Length of air gap (total both sides).

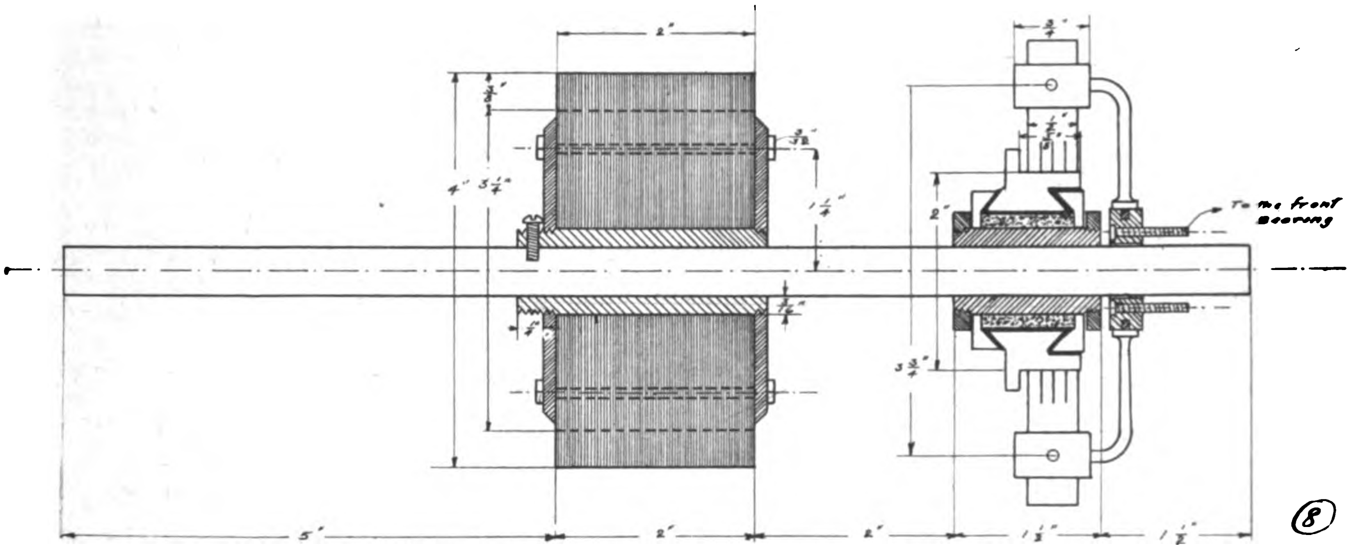

Fig. 8—Cross-section of machine showing shaft, armature, and commutator.

(The above key will be followed in the following formulas for finding densities per square inch.) Then

$$\frac{300{,}000}{8} = 37{,}500 \text{ B in field cores.}$$

The density per square inch in field frame is:

$$B = \frac{a \times P}{\phi} \text{ where}$$

P = Number of magnetic paths through field frame.

$$\frac{300{,}000}{5 \times 2} = 30{,}000 \text{ B in field frame.}$$

The density per square inch in armature core is:

$$B = \frac{\phi}{a} = \frac{272{,}000}{5} = 54{,}400 \text{ B in armature core.}$$

Then density per square inch in the armature teeth is:

$$B = \frac{\phi}{a} = \frac{272{,}000}{4.2} = 65{,}000 \text{ B in armature teeth.}$$

The density per square inch in the air gap is:

$$B = \frac{\phi}{a} = \frac{300{,}000}{9.6} = 31{,}300 \text{ B in air gap.}$$

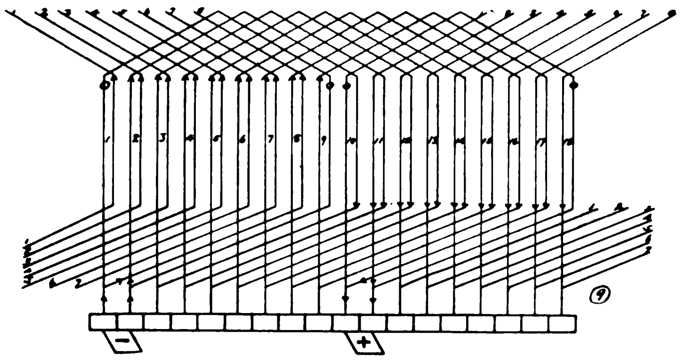

Fig. 9—Development of armature winding.

$$\text{Then IT} = \frac{31{,}300 \times 3/16}{3.192} = 1840.$$

The current passing through the armature windings sets up a demagnetizing effect and thereby cuts down the field strength. For this reason some extra turns must be put on the field coils to overcome this demagnetizing effect.

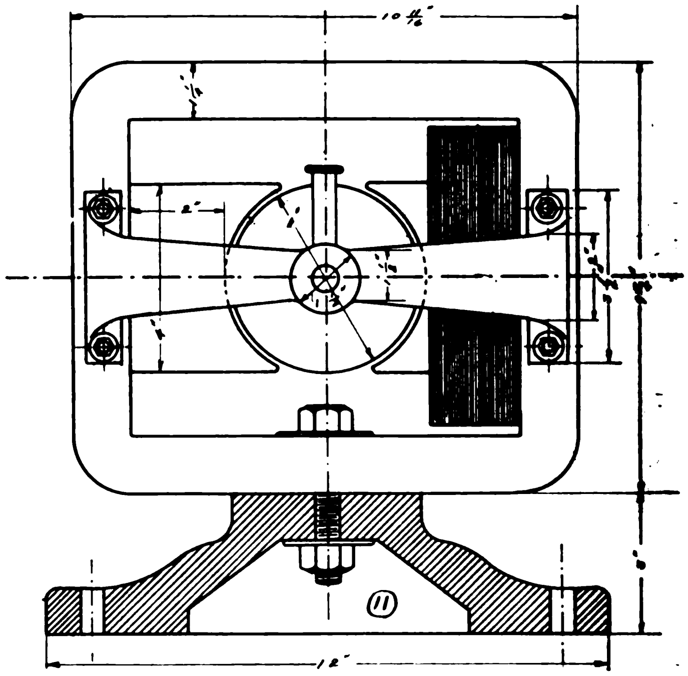

Fig. 10—End view of complete machine.

On the lead at which the brushes are set depends the number of slot which will be in the demagnetizing belt. In this machine there will be one slot per brush, or two slots which will tend to demagnetize the field. The number of ampere turns contained in this section of the armature are:

No. of slots × No. of turns per slot × current carried per path of the winding; or

2 × 64 × 2.45 = 313.6 or 314 ampere turns acting against the field strength.

From a standard magnetization chart as shown in Fig. 12 it can be determined how many ampere turns per inch of length will be required to maintain a given number of lines of force per square inch of cross-section, in the different qualities of iron.

The following table shows the different flux densities in the various qualities of iron and the number of ampere turns per inch length, also the total number of ampere turns required to maintain a flux of 300,000 lines of force.

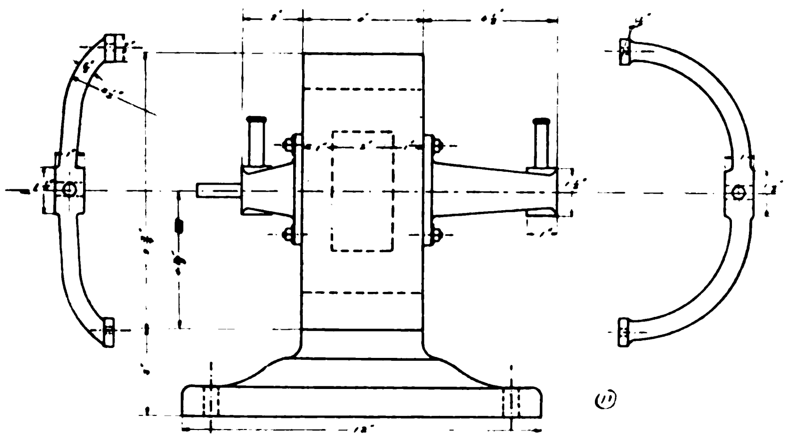

Fig. 11—Outline sketch of machine showing dimensions of frame.

Magnetic circuit	B, lines per sq. in.	Length of mag. circuit in in.	I. T. per in.	Total I. T.
Field cores (Steel)......	37,500	4.	12.5	50
Field frame (Steel)......	30,000	15.5	10.	155
Arm. core (Sheet Iron)..	54,400	4.5	8.	36
Arm. teeth (Sheet Iron).	65,000	.75	115.	86
Air gap	31,300	.1875	—	1840
Deinag. I. T............	——	——	—	314

Total number of ampere turns to produce 300,000 lines = 2481

To determine the size of wire with which to wind the field coils, it is first necessary to assume the length of an average turn of wire in the field. This is shown by the dotted line in Fig. 13, which is 1 ft. 3¼ in. or 1.3 ft. approximately. Then

$$CM = \frac{IT \times L' \times 12.8}{E} \text{ where}$$

CM = Circular mil area of wire.

IT = Ampere turns required to produce 300,000 lines of force.

L' = Length of average turn in field coil expressed in feet.

12.8 = A constant.

E = Voltage impressed at field terminals (the drop in voltage through the armature is substracted from full voltage which is approximately 10 volts.

$$\text{Then } \frac{2481 \times 1.3 \times 12.8}{100} = 412.8 \text{ CM.}$$ This is equal to a number 24 B & S gage wire, the resistance per 1000 ft. of this wire is 26.2 ohms.

To find the amount of wire in feet that are required

$$L = \frac{IT \times L'}{i} \text{ where}$$

L = Length of wire used on field windings (in feet).

IT = Ampere turns.

L' = Length of an average turn in field coil (in feet).

i = Current passing through field windings.

$$\text{Then } L = \frac{2481 \times 1.3}{.3} = 10{,}751 \text{ ft.}$$

To find the number of turns on each field coil of which there are two:

$$TC = \frac{L}{L' \times 2} = \frac{10{,}751}{1.3 \times 2} = 4135 \text{ turns per coil in field}$$ windings.

The field winding, like the armature winding, will heat when the current is passed through them and this will cause a certain waste energy. This waste energy is calculated by the same formula as for the armature, $i^2 \times R = W$. The resistance per 1000 ft. of No. 24 B & S gage wire was above stated as 26.2 ohms, then 10,751 ft. will have a resistance of 10,751 × 26.2 = 281 ohms approximately.

Then $i^2 \times R = 0.3 \times .3 \times 281 = 25.21$ watts.

The circumference of a field coil is about 21 in. and its thickness 2 in. Then 21 in. × 2 in. = 42 sq. in. radiating area per coil; and 42 × 2 = 84 sq. in. on both coils.

The temperature rise of the field coils will be:

$$T = \frac{t \times w}{RS} = \frac{75 \times 25}{84} = 22° \text{ F.}$$

This is very satisfactory, as on stationary coils an allowance of 0.75 watt lost per sq. in. can be safetly made. As to the efficiency of this machine, 500 watts are being generated and 46 are lost in the armature and 25 in the fields, making a total of 46 + 25 = 71 watts. Then 500 — 71 = 420 watts delivered at the terminals. Then the efficiency which is equal to $\frac{\text{w delivered}}{\text{w generated}}$ or $\frac{429}{500}$ = 85 %.

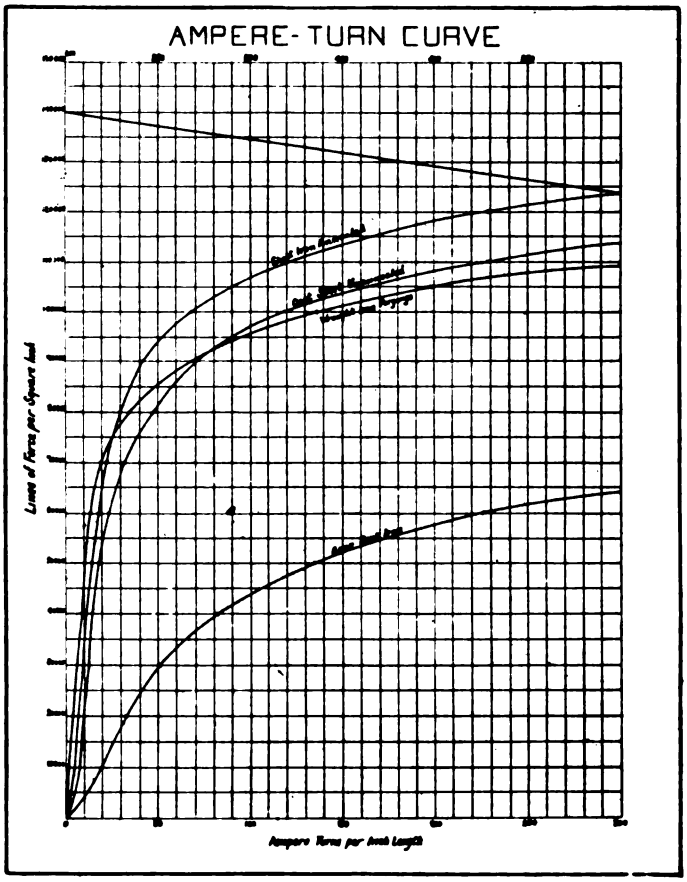

Fig. 12—Standard magnetization chart.

CLEANING SILVER ELECTRICALLY

To clean sliver, the best way is to do so electrically, and this may be done conveniently in any kitchen or butler's pantry. The first requisite is an earthenware pot. Metal will not do. Then put into the pot one or two pieces of zinc or aluminum, such as may be purchased at nearly any hardware store. One or two pieces of sheet-metal, say 4 by 10 in. will be enough. Fill the pot one-half to two-thirds fulls of hot water and add two or three heaping tablespoonfuls each of table salt and of bicarbonate of soda. These are the electrolytes. Then put in the tarnished silverware, and it will grow bright in a little while.

We must go back to the ionization theory to explain this. Both zinc and aluminum are electropositive to silver, and a current is set up between them. The salt, NaCl, splits into sodium and chlorine ions, the chlorine ions going over to the zinc and forming zinc chloride, which goes into solution. The sodium ions go to the other pole, which are the silver articles. Here they act upon water, release hydrogen, and form caustic soda:

$$Na_2 + 2\ H_2O = 2\ NaOH + H_2.$$

The hydrogen just released acts upon the silver sulphide and produces hydrogen sulphide and free silver:

$$Ag_2S + H_2 = H_2S + 2\ Ag.$$

The free silver is now just where it is desired—on the outside of the spoons, or wherever it was before it was tarnished. All grease must be removed before the articles are put into the pot.

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ALTERNATING CURRENT SKIN EFFECT

Alternating current causes an unequal distribution of current in a wire, the current density decreasing towards the centre of the conductor. One result of this phenomenon is that in large wires the centre portion is useless as a conductor, thus increasing the resistance of the wire above that which would occur in case it were used for direct current service. This is know as "skin effect." This skin effect increases with the frequency and also with the diameter of the wire. It increases in such a way that for the same percentage of increase due to the skin effect, the product of the frequency times the square of the diameter is a constant.

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ENGINEER STUDENTS AND THE WAR

Most of the students in engineering colleges will be exempted from the draft and permitted to join the reserve corps for future service under regulations recently issued by Provost Marshall General Crowder. He has ruled that a proportion of the students in technical engineering schools may enlist in the engineer enlisted reserve corps, and that those so enlisting will be placed in the last draft classification upon presenting certificate of such enlistment to their local boards.

The greater part of 4,300 graduates of engineering schools in the class of 1917 are now in the service. One-third of the class of 1918 has enlisted without waiting for graduation.

The danger is not that students in engineering school will refrain from enlisting, Gen. Crowder was told, but that they will enlist before they are sufficiently trained to be most effective in active service.

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LOW VOLTAGE HAZARDS

Writing on this subject in a recent issue of the *Electric Journal*, Chas. A. Stauffer, M. D., of the Westinghouse Electric & Mfg. Co., says that voltage is never dangerous except as it serves to send current through the body in accordance with ohm's law. The definite amount of electric current that may pass through the human body without danger to life has not been determined. It is conceded, however, that one-tenth ampere may become dangerous, one-fourth ampere may prove fatal, though seven to ten amperes are registered on the ammeter in criminal electrocutions.

It is apparent that the relatively high skin resistance of the human body is the element of safety in handling low-voltage lines. A moist skin, however, reduces the skin resistance.*

On a high-potential circuit, the current which will flow in case of accidental contact depends principally upon the external resistance in the circuit, on the nature of the contact, and on the extent of the arc which usually forms part of the circuit. On low voltages, however, the resistance in the metallic circuit is usually negligible as compared with that of the body and hence the body resistance becomes the limiting factor.

The skin resistance of the human body is relatively high, measuring approximately 4000 ohms. The dry calloused palms of a workingman afford a much higher electrical resistance. No accurate figures can be given, as individuals vary in their response to electric currents, and the readings for the same individual will show variations. The accurately measured electrical resistance of hand-to-hand contact, obtained by the bridge method, expressed in equivalent ohms, dry surfaces, six inches tin-foil contact, gives a minimum of 40,000 ohms, maximum of 140,000. The internal resistance of the body is relatively low, so that when the skin resistance is broken and the current passes through the body, a dangerous volume of current may flow even at relatively low voltages.

	Minimum Ohms	Maximum Ohms
*Forehead to neck (back)	3,400	4,000
Neck (back) to chest	5,300	7,500
Neck to right hand	14,000	60,000
Neck to left hand	26,800	55,000
Neck to both hands	10,850	35,000
Neck to hip	18,500	80,000
Neck to knee	120.000	170,000
Hand to hand	40,000	140,000
Hip to knee	47,000	165,000

The effect of an electric shock is cumulative. Thus a momentary contact with a low voltage circuit may result in no damage, yet the same contact, if prolonged, may result in serious injury.

High Amperage on Low Voltage Circuits

The increased hazard of high amperage circuits of low voltage arises from the high-generating capacity of the circuit. Contact with the high-voltage side of an induction coil involves no serious danger, due to the fact that the capacity of the coil is insufficient to maintain its high voltage when delivering current through the body; the induction coil may develop 5,000 volts on open circuit, but does not sustain it. However, short-circuiting a low-voltage conductor on a large generating system releases a tremendous amount of energy. The high-capacity, low-voltage circuit, if the arc is short, may prove more dangerous than an equal capacity, high-voltage circuit with a long arc. The danger of electrical burns is, therefore, much greater on a large system than on a small one.

The danger in a low-voltage circuit of high amperage capacity is evoked by interrupting the circuit, and is manifested by fire and flame. Such arcing may cause flash burns. Interrupting a circuit of great capacity feeds more energy into the arc, and may vaporize metal in its initial arcing; this vaporized metal, by reducing the resistance of the arcing path, may establish a dangerous arc. Low voltage does not sustain an arc, however, as well as a high voltage; an alternating current does not sustain an arc as well as does a direct current.

*Certain high-frequency currents are relatively safe. This discussion is limited to the effects produced by power circuits at the usual commercial frequencies.

NUTS FOR THE KNOWING ONES

QUERIES AND ANSWERS IN TECHNICS

What should be done to change a direct-current motor into a generator? Will it give the same voltage and amperage if run at the same speed as it runs as a motor? As a motor its speed is 1900 rev. per min. when operated at 220 volts, 132 amperes. M. E. Longhurst, Eddystone, Pa.

A motor which has 220 volts applied to its terminals carries a load of 132 amperes at a speed of 1900 rev. per min.; if this motor is belted to an engine and driven at the same speed will it produce 220 volts as a generator and be able to carry an external load of 132 amperes?

In answer to M. E. Longhurst's question as given above, I would say that it depends on the resistance of the armature what the generated voltage will be, and the current capacity will be less than the amount required to excite the field windings. Assuming it to be a shunt machine, the current required to excite the field windings is a part of the load carried by the armature. On small machines the amount of current required to excite the field windings is about 7% or 8% of the full load current. On some of the larger ones it is as low as 1% of the full load current. On the machine under consideration about 3% of the full load current can be safely allowed for field excitation.

The writer is going to assume the following in regard to this question: armature resistance at the brushes as .02 ohms. Current for field winding excitation (at 3% of full load current) 3.96 amperes.

The voltage generated by the armature will be equal to the counter electromotive force produced in the armature when running as a motor. The voltage drop in the armature of this motor will be I × R where:

I=full load current.

R=armature resistance.

Then 132 × .02 = 3.64 volts drop, and the counter electromotive-force will be equal to E—e, where:

E=full machine voltage.

e=volts drop through the armature.

Then 220 — 3.64 = 216.36 at a speed of 1900 rev. per. min.

The full load rating of this machine is 132 amperes, then the external load would be equal to I — i where:

I=full load current.

i=current for exciting fields.

Then 132 — 3.96 = 128.04 amperes.

From this it will be seen that a motor rated at 220 volts, 132 amperes, 1900 rev. per min. would develop when run as a generator at a speed of 1900 rev. per min. 217 volts and 128 amperes.

Mr. Longhurst will please remember that these results are based on an armature resistance of .02 ohms and a field current of 3.96 amperes. If these values differ from those of his machine the results will also differ.

Jacob Gintz, Jr.

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HANDY ARMATURE TESTER

Here is an armature tester that M. E. Longhurst, of Eddystone, Pa., has found useful. Connect two dry cells in series with a fork and buzzer, then get a telephone receiver and connect to the two inside prongs of the fork so they rest on two bars, while the two outside prongs are across about six bars and the sound from the buzzer can be heard through the receiver. Any change in the sound will show a bad coil or open circuit. Each prong of the fork must be insulated from the other.

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Will you tell me how to get the formulas for the size of wire to use for both direct and alternating current circuits when the number of amperes, the voltage, and length of circuit are given. F. A. Hurd, Pittston, Pa.

Direct-Current Circuits

In calculating wire sizes for two-wire direct-current circuits of ordinary length it is first necessary to determine the load in amperes that the circuit will carry, then to find the distance from the center point of distribution to the load center of the circuit, and then decide the allowable voltage drop. The load center usually can be estimated by inspection, but can be calculated accurately by multiplying the normal current taken by each lamp or other current-consuming device by its distance to the central distribution point, adding these results, and then dividing by the total current in the circuit.

The resistance of a circuit varies directly with the length and inversely with the area of the conductor; that is,

$$R \text{ varies as } \frac{L}{A}. \qquad \text{For copper, } R = 10.75\,\frac{L}{A},$$

10.75 being the resistance of one foot of ordinary copper wire with a cross-sectional area of one circular mil, L being the length in feet, and A the area in circular mils.

From Ohm's law we have

$$e = RI$$

Substituting for R,

$$e = \frac{10.75 \times L \times I}{A} \text{ or } A = \frac{10.75 \times L \times I}{e}$$

In the above formulas L is the length of wire measured one way, or the single distance of the circuit. For the entire circuit the formula becomes

$$A = \frac{21.5 \times L \times I}{e}$$

This is the working formula. By substituting the distance in feet from the point of distribution to center of load for L, the current in amperes for I, the allowable voltage drop for e, and solving the result A is the area of the wire in circular mils. When this result is obtained, the proper size of wire can be determined by referring to the standard copper wire table.

If it is desired to calculate the wire size for a circuit having a certain number of lamps substitute for the current I the number of lamps N multiplied by the current i taken by each lamp. The formula then becomes

$$A = \frac{21.5 \times L \times N \times i}{e}$$

If it is more convenient to make the calculation in terms of the wattage of the lamps substitute for i the wattage W divided by the circuit voltage E.

$$A = \frac{21.5 \times L \times N \times W}{E \times e}$$

For example, it is desired to install 40 100-watt lamps on a 115-volt circuit at an average distance of 100 feet with an allowable voltage drop of 2 volts. Substituting in the preceding formula,

$$A = \frac{21.5 \times 100 \times 40 \times 100}{115 \times 2} = 37{,}391 \text{ circular mils.}$$

The wire table shows the proper wire size to be No. 4.

After the wire size has been calculated it is necessary to determine whether the wire will safely carry the current in the circuit. Safe current-carrying capacities of wires can be got from wire tables. In the example given, the current would be 40 times 100 divided by 115, or 34.8 amperes, which is permissible for No. 4 wire.

In making wiring calculations for direct-current three-wire circuits a balanced circuit is assumed. The current in the outside wires is determined for use in the formulas for A. The voltage drop e is the drop in both of the outside wires and may be twice as large for a three-wire circuit as for an equivalent two-wire circuit.

Alternating-Current Circuits

Wire sizes for alternating-current circuits of ordinary length and high power-factor, such as for incandescent lamps, may be calculated sufficiently accurate for practical purposes by using the formulas given for direct-current circuits.

The formula for the current in a single-phase circuit is

$$I = \frac{K\ W. \times 1{,}000}{E \times P.\ F.}$$

where I is the current in amperes, $K.\ W.$ the kilowatt value of the load, E the voltage of the circuit, and $P.\ F.$ the power-factor of the load.

The area of the conductor in circular mils will be

$$A = \frac{21.5 \times L \times I}{e}$$

where L is the length in feet of the conductor (one way), and e the allowable voltage drop.

Wire sizes for single-phase branches of three-phase circuits are calculated in the same way. In case the branch is connected to the neutral and one of the outside wires the voltage of the branch circuit will be .58 times that between any two outside wires.

For two-phase, four-wire circuits the current in each of the four wires may be calculated from the formula

$$I = \frac{K.\ W. \times 1{,}000}{E. \times P.\ F. \times 2}$$

and the area A may be calculated from the formula above.

For balanced three-phase three-wire circuits the current in each of the three wires may be calculated from

$$I = \frac{K.\ W \times 1{,}000}{E \times P.\ F. \times 1.73}$$

and the area A may be calculated from

$$A = \frac{10.75 \times I \times L \times 1.73}{e}$$

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A SIMPLE FRICTION TEST

By W. F. Schaphorst

How do you know that your bearings, belts and machines are consuming less power this year than last? By means of indicator diagrams taken on the engines? Or, by noting the amount of money you have spent for fuel during the last year? Or, by means of a transmission dynamometer?

The first two methods are generally unsatisfactory, because they are not highly accurate, or because they are too slow. The last method is accurate, but transmission dynamometers are rather expensive and the average owner can't see why one should be bought anyway. He would consider one "just an added expense." I agree with the owner in this case, especially if the plant is driven by an engine which is equipped with a large and heavy flywheel. The flywheel can be used as a mighty sensitive "indicator of power loss," and this is the way it is done:

After steam is shut off from any engine, the stored energy in the moving parts keeps the engine and machinery a-going for some time. We all have observed that fact. Much depends upon the weight of the flywheel, of course, for a heavy flywheel will naturally have more energy stored in it than a light wheel would have, both running at the same speed. This is evident from the old and well-known formula:

$$E = \frac{MV^2}{2}$$

where E = the energy of the flywheel in foot pounds
V = velocity of the flywheel rim in feet per second.
M = the mass of the flywheel, or the weight in pounds divided by the acceleration due to gravity (32.16 at sea level).

All engines generally operate at a so-called "constant" speed. That is, if a Corliss engine runs at 80 rev. per min., you can bank on the fact that it isn't exactly 80 rev. per min., but so close to it that we can safely call it 80 rev. per min. The energy stored in the flywheel while running at that speed is, therefore, a constant amount, for in the above formula M is certainly constant.

Therefore, on shutting off steam the same interval of time will always be required for the flywheel to come to rest, if the hindering force is a constant force. If you will take out your watch and observe the time required for your engine to come to a standstill you will find it to be the same every time, with all conditions the same. If, for instance, your engine came to a dead stop in 2½ min. last year, whereas this year it requires 3 min. to stop, the friction or hindering force is less this year than last. The longer the stopping time the better. That's the whole solution in a nutshell. Make the stopping time as long as possible.

To test the friction of your machinery, just see how long the flywheel will keep the machines running when "empty." It is obviously best not to have the machines working during the test, because power requirements are not constant; sometimes they are considerably more than at other times. After being sure of the stopping time, fix up the bearings; align, clean and oil them. Wherever necessary babbitt them. In some places it may be deemed wise to install ball or roller bearings. Fix the belts also. Don't allow them to run too tight, because extreme tightness is unnecessary and bad. Treat them with a good belt treatment, so that they will become nice and pliable. If pulleys are too small, and if belt slip cannot be stopped in any other way, it will pay to put on larger pulleys.

Then, after all of these improvements have been made, take the stopping time of the engine again. You will doubtless find that it has increased considerably. If it has, well and good. You can rest assured that you are going to save coal in the future, or you can run more machines with the same engine without burning more fuel. "How much money will I save per year by improving my transmission?" you ask, "and how can you tell beforehand how much the saving will be?" To answer that question I have developed a formula which will tell you closely enough for all practical purposes. Here it is:

Cost of excessive friction per year

$$= \frac{WV^2CND\ (Tg - Tb)}{17{,}700\ Tg\ Tb}$$

where W = The weight of the engine flywheel or flywheels in pounds. (In computing this weight it may be well for you to be reminded that one cubic inch of cast iron weighs 0.26 pounds).
V = velocity of flywheel periphery in feet per second.
C = The average cost of power in your plant per horse power hour.
N = The number of hours you run, per day.

D = The number of days you run, per year.
Tg = Stopping time of engine *after* transmission has been improved, in seconds.
Tb = Stopping time of engine *before* transmission was improved, in seconds.

If, for example, the weight of your flywheel is 4,000 lb.; V = 80 ft. per sec.; C = \$.01; N = 9 hours; D = 300 days; Tg = 240 sec.; Tb = 180 sec.; we get

$$\frac{4{,}000 \times 6{,}400 \times .01 \times 9 \times 300\ (240 - 180)}{17{,}700 \times 300 \times 240} = \$32.50$$

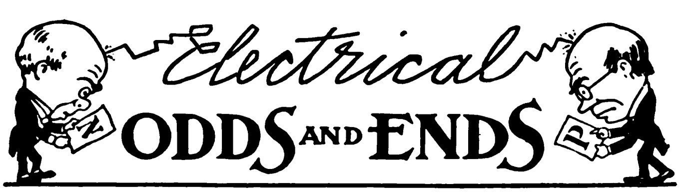
It will be noted that this engine ran for 4 min. after closing the valve after transmission had been improved. The engine wasn't driving all of the machines. It was just driving the main shaft. So, \$32.50 saved per year on the main shaft alone isn't so bad.

Next, with all machines running empty, the stopping time was increased from 40 to 55 sec. We then get

$$\frac{4{,}000 \times 6{,}400 \times .01 \times 9 \times 300\ (55 - 40)}{17{,}700 \times 55 \times 40} = \$265$$

Quite a difference isn't it? And in the first example, the stopping time was increased 60 sec., whereas in the second example it was increased only 15 sec. Much depends upon conditions. The above test is not exaggerated one whit. I would suggest, if you think it is exaggerated, that you try it out and see for yourself.

To repeat, and to summarize the whole idea: Make the stopping time of your engine as long as possible. If your plant is driven by a motor or a steam turbine, you cannot detect the difference quite so accurately, perhaps, but the same arguments hold. Much depends upon the mass of the motor's rotor, and of the turbine's rotor, and their speed and size. In any event, try it out.



BRIEF TIDINGS FOR THE BUSY MAN

The character of tungsten filaments is not affected by alternating current of different frequencies, the life of the lamps on alternating current being the same as on direct current.

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In constant service for more than 18 years and still going the daily rounds in New York City, giving just as efficient service as when originally installed, a fleet of electric trucks purchased in 1899, indicates the sturdy construction of the early auto trucks.

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At the convention of the American Society of Mechanical Engineers of New York last month David M. Myers said that present examinations of operating engineers for licenses call for practically no knowledge of steam and fuel economies. This is a very serious defect and is directly responsible for a large preventable waste of fuel.

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How to increase production is the problem facing that part of the industrial world engaged in manufacturing wartime essentials. If men are scarce, why not let the women go to work? If the women can't stand the physical strain, why not install horsepower in the shape of electric motors to take the heavy part of the burden? If the factory must be run 24 hours a day, at night there must be plenty of light sources properly located and fitted with suitable reflectors. What is wanted in most machine shops is intensity of light without glare. Our war industries must be speeded up from now until peace comes once more and men begin again fight each other with brains instead of with T. N. T. shells, liquid fire and gas.

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The numbei of American Telephone & Telegraph stockholders on October 31, 1917, was 80,782, which compares with less than 75,000 on December 31, 1916. This increase shows the number of actual investors impressed by the value of American Telephone & Telegraph stock sufficiently to compel its purchase in a market which has driven the price of the stock below the bottom price touched in the last nine years.

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The Bell system maintains an engineering and scientific staff of more than 550 specialists, among them former professors and instructors of our universities, post graduate students, and other graduates holding various engineering and scientific degrees from seventy different scientific schools and universities, sixty American and ten foreign institutions of learning being represented. No other telephone company, no government telephone administration in the world, has a staff and scientific equipment such as this.

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A meeting of the American Association of Engineers was held in Washington, D. C., on the evening of December 14. During the present critical period when patriotism and co-operation are the main issues, the association is working with full power to enable our Government to secure desirable and qualified technical engineers. Among those present were Admiral F. R. Harris, chief of the Emergency Fleet; Admiral Baird; Major Zimmerman of the Engineers' Dpot; and Major Harrison.

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In co-operation with corporations affected, the California Railroad Commission will survey railroad, electric, and gas industries to discover, if possible, ways and means for decreasing expenditures and increasing the aid which these companies can give the Federal and State governments. The commission will endeavor to provide for fuel conservation, manufacture by gas companies of by-products for war use, raising efficiency of hydroelectric concerns, making railroads most serviceable.

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Reports indicate the success of the nation-wide "America's Electrical Christmas" campaign, conducted under the general direction of The Society for Electrical Development. Sales in all parts of the country, particularly by the contractor-dealers, resulted in a real electrical Christmas. The campaign was not intended to be as spectacular as the big electrical weeks of pervious years, but the society had not anticipated so big a rush for sales helps, which in some respects rivalled the 1916 campaign.

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The increase in recent years in the number and length of alternating current transmission systems and distribution net works makes the need of voltage regulating equipment essential if proper service is to be given to consumers. The following conditions, frequently met with in practice, can be greatly improved by voltage regulating equipment and are best taken care of by means of outdoor type regulators for improving the voltage regulation. First: a long feeder circuit serving scattered loads, such as is found in suburban districts. Second: branch circuits tapped off a main feeder. Third: lighting circuits tapped off a feeder carrying a power load. In this case a feeder regulator will prevent fluctuation of lamp voltage as the power load changes. Fourth: lighting circuits taken from a transmission line through step-down transformers.

THE TRADE IN PRINT

What The Industry is Doing in a Literary Way

Type FK-25 Oil Circuit Breakers are described and illustrated in several loose-leaf catalogue sheets issued last month by the General Electric Co., of Schenectady, N. Y.

Electricity in the Textile Industry, issued by the Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., was distributed at the Southern Textile Exposition held at Greenville, S. C., last month.

Tate-Jones & Co., Inc., Pittsburgh, Pa., furnace engineers, are distributing Bulletin 160, dated October, 1917, on recuperative gas oven furnaces. On request this company will send a booklet entitled "Heat Treating Steel."

Electrical Equipment for Rubber Factories is the title of an illustrated publication (Circular No. 7352) with an attractive art cover, which has just been issued by the Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa. There are a large number of illustrations of application of motors to the rubber industry, taken in different parts of the country.

Youngstown Sheet & Tube Company, Youngstown, Ohio, has issued an attractive calendar for 1918. It is featured by twelve large two-color illustrations of as many different operations in the manufacture of iron and steel. The plates were made from photographs taken in the works of the company and are both handsome and instructive. The calendar will be sent to any address on receipt of four cents in stamps to pay cost of mailing.

Modern Methods in Textile Mills is the title of a recent brochure issued by the Westinghouse Lamp Co. The author is Eugene Szepesi. In binding, type, illustrations, and text—it reads like the sort of novel that informs while it entertains—it is the best of the several publications of the sort that have come to us from the literary shop of this enterprising company. Though this little book may be had just for the asking, it is much better reading than many a so-called latest best seller that retails at the more or less fixed price of one-fifty net.

Tests of Oxacetylene Welded Joints in Steel Plants, by Herbert F. Moore, research professor of engineering materials, has been issued as Bulletin 98 of the Engineering Experiment Station of the University of Illinois. This bulletin gives the results of a series of tests of the strength of oxyacetylene welded joints in plates of mild steel. The joints were welded by skilled workmen in a plant equipped for the purpose. The specimens were tested under three conditions of loading: (a) static load in tension (in a testing machine), (b) repeated load (bending), and (c) impact in tension (in a drop testing machine). In general, the test results tend to increase confidence in the static strength and in the strength under repeated stress of carefully made oxacetylene welded joints in mild steel plates.

Roll of Honor of the employees of the General Electric Co. is contained in a supplement to the General Electric *Review* of November, 1917. This list shows how the working force of this concern has been cut into by the army and navy since the United States joined in the fight against Teutonic aggression. About 1,000 have enlisted from Schnectady, 500 from Lynn, 275 from Pittsfield, 50 from Erie, 110 from Ft. Wayne, 75 from the Edison Lamp Works, 120 from the National Lamp Works, 7 from the Sprague Electric Works, and 175 from the various district offices. All told there are about 2,300 General Electric men in the service at this time.

Westinghouse Catalogue of Industrial Motors. The second of a series of catalogues of industrial motors has just been distributed by the Westinghouse Electric & Mfg. Co. It covers the company's complete line of direct current motors and generators for industrial service. After several pages giving general information regarding the ordering, classification and selection of direct current motors there follows complete description, rating and dimensions for type SK commutating-pole motors, various modifications of type SK elevator motors, reversing planer motor equipment, Type CD motors, headstock equipment for woodworking plants, type SK and CD motor generators and arc welding equipment. Much new information is given especially on such subjects as arc welding, headstock equipment, motion picture service and battery charging service.

Useful Information on the Application of Electrical Protective Devices is contained in a limp leather book of 164 pages issued on January 1, 1918 by the Condit Electrical Mfg. Co., of South Boston, Mass. In this book the company gives, in compact and convenient form, information necessary for the application of control and protective equipment that has been gathered from widely scattered sources. On page 33 there is presented in novel form formulas for determining current values in alternating circuits. Each formula is illustrated by a diagram of connections showing the respective working conditions to which the formula applies. Formulas for combining resistance and reactance, also illustrated, are given on page 34. On other pages will be found numerous other tables of direct application in solving practical electrical problems. This book is worth far more than the author demands for it—it may be had merely for the asking.

Catalogue 8-E, just issued, the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa., describes all of the industrial electric heating apparatus which it manufactures. The line includes steel-clad heaters for many industrial processes, immersion type water heaters, stoves of various forms, chocolate warmers, tailors' irons and electric oven heaters for use in enameling. Data are given for the calculation of the proper amount of heating to provide for water and for the heating of buildings. Several pages are devoted to the subject of electrically heated ovens, covering the design and construction of the ovens themselves, a discussion of the various types and their uses, and the efficiencies in operation which can be secured. This catalogue is a valuable addition to the library of any man whose work includes the application of heat at moderate temperatures for industrial purposes.

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NEW BOOKS

Everyman's Chemistry

Ellwood Hendrick has put all engineers, embryo and arrived, under lasting obligation to him for writing this readable book. Next to a family genealogy or a railway time-table, the dullest reading on earth is that usually found between the covers of a manual of chemistry. Written by chemists who take themselves and their subject seriously, are technical to the last gasp, and intent on writing for themselves rather than for their readers, such books are sooner or later to be had for a nickel in a second-hand book store.

Now here comes a man who writes chemistry stuff for his readers, and has a lot of fun in doing it. Not appearing to take either himself or his subject seriously, he brings out a rollicking book that marches—the acid test of a story, says J. M. Barrie, is "does it march." He treats chemical elements as if they were human beings possessed of foibles, whimsies, and imaginations. He put flesh, intelligence, beauty, and sprightliness in what has heretofore been regarded as a lot of old bones. Under his deft guidance, chemistry is made to entertain as well as to inform. What the science cult needs is a batch of authors like E. Hendrick, authors who can write as chattily about their specialties as he does about the erstwhile humorless science of chemistry. Then their books will be read, and treasured.

In the preface, Mr. Hendrick speaks of chemistry as that branch of philosophy and poetry which has to do with the "Ways of Stuff." Ways of Stuff would be a good title for the book, and not a misleading one either. The stuff that he talks about in the following 360 pages includes air and water, red-headed halogens, sulphur, phosphorus, arsenic, antimony, bismuth, alkali metals, sand and clay, lime and magnesia, iron, steel, copper, zinc, tin, lead, nickel, cobalt, manganese, and the rare metals like gold, silver, platinum, and other ums. Nickel and cobalt are imps, he says, called so by old Philippus Aureolus Paracelsus Bombastus von Hohenheim, their discover. Paracelsus was a rummy as well as a chemist of great renown.

The third part of the book takes up organic chemistry. Here will be found equally entertaining chapters on paraffin and petroleum bodies, olefins and acids, alcohols and some relatives, fats, oil and other products, also sugars, starch and gums, cellulose, aromatic compounds, coal tar and finished products.

"I confess frankly," say the author in the first part of the book, " that I am after something of yours that is not included in the money you pay for this book—I am after your curiosity. If I can get that, there will be no holding you back from the subject. The whole work is designed as a man's book rather than as a torment for the nursery, so I have not hesitated to enter into some of the profoundest problems, but if you can only keep good-natured about them, there is no reason why they should be dull."

Later on in the book, discussing soaps in his characteristically whimsical and clever way, he says: "Very often the big yellow cakes of the laundry and scented 'Thing of Perfection' in the boudoir are made from the same stock. Many French persons always use American soaps on the ground that they are the best. Many Americans, on the other hand, prefer French soaps for toilet use, on the ground that they are still better. Others buy those which cost the most in the same search after perfection. Now soap, I repeat, is soap. It is not chemistry that makes a good neutral soap with no free alkali a little scented nubbin worth 50 cents; it is art."

This book is published by Harper & Brothers, New York. It costs $2 but is worth a lot more.

DID YOU KNOW THAT—

BITS OF GOSSIP FROM THE TRADE

The Okonite Co., 501 Fifth Avenue, New York—due to a typographical error which was overlooked in the hurry of going to press with our December issue, we stated in the advertisement at the bottom of page 73 that the General Electric Co., Chicago, Ill., are General Western agents for The Okonite Co. Instead of General Electric Co. it should read Central Electric Co., Chicago, Ill., General Western Agents.

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Detroit Fuse & Mfg. Co., Detroit, Mich., has sold its rights and materials for the manufacture of "Arkless" enclosed fuses to the Economy Fuse & Mfg. Co. of Chicago, Ill. The transaction includes the conveyance of all merchandise, materials, machinery, tools, designs, patents, good will and unfilled orders. The "Square D" line of enclosed safety switches remains the property of Detroit Fuse & Mfg. Co., who will concentrate on its production and marketing.

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Combustion Engineering Corporation is represented in the various branches of the National Service, so far as its drafting room is concerned, by six men who are enrolled as follows: Hugh Campbell, National Army, Camp Upton; Robert Weber, Naval Reserves, 3rd District; Hubert Ahearn, Naval Militia, N. Y. 5th Battalion; Murray Harris (Corp), O. E. R. C., Camp Upton; J. Nelson Hunter, British Royal Flying Corps; Raymond Zimber, U. S. A. Flying Corps, Mineola, L. I.

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Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has received from the Brier Hill Steel Company, of Niles, Ohio, an order for a 132-in. plate mill equipment consisting of a 5,000 hp. induction motor with primary control panel and step regulator; a 24-in. reversing roughing mill with a 7600 hp. direct current motor, and a 2250-kw. 1500 hp. motor-generator set with 60,000 lb. flywheel; and an 84-inch plate mill equipment with a 2500 hp. induction motor, primary control panel and slip regulator. Additional electrical equipment ordered for this plant includes two 750-kw. synchronous motor-generator sets and four 3500-kva. radiator-type transformers.

The Westinghouse Company has also received an order for electric hoisting equipment from the Nevada Consolidated Copper Company for its mine at Ruth, Nevada.

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The year 1917 has seen a great advance in the use of electrical appliances. Most dealers and utility companies report largely increased sales of household electric appliances due no doubt to the national need for the conservation of time and energy of housewives and reduction in the number of servants.

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Work on a new underground cable from Washington to New York is now well under way. This cable will contain 80,000 miles of wire and will be a valuable addition to the existing underground system which provides the National Capital with all underground communication with Baltimore, Wilmington, Philadelphia, Trenton, Newark, New York, Bridgeport, New Haven, Hartford, Providence and Boston, all centers of extraordinary activity in the manufacture of munitions and war materials.

In accordance with a resolution passed at the last meeting of the Electrical Manufacturers' Council the following appointments have been made on the War Service Commission of the Electrical Manufacturing Industry: For the Associated Manufacturers of Electrical Supplies—J. R. McKee, General Electric Company, and R. K. Sheppard, Simplex Wire & Cable Company. For the Manufacturers' Club—C. A. Terry, Westinghouse Electric & Mfg. Co., and W. W. Nichols, Allis-Chalmers Mfg. Co. For the Electric Power Club—C. L. Collens, Reliance Electric & Engineering Co.

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The most efficient incandescent lamp for street lighting to-day is the mazda series lamp. It can be equipped with a variety of accessories suitable for all types of outdoor lighting from the rural highway to the so-called "white-way" or ornamental systems in business districts. Various equipments of glassware and reflectors together with a wide range of candle-power sizes give a flexibility which adapts this lamp to almost every condition to be met in street lighting service. Never before has there been so large a number of units to select from, which will meet both small and large appropriations and give satisfactory results.

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PURELY PERSONAL

Stanley Walton, commercial manager of the Pacific Gas & Electric Co., resigned his position on January 1.

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G. A. Schneider, formerly of the San Francisco sales organization of the Western Electric Co., has been appointed manager of that company's Buffalo house succeeding J. W. Tabb, who has been transferred to the New York house.

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T. J. McGrath, secretary to H. M. Byllesby, has entered the navy as chief yeoman, and Eugene Stoddard, of the engineering department, has joined the ordnance department at Washington. This makes a total of 27 Byllesby men, Chi- in either the army or navy.

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C. H. Andrews, assistant to president and chief engineer of the North Carolina Public Service Company, Greensboro, N. C., has been appointed general superintendent of the Southern Utilities Company, which corporation operates electric, gas and ice properties throughout Florida, under the management of The J. G. White Management Corporation, New York, N. Y. He assumed his new duties on January 1.

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Chas. T. Main, of Boston, a consulting engineer, has been elected president of the American Society of Mechanical Engineers. Mr. Main has designed and supervised the construction of numerous industrial, steam power, and water power plants. Among the larger of his undertakings are four hydroelectric developments for the Montana Power Co., aggregating about 280,000 hp.

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Frank W. Hall has been appointed commercial manager of the Sprague Electric Works of General Electric Company. With the exception of a short period, Mr. Hall has been connected with the Sprague Works continuously for 22 years in various engineering and sales capacities, and for the three years prior to his present appointment occupied the position of sales manager. D. C. Durland, former executive head of the Sprague Electric Works, has resigned to accept the presidency of the Mitchell Motors Company, Inc.

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Lenoard S. Cairns, assistant general manager of the Manila Electric Railroad and Light Company, Manila, P. I., has been appointed general manager of the Eastern Pennsylvania Railways Company, Pottsville, Pa., by The J. G. White Management Corporation, New York City, the operating managers of both companies. Mr. Cairns has arrived in the United States and has assumed the duties of his new position. He succeeds L. H. Palmer, who lately became assistant to the president of the United Railways and Electric Co., Baltimore, Md., as recently announced in these columns.

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ASSOCIATION NEWS

National Institute of Inventors held a meeting at the Broadway Central Hotel, New York, on December 7, 1917. Fred W. Barker gave an address on aviation—the need of inventions in the aviation field. An address was made by George J. Houtain on the matter of weeding out the fake patent attorneys and promoters from preying upon the inventors.

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New England Section of the N. E. L. A. held a war conference at the Engineers' Club, Boston, on December 18. Coal shortage was the chief topic of conversation. In New England fuel is so scarce that all power plants are co-operating to the limit with the Federal authorities in enforcing lightless nights and curtailing the supply of electrical energy to non-essential industries. The New England Power Co., the largest water power system in New England, is urging its customers to curtail energy consumption equivalent to one working day a week.

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Southwestern Gas & Electric Assn. announces that after six years of effort it has finally induced the Texas Legislature to pass an efficient and equitable law to prevent the stealing or diverting of gas, electricity, or water supply. The old law required proof of the intent to cheat or steal—an impossible feat in ninety-nine cases out of one hundred. The new law allows any physical evidence of cheating or stealing to be prima facie evidence of the intent to cheat or steal, thereby making conviction more easy.

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ter-sectional meeting in Boston, January 8, New York, January 11, and Chicago, January 14, 1917. The same paper will be presented and discussed at the three places. The paper to be presented is entitled "Effects of War Conditions on the Cost and Quality of Electric Service" by Lynn S. Goodman and William B. Jackson, and is given under the auspices of the Committee on Economics of Electric Service. The paper will be presented at the Boston and New York meetings by Mr. Goodman and at the Chicago meeting by Mr. Jackson. Non-members of the Institute who are interested in this subject are cordially invited to attend and take part in the meeting.

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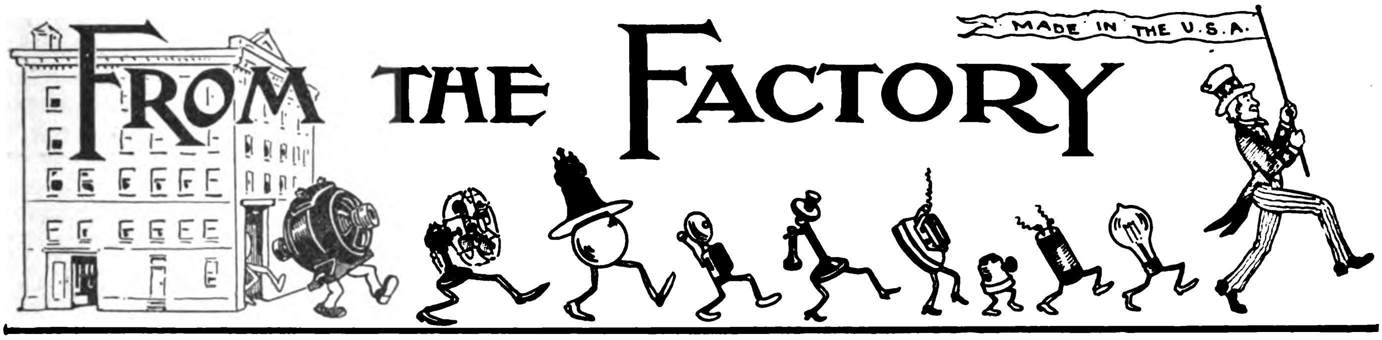
The most elaborate and interesting meeting ever held by the New York Companies' Section, N. E. L. A., took place on the evening of December 18 at the aduitorium of the Consolidated Gas Company, 130 East 15th Street. Tickets were issued to section members and one thousand of them were in attendance. The program of the meeting—which was entitled the "Xmas Festa" was arranged by the Women's Committee. "Women in the Business World" was the subject of a timely address by Mrs. Jacob Riis, the journalist and settlement worker. Miss Edith Diehl, Director of Auxiliary Workrooms of the New York Chapter, described the work being done by the Red Cross. Another speaker was Mrs. Ethel Watts Mumford, who described with pungent humor the "stunts which the suffrage campaigners had been compelled to resort to in order to break into the newspapers and obtain their share of publicity." Miss Virginia Powell, the reader of O. Henry stories, and the Marvelous Maurice, prestidigitator, had played their parts, the audience went to the 19th floor to see the company Xmas tree and to dance to the music of a Jazz band.



Short Stories About Electrical Goods Offered By Manufacturers

AUTOMATIC ELECTRIC IRON

An electric iron equipped with a switch which opens automatically when the iron is not in use, is announced by the Savo Electric Co., Toledo, Ohio. A switch button is located in the forward part of the handle, just where the thumb ordinarily rests. Under normal ironing conditions, the thumb presses against the switch button and keeps the iron in circuit; removing the thumb cuts it out of circuit. By means of this switch button, the current may be cut in and cut out at will by the operator, merely by moving the thumb. This will be found convenient when ironing lighter fabrics, the heat being shut off when not needed to prevent scorching.

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PORCELAIN SHURLOK SOCKET

Pass & Seymour, Solvay, N. Y., announce the marketing of an all porcelain Shurlok socket. These sockets have been designed for installation in places where there is a high percentage of steam, humidity, acid fumes, or gases; places where the ordinary metal socket is likely to deteriorate rapidly by corrosion.

Porcelain Shurlok. Pass & Seymour, Solvay, N. Y.

In locking the lamp in, by means of the Shurlok device, the shell and cap of the socket are locked so that they cannot be taken apart.

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CHAIN-PULL CANDLE SOCKET

A straight chain-pull socket for use in candle fixtures is being made by Pass & Seymour, Solvay, N. Y. Large binding screws are provided and the raceways for wires are conveniently deep. The combination of candle-socket and switch provides a practical economy, the manufacturer points out, in individual control of the lamps. The fitting complete is 3¼ in. long and has a diameter of 1 5/32 in.

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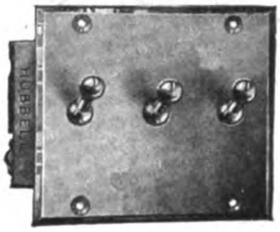
HUBBELL TOGGLE SNAP SWITCHES

The Hubbell toggle surface switch differs from the ordinary snap surface switch in that manipulation is by the throw of a lever or toggle, instead of by the turning of a key or button. Throwing the lever up makes the circuit; throwing it down breaks the circuit. The movement is positive—the make-and-break quick and snappy.

The advantages of the toggle movement in a surface switch are three-fold—first, it permits making the switch more attractive and stronger than the ordinary switch; second, manipulation is much more convenient by means of the lever than by the turning of a key; third, the switch is self-indicating, the position of the lever showing at a glance whether the current is "on" or "off" without any marker or dial. These switches are offered in two capacities—10 amperes, 125 volts; 5 amperes, 250 volts—by Harvey Hubbell, Inc., Bridgeport, Conn.



Toggle snap switch. Harvey Hubbell, Inc., Bridgeport, Conn.

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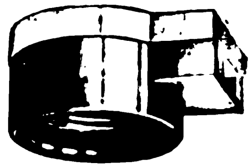
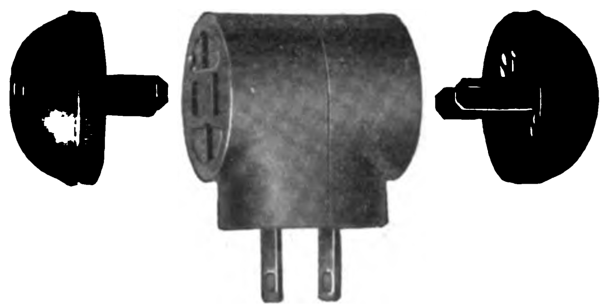
SPARTAN DUPLEX ADAPTER

A duplex adapter, a device which transforms a single outlet receptacle into a "double service" receptacle from which two portable lamps or other pressure consumers can be simultaneously fed, has been added by the Bryant Electric Company, of Bridgeport, Conn., to its Spartan line of interchangeable receptacles and plugs.



EH Spartan duplex adapter. Bryant Electric Manufacturing Co., Bridgeport, Conn.

It consists of a double Spartan receptacle and plug combined. The plug can be inserted into any of the standard Spartan receptacles and two outlets are then provided which will take any plug cap, either of the parallel blade or polarity type. It can also be used in conjunction with the Spartan screw base adapter to transform an Edison screw base socket or receptacle to a duplex Spartan.



BZ New Wrinkle canopy tap. Bryant Electric Manufacturing Co., Bridgeport, Conn.

This company has also added to its New Wrinkle line of wiring devices a novel canopy tap of wide application. It can easily be attached to any ceiling or side wall fixture where a current tap is desired.

The new device which is known as the "BZ New Wrinkle Canopy Tap," is National Electrical Code Standard and consists of a New Wrinkle ring and a porcelain base which are easly

Applying the BZ New Wrinkle canopy tap to chandelier. Bryant Electric Manufacturing Co., Bridgeport, Conn.

and firmly attached to the outlet box by means of a stamped steel rings, rings being made to fit 3¼ in. and 4 in. boxes. In lath and plaster work construction, the rings are omitted and the base attached by wood screws. After notching the canopy to fit over the neck of the tap it can then be replaced flush with the ceiling or wall, resulting in a neat and unobtrusive job. The accompanying cuts shows this device and how it is applied to an electrolier.

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LUCERO

"Lucero" is the name of a new copper-nickel alloy brought out by the Electrical Alloy Co., 135 Broadway, New York. It is designed to replace German silver; is said to be permanent and non-corrosive, and to withstand higher temperatures much better than German silver. It does not contain any zinc. It will be found useful for rheostats and car heaters. It has a resistance of about 290 ohms per mil-foot.

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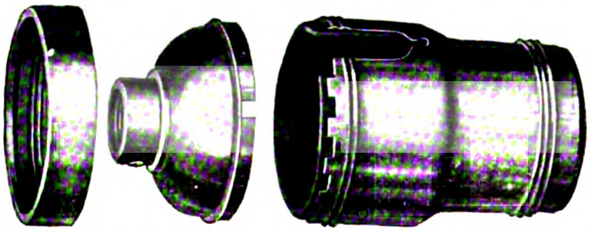
THREADED CATCH SOCKET

A threaded catch socket designed in such a way that it can be easily assembled and so that the shell cannot be pulled apart by many times the strain to which it will be subjected



Threaded catch socket. General Electric Co., Schenectady, N. Y.

in service is now being made by the General Electric Company, Schenectady, N. Y. The parts of this socket are shown in the accompanying illustration. Lugs on the cap fit into the body of the shell and the threaded ring shown at the top of the illustration holds the cap firmly in place.

This improved socket design is offered in place of ordinary types where the threaded feature mentioned is essential. This type of socket is made in key, keyless, and pull designs and in locking types, key and keyless. The shell of the key type is shown here.

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EMERSON 150-WATT CHARGING SET

In addition to the 80-watt and 150-watt motor-generator sets without switchboards, the Emerson Electric Mfg. Co., 2024 Washington avenue, St. Louis, is now offering a motor-generator set of 150 watts capacity complete with switchboard, on which are mounted motor and generator switches, fuse blocks and fuses, ammeter and rheostat. This set is expected to be ready for delivery this month.

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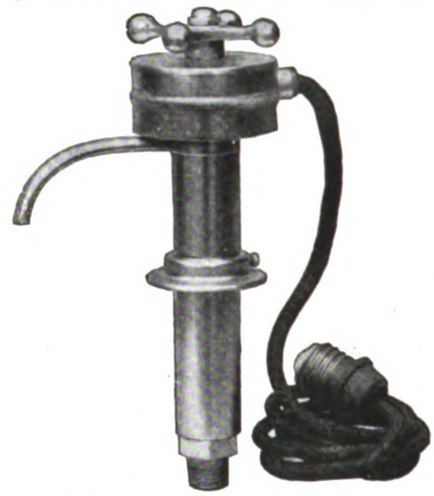
HOT-FLO ELECTRIC FAUCET

The Hot-Flo electric faucet is designed as a stationary fixture to replace the regular faucet. It has standard fittings, with ⅜ in. male thread, suitable for attachment to any standard plumbing. Once attached to the pipe coupling the plug is inserted into the electric light socket.

One turn of the faucet handle will supply cold water, the second turn makes the electrical connection and supplies running hot water. The volume depends somewhat on the original temperature of the water; the average flow is approximately 24 gal. per hour at an operating cost equal to about that of an electric iron.

The temperature of hot water produced depends upon the original temperature of the water, the average will be between



Hot-Flo electric faucet. Electrical Products Corp., Baltimore, Md.

110 and 140 degrees Fahrenheit. The standard Hot-Flo is adapted for use on a 110-volt circuit, alternating or direct.

The maximum flow of this faucet is about 36 gal. per hour at 30 lb. pressure, and can be reduced to about 2 gal. per hour while the faucet is in service. The reducing or increasing of the flow correspondingly increases or reduces the temperature of water.

For different water pressures this device has a screw adjustment on the inside which can be set permanently. For water pressure higher than 50 lb., the maker recommends the use of a reduction valve ahead of the faucet.

Energy input is proportionate to resistance in ohms of the heating element, and can be varied to take from 5 to 20 amperes at 110 volts. The standard model of the Hot-Flo is adjusted to 8 amperes.

With the original temperature of water at 60 degrees F., the flow of hot water can be regulated from 8 to 24 gal. per hour, the temperature varying from 180 to 100 degrees F., with the consumption of current approximately 8 amperes on 110 volts direct. With alternating current the temperatures and volume of flow would increase about 20 percent. for the same current consumption.

This device can be used on either grounded or ungrounded systems of current supply, with either direct or alternating current.

The heating element is wound on the procelain molded base, which is seated into a cylinder of Bakelite.

The only repair parts necessary for the faucet is the heating element, which can be repaired at a nominal cost by unscrewing the switch-cap. The faucet is guaranteed for one year, and tests made would indicate wearing qualities under average use much beyond that period.

HUBBELL AUTOMOBILE SWITCHES

Harvey Hubbell, Inc., Bridgeport, Conn., is offering the trade the new line of automobile switches shown in the accompanying cuts. These switches come in the following types: single-pole switch, three-way switch, momentary contact switch, two-toned horn switch, and combination battery-

Hubbell automobile switches. Harvey Hubbell, Inc., Bridgeport, Conn.

magneto switch. All these are equipped with flush plates. He is also making single-pole and three-way switches with recessed plates, single-pole and three-way lock switches with flush plates.

All are furnished in polished nickel and black enamel. Two keys are furnished with the lock switches.

Combinations of any of these units except the recessed, can be furnished in side-by-side or tandem gangs up to four gangs. Various lighting systems of special character can be arranged by these gang combinations.

DORRITE

About the first of next month, the Dorrite Insulation Co., Inc., Culver Ave., Jersey City, N. J., expects to market a new kind of insulating material called "Dorrite." This material is said to be fireproof, waterproof, proof against acids, and also to have unusual electric insulating properties. It consists of chemically treated pulverized waste material which can be molded, stamped or pressed into commercial or special sizes and shapes.

PORTABLE OUTLET PANELS FOR ELECTRIC WELDING SERVICE

For an electric welding outfit to be of maximum service, it must be so arranged that it can be taken to the work no matter where it may be located. One solution of the problem would, of course, be to locate a panel outlet of a suitable type wherever it is anticipated that electric welding might be desired. However, this is rather an expensive proposition and many electrical engineers would prefer to accomplish the same result in a simpler manner. A recently developed portable outlet panel manufactured by the Westinghouse Electric & Mfg. Co. takes care of this situation with a minimum of expense and with all the simplicity of the familiar distributing system for storage battery charging.

Two types of portable outlet panels are furnished, both being mounted on light trucks. They consist of a control panel mounting a handle trip railway type circuit breaker having overload release with magnetic blowout, and a 13-point face plate connected to a resistor mounted in the rear of the panel. The face of the panel is protected by a metal cover through which the handles of the rheostat and circuit breaker project. The resistor is made up of grids and is protected by a cage of expanded metal.

Type E panel is intended for metal electrode welding, only, having a capacity of from 80 to 170 amperes. With this outfit one metal electrode holder and one shield are supplied. For a wider range of work a Type F panel should be used. This will handle metal electrode work from 80 to 160 amperes and light graphite electrode work up to 300 amperes. The outfit includes one metal electrode holder, one graphite electrode holder and one mask.

HIGH VOLTAGE SERIES RELAY

An improved form of high voltage series relay used for the automatic tripping of oil circuit breakers is announced by the General Electric Co., Schenectady, N. Y.

As illustrated, the mechanism of the relay consists of two main elements joined by a wooden rod. The upper element—consisting of solenoid, counterbalancing weight, and a mechanism for transmitting the motion of the solenoid plunger to the operating rod—is mounted on a high tension insulator and isolated from ground. The lower element—consisting of relay con-

High voltage series relay. General Electric Co., Schenectady, N. Y.

tacts, cover for contacts, calibrating parts, and time limit arrangement when used—is mounted below the upper element.

The solenoid is connected in series with the circuit and one end of the coil is electrically connected to the solenoid frame to avoid static stresses. The solenoid coil and mechanism do not require adjustment after installation and thus are not a source of danger to the attendants.

The relay is calibrated from normal to three times normal current. Current calibration is made by the sliding weight. Time delay adjustment is made by an oil pot shown. When instantaneous operation of the relay is desired, the time delay features are omitted.

This relay is used mostly when the cost of high potential current transformers for tripping purposes is prohibitive.

LITTLE WONDER TELEGRAPH SET

An electrical novelty that will appeal to youthful electricians has just appeared in the shape of a telegraph set with both key and sounder mounted on a small wooden base. It is designed to operate on lines having a maximum length of 500 ft. It can be used from room to room, from house to barn, from floor to floor, across the street, or down the block. When used indors No. 18 B & S wire is employed; No. 14 should be used for across the street service. If the line is a comparatively short one, not more than 50 ft. long, one dry cell at each end will suffice. For longer lines two cells at each end may be needed.

As with standard telegraph apparatus, it is possible to use the earth as a return circuit and do away with one wire by making proper connections to water or gas pipes at each end of the line. In such cases, however, more battery power may be required to drive the energy through the circuit.

This novelty is made by the Adams, Morgan Co., of Upper Montclair, N. J.

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PACKARD BELL-RINGING TRANSFORMER

An improved bell-ringing transformer is announced by The Packard Electric Company of Warren, Ohio. The new instrument is of the same electrical construction as the former Packard Belle Transformer but several improvements have been made in the design of the case. The former type had a brass-bolted two-piece case with lugs projecting from the top and two lower sides and these have been eliminated by making the heavy porcelain case in one piece. This results in a neater, more compact instrument—the only projecting parts being the bell-wire binding posts and two small slotted flanges on the base to receive the screws by which the instrument is secured in place.

The electrical element is inserted in the case through an opening in the base and then completely covered with a fine grade of sealing compound thus forming the unit into practically one solid piece. The leads are marked in raised letters on the adjacent porcelain thus insuring against any possible mistake in making connections.

The new instrument is so made that a dead short circuit on the secondary or bell side for an indefinite length of time will pull less than 15 watts from the 110 volt service wires.

The cases are finished in blue with a high glaze which renders the unit attractive to the eye and assists materially in making sales.

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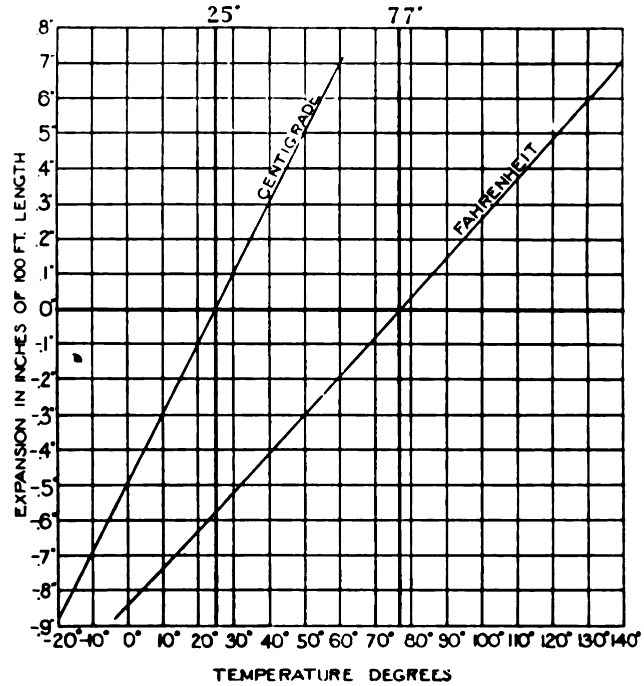
BUSBAR EXPANSION JOINTS

In many central-station and industrial power plants the linear expansion of bus runs with changes of temperature has caused trouble. In some cases the displacement due to expansion has damaged the insulators used in the bus mounting, and in other cases has destroyed the alignment of switches placed in immediate connection with the buses.

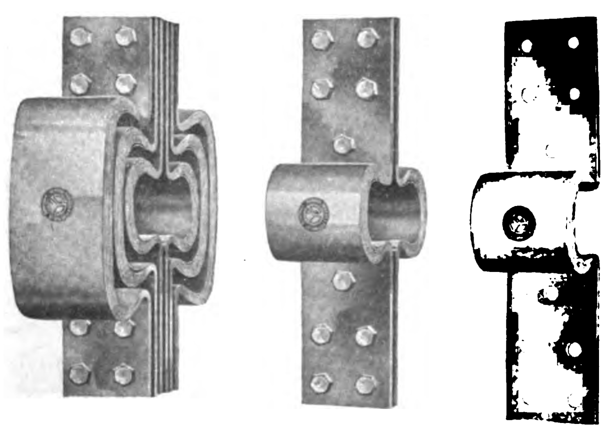
Any damage to insulators or nearby switches may be forestalled by the judicious relief of this bus travel by means of expansion joints.

To forestall the difficulties arising from busbar expansion, the General Devices & Fittings Co., of Chicago, Ill., has produced an expansion joint identical in principle with that previously made up and used by several power companies. These joints bolt into the bus and impose no poor connection nor reduction of bar-stack conductivity.

These elements are furnished for stacks of any number of bars of all the bar sizes and spacing common to present practice. The conductivity of the joint is equal to, or greater than, that of the bar stack which it joins, and the joint itself is flexible because of its thorough lamination.



A diagram showing expansion in inches per 100 feet in length both Fahrenheit and Centigrade scales. General Devices & Fittings Co., 817 W. Washington Blvd., Chicago, Ill.



Busbar expansion joints. General Devices & Fittings Co., 817 W. Washington Blvd., Chicago, Ill.

The chart shown above is arranged for determining the actual expansion of a bus run of 100 ft. in length over any reasonable range of temperature established in either degrees centigrade or fahrenheit.

The expansion determined from the chart is the actual expansion and is somewhat greater than the relative expansion of the bar as related to the supporting structure. The latter has generally less expansion over any range of temperature, and is not subjected to such a wide variation of temperature as the busbar itself, nor does it respond so quickly since the temperature variation is first in the room air and not in the building material itself.

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MOTOR OPERATED BENCH PLANER

The J. D. Wallace & Company, of Chicago, has developed a portable motor operated bench planer and joiner for light woodworking operations.

This device and operating motor are a single unit with direct drive through a flexible coupling which delivers approximately 100 percent. of the power applied. Current to actuate the motor which supplies power is obtainable from an electric light socket.

A feature of the machine is that three knives are operated on the cutter head if an alternating current motor is used and two if a direct current motor furnishes the service. The direct current motor makes 4000 rev. per min. and the alternating current motor 3600 rev. per min.

General Electric fractional horsepower motors are used. They are standard equipment and can be used on practically any type of current supplied.

BELL RINGING TRANSFORMER

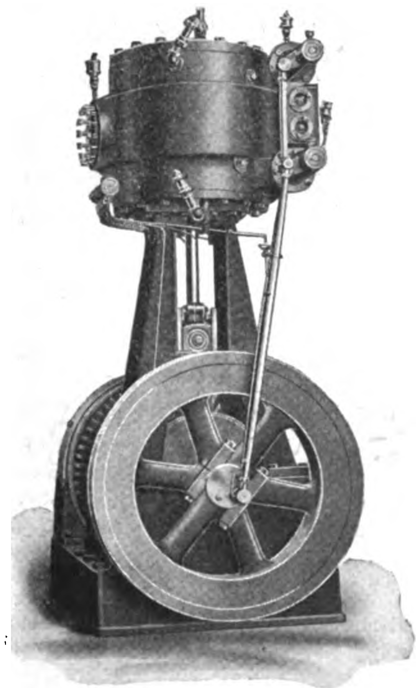
A new comer among the bell ringing transformers is announced by the A. C. Gilbert Co., of New Haven, Conn. It operates on 110 volts, alternating of course. The proportion between primary and secondary windings is such as to give a pressure of about 9 volts at the secondary terminals. Like others of its kind, it will ring door bells, open locks, and operate other low-voltage electrical devices.

Polar Cub bell ringing transformer. A. C. Gilbert Co., New Haven, Conn.

✦ ✦ ✦

VERTICAL DRY VACUUM PUMP

This vertical type of dry vacuum pump manufactured by the Wheeler Condenser & Engineering Co., of Carteret, N. J., is in demand by ship and stationary plant builders who are anxious to save as much space as possible, and who at the same time have their eyes open to economy.



Vertical dry vacuum pump. Wheeler Condenser & Engineering Co., Cartaret, N. J.

The pump shown was recently shipped by the manufacturers for installation in an American navy vessel. Ancther is in course of completion and will soon be shipped.

Where much condensing is to be done and where high vacuum is to be maintained, it is generally best to install separate condensate and air pumps. Thus a motor or turbine-driven centrifugal hot well pump can easily take care of the condensate while this Wheeler dry vacuum air pump withdraws the air.

As shown in the cut, the inlet valves of this pump are of the semi-rotative type, which are so manipulated by the valve gear as to draw air from the condenser during its full stroke. Clearance difficulties are eliminated in this design of valve gear by providing ports which register with an equalizing passage.

All parts are easily accessible, a point that is of great value in high-vacuum pumping machinery. Valve arrangement is such as to insure perfect drainage at all times.

A motor-driven dry vacuum pump has numerous other advantages over direct steam drive, among which are: ease of installation; less attention is required; no steam pipe radiation losses; and improvement of plant load factor. A few years ago it was argued that motor drive was poor practice because of the long train of elements through which power must pass before reaching the motor—the engine, generator, transmission lines, switchboard, etc.—but to-day shut-down troubles have practically vanished and authorities are strongly recommending motor-driven auxiliaries such as this dry vacuum pump.

✦ ✦ ✦

MAYHEW-ELECTRIC

The Mayhew-Electric small lighting plant has been placed on the market by the Mayhew Company, of Milwaukee, Wisconsin, to meet the demand for a reliable small lighting set. Both the plant and the sales policy of the manufacturer have been designed to give the dealer the best possible proposition and to eliminate some of the petty annoyances that have been encountered previously in handling the small lighting set business. A lot of cheap sets thrown on the market have made many buyers a bit skeptical.

The plant is of the belted type and consists of a generator and switchboard made up in one unit and a storage battery which is shipped separately. The generator and switchboard are shipped in one box, the batteries are packed in two boxes so as to keep the weight of each box as low as possible, and permit more careful handling while in transit. The special method used in packing the batteries has eliminated breakage in shipment.

The various elements of the plant are of well-known standard makes. The generator is made by the Peerless Electric Company, of Akron, Ohio; the batteries by the Globe Electric Company, of Milwaukee, Wis. Jewell instruments and Cutler-Hammer rheostat are used on the switchboard, which also includes a Mayhew-Electric cut-out which is of an improved design. Glass fuses are furnished.

These plants are made in three standard sizes provided with 60, 90, and 120 ampere-hour batteries, respectively. The generator has a capacity of 800 watts.

✦ ✦ ✦

According to *Electric Traction*, a simple safety device is in use in the Sacramento shops of the Pacific Gas & Electric Company for intercepting flying pieces of metal when armature bearings are being chipped. A. McDonald, machinist, conceived the idea of mounting on the work bench, back of and to one side of the vise in which the bearings are held, a canvas screen, with wings, to serve as a protection to nearby workmen.

The canvas, which is shellaced to stiffen it, is stretched on a wire frame with a piece of gas pipe for a standard. This pipe is simply set or swung back out of the way.

There are two wings, one on top and one on the outer side of the bench, which offer additional protection from flying chips. These wings fold up and the entire screen can be removed from the bench and folded up out of the way when not in use.

MAGNETIC BRAKES

The principle of the type of magnet which has been incorporated in the design of magnetic controllers by the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa., has been employed by the company in a new design of magnetic brakes just developed for use with mill, crane and hoist motors. The use of a clapper type magnet eliminates all moving parts within the coil and the consequent wear, sticking or damage to insulation. The modified and improved type A alternating current brake with which the trade is already familiar and the new type B direct current brake are similar in operation and have common parts throughout except for the armature lever and magnet.

These brakes are characterized by the quickness of their operation. They respond almost instantly "releasing" when the power is applied and "setting" when the power is cut off. This is due to the design of the operating magnet which gives high initial pull and a very small distance of travel (¼ in. to 1 in.).

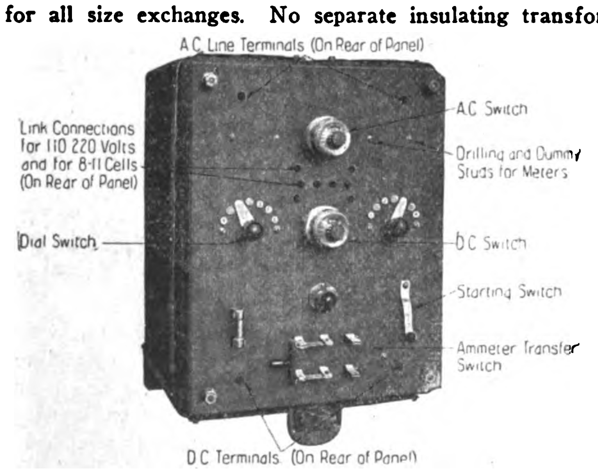
Their operation is similar. When voltage is impressed on the motor the magnet is energized and the magnet armature lever overcomes the pressure of the compression springs through a toggle and releases the brake-shoe grip upon the brake wheel. While the magnet remains energized the brake wheel is allowed to rotate freely. As soon as the current is shut off from the motor the brake magnet releases and the compression springs force the shoes against the brake wheel and bring the motor quickly and smoothly to rest without shock or jar. The compression exerted by the springs can be easily adjusted so that any holding or retarding torque up to the full capacity of the brake can be obtained for equal braking effort for both directions of rotation. Simple means for making adjustment for shoe wear are provided.

In case adjustments for shoe wear should be neglected a safety feature has been introduced so that the brake does not fail to hold the load but the magnet will not release the grip on the brake wheel. This insures proper brake operation and the elimination of accidents due to the slippage of the brake-wheel.

✦ ✦ ✦

MERCURY RECTIFIERS FOR CHARGING TELEPHONE EXCHANGE BATTERIES

Figs. 1 and 2 show two telephone type mercury rectifiers of 30-ampere and 50-ampere rating, respectively. These are typical of a line of type AT rectifiers manufactured by the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa., which have been designed especially for use in charging telephone exchange batteries while in service without making necessary their removal. The complete line comprises self-contained outfits for all size exchanges. No separate insulating transformers or noise-reducing coils are required, as a two winding transformer for insulating the battery from the supply circuit and damping coils for reducing noise are incorporated in the outfits.



Telephone battery mercury rectifier. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

The transformer, inductance coil, control switches, etc., of these rectifiers are mounted on an upright cast iron frame, and all are enclosed by ventilated metal covers, forming a compact unit that is well protected from mechanical injury or any likelihood of contact by the operator with live parts. Two dial switches at the top of the case, controlling the transformer taps, provide the necessary means for adjusting the current on which the outfit will run, whether the battery is empty or fully charged, or the line voltage is low or high. One of these switches gives coarse and the other fine adjustment. Thus it is possible to obtain full rated current under any operating condition for line voltages down to 100 or 200 volts with currents as low as 10 amperes, or as low as 4 or 5 amperes on any line voltage up to 115 or 230 volts. The steps on the dial switches are evenly spaced between extremes for the number of cells for which the outfit is primarily designed. For the other number of cells the steps are not even except in the case of the 10 ampere outfit where the difference is very slight.

The outfits are provided with two-winding transformers, making it an easy matter to arrange them for operation on either 110- or 220 volt circuits by a series or parallel arrangement of the two halves of the primary winding. All outfits are intended for charging either 11 or 17 cells in series, which are

Telephone battery mercury rectifier. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

the batteries most commonly used in telephone work, and are adapted to either condition by means of link connections mounted on the back of the slate panels carrying the dial switches and protected by metal covers. Two or more rectifiers may be operated in parallel without the use of extra paralleling coils, and when so operated have the same efficiency as single outfits. The rate of charge can be adjusted very readily and will be practically constant for any setting of the regulating dials, the current falling off comparatively little as the battery voltages rises.

The great advantages accruing from the use of mercury rectifiers for charging telephone batteries are their low first cost and maintenance expense, their high efficiency, the small floor space required for their installation, and their permanent freedom from noise of all kinds. In early applications not all of these advantages were realized, as it was customary to use ordinary vehicle battery outfits with separate insulating transformer and inductance coil. This led later to the compact unit construction now adopted, which is not only more advantageous from a mechanical standpoint, but is more efficient electrically, due to the elimination of the losses in the extra apparatus.

THE CLEARING HOUSE

Advertisements on this page 5 cents a word. No advertisement accepted for less than $1.00. Electrical Engineering reserves the right to open all letters addressed in its care and agrees to forward only answers that are germane to the product or subject advertised.

THE CLEARING HOUSE

(Continued)

DIRECTORY OF CONSULTING ENGINEERS ARCHITECTS and CONTRACTORS

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Allis-Chalmers Mfg. Co., Milwaukee.

AIR COMPRESSORS
Allis-Chalmers Mfg. Co., Milwaukee.

AIR WASHERS
Spray Engineering Co., Boston, Mass.

ALARMS, Fire
Benjamin Elec. Mfg. Co., Chicago, Ill.
Palmer Elec. Mfg. Co., Boston, Mass.
Western Electric Co., New York City.

AMMETERS and Voltmeters
Duncan Electric Co., Lafayette, Ind.
General Electric Co., Schenectady, N. Y.
Norton Electrical Inst. Co., Manchester, Conn.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

ANNUNCIATORS
Western Electric Co., New York City.

ARMATURES
Chattanooga Armature Works, Chattanooga, Tenn.

ATTORNEYS, Patent
Geo. P. Kimmel, Washington, D. C.

BATTERY CHARGERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

BATTERIES, Dry
Novo Mfg. Co., New York City.
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City.

BELLS
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City.

BELT DRESSING
Dixon Crucible Co., Jos., Jersey City.

BONDS AND STOCKS
Electric Bond & Share Co., N. Y. City.

BOOKS, Technical & Practical
McGraw-Hill Book Co., New York City.
Technical Journal Co., New York City.

BOOSTERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

BOXES, Conduit
Columbia Metal Box Co., N. Y. City.
Cutter Co., Geo., South Bend, Ind.
Krantz Mfg. Co., Brooklyn, N. Y.
National Metal Molding Co., Pittsburgh, Pa.

BOXES, Cutout
Adam Electric Co., Frank, St. Louis.
Columbia Metal Box Co., N. Y. City.

BOXES, Fuse
General Electric Co., Schenectady, N. Y.

BOXES, Meter
Adam Electric Co., Frank, St. Louis.

BOXES, Outlet and Junction
Adam Electric Co., Frank, St. Louis.
Columbia Metal Box Co., N. Y. City.
National Metal Molding Co., Pittsburg.

BRUSHES, Motors and Generators
Calebaugh Self-Lubricating Carbon Co., Philadelphia, Pa.
Dixon Crucible Co., Joseph, Jersey City.
General Electric Co., Schenectady, N. Y.

BRUSHES, Pneumatic
Spray Engineering Co., Boston, Mass.

BRUSHINGS
National Metal Molding Co., Pittsburgh, Pa.

BUS BAR SUPPORTS
Delta-Star Electric Co., Chicago, Ill.

CABINETS
Adam Electric Co., Frank, St. Louis.
Columbia Metal Box Co., N. Y. City.
Cutter Co., Geo., South Bend, Ind.
Krantz Mfg. Co., Brooklyn, N. Y.

CABLES, Aerial Power
" See Wires and Cables.

CABLE, Insulated
Okonite Co., The, New York City.
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Steel Taped
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Submarine and Lead Covered
Hazard Mfg. Co., New York City.
Moore, Alfred F., Philadelphia, Pa.
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Rome Wire Co., Rome, N. Y.
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Telephone
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CABLE, Underground
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Junction Boxes
Standard Underground Cable Co., Pittsburgh, Pa.

CARBONS, Brushes
Calebaugh Self-Lubricating Carbon Co., Philadelphia, Pa.
Dixon Crucible Co., Jos., Jersey City.
General Electric Co., Schenectady, N. Y.

CIRCUIT BREAKERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CLEATS
National Metal Moulding Co., Pittsburgh, Pa.

COILS, Armature and Field
Chattanooga Armature Works, Chattanooga, Tenn.

COILS, Choke
Delta-Star Electric Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

COILS, Induction
Thordarson Elec. Mfg. Co., Chicago.
Western Electric Co., New York City.

COMMUTATORS
Chattanooga Armature Works, Chattanooga, Tenn.

COIL TAPING MACHINES
Chattanooga Armature Works, Chattanooga, Tenn.

COMPOUNDS, Boiler
Dixon Crucible Co., Joseph, Jersey City.

CONDENSERS
Allis-Chalmers Mfg. Co., Milwaukee.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CONDUCTORS, Armored
National Metal Molding Co., Pittsburgh.
Roebling's Sons Co., John A., Trenton.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT FITTINGS
Columbia Metal Box Co., N. Y. City.
National Metal Molding Co., Pittsburgh.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT, Flexible
American Circular Loom Co., New York City.
National Metal Molding Co., Pittsburgh.
Tubular Woven Fabric Co., Pawtucket.

CONDUIT, Interior
American Circular Loom Co., New York City.
American Conduit Mfg. Co., Pittsburgh.
National Metal Molding Co., Pittsburgh.
Tubular Woven Fabric Co., Pawtucket.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT, Rigid
American Circular Loom Co., New York City.
National Metal Molding Co., Pittsburgh.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT, Underground
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Connectors and Terminals
Dossert & Co.

CONSTRUCTION Material
Southern Electric Co., Baltimore, Md.

CONTROLLERS
Allis-Chalmers Mfg. Co., Milwaukee.
General Electric Co., Schenectady N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

COOKING APPARATUS, Electrical
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COOLING SYSTEMS, Air
Spray Engineering Co., Boston, Mass.

CORDS
Moore, Alfred F., Philadelphia, Pa.
Samson Cordage Works, Boston, Mass.
Standard Underground Cable Co., Pittsburgh, Pa.

CORD, Arc Lamp
Samson Cordage Works, Boston, Mass.

CORD, Flexible
General Electric Co., Schenectady, N. Y.
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Samson Cordage Works, Boston, Mass.
Southern Electric Co., Baltimore, Md.
Standard Underground Cable Co., Pittsburgh, Pa.

CORD, Telephone
Moore, Alfred F., Philadelphia, Pa.
Standard Underground Cable Co., Pittsburgh, Pa.

CORD, Trolley
Samson Cordage Works, Boston, Mass.

CROSS-ARMS
Southern Exchange Co., The, New York City.
Western Electric Co., New York City.

CUT-OUTS
Brady Elec. & Mfg. Co., New Britain, Conn.
Cutter Co., Geo., South Bend, Ind.
General Electric Co., Schenectady, N. Y.
Palmer Electric Mfg. Co., Boston.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

DYNAMOS AND MOTORS (Second Hand)
Atlanta Electric Machine Co., Atlanta, Ga.
Chattanooga Armature Works, Chattanooga, Tenn.

ELECTRICAL REPAIRING
Chattanooga Armature Works, Chattanooga, Tenn.

ELECTRIC FIXTURES
Adam Electric Co., Frank, St. Louis.
Benjamin Electric Mfg. Co., Chicago.
Cutter Co., Geo., South Bend, Ind.
Luminous Specialty Co., Indianapolis.
Southern Electric Co., Baltimore, Md.

ENGINES, Gas and Gasoline
Allis-Chalmers Mfg. Co., Milwaukee.
General Electric Co., Schenectady, N. Y.
Westinghouse Machine Co., E. Pittsburgh, Pa.

ENGINES, Steam
Allis-Chalmers Mfg. Co., Milwaukee.
Westinghouse Machine Co., E. Pittsburgh, Pa.

ENGINEERS, Consulting
Arnold Co., The, New York City.
Byllesby, H. M. & Co., Chicago, Ill.
Cooper, Hugh L. & Co., N. Y. City.
Sanderson & Porter, N. Y. City.
Stone & Webster Engrg. Corp., Boston, Mass.
White & Co., J. G., New York City.

ETCHING SOLUTION
Union Electric Co., Pittsburgh, Pa.

FANS, Exhaust
Peerless Electric Co., The, Warren, O.
Robbins & Myers Co., Springfield, Ohio.
Southern Electric Co., Baltimore, Md.
Star Fan & Motor Works, Newark.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

FAN MOTORS
General Electric Co., Schenectady, N. Y.
Peerless Electric Co., The, Warren, O.
Pittsburgh Elec. Specialties Co., Pittsburgh, Pa.
Robbins & Myers Co., Springfield, Ohio.
Southern Electric Co., Baltimore, Md.
Star Fan & Motor Works, Newark.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

FIBRES
Continental Fibre Co., Newark, Dela.
Standard Underground Cable Co., Pittsburgh, Pa.

FINANCIAL
Electric Bond & Share Co., N. Y. City

FIXTURES, Lighting
Adam Electric Co., Frank, St. Louis.
Benjamin Elec. Mfg. Co., Chicago, Ill.
Cutter Co., Geo., South Bend, Ind.
Luminous Specialty Co., Indianapolis.
Southern Electric Co., Baltimore, Md.

FRICTION Tape and Cloths
Okonite Co., The, New York City.

FROSTING SOLUTION
Union Electric Co., Pittsburgh, Pa.

FUSES, Electric
Daum Co., A. F., Pittsburgh, Pa.
Delta-Star Electric Co., Chicago, Ill.
Economy Fuse & Mfg. Co., Chicago.
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City.

FUSES, Refillable
Economy Fuse & Mfg. Co., Chicago, Ill.

FUSE BOXES
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GAS ENGINES
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

GENERATOR BRUSHES
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GENERATORS and Motors
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, O.
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GLOBES, SHADES, Etc.
General Electric Co., Schenectady, N. Y.

GRAPHITE
Dixon Crucible Co., Jos., Jersey City

HAND LAMPS, Electric
Southern Electric Co., Baltimore, Md.

HANGERS, Cable
Standard Underground Cable Co., Pittsburgh, Pa.

HEATING Apparatus, Elec.
General Electric Co., Schenectady, N. Y.
Russell Electric Co., Chicago, Ill.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

HOISTS, Electric and Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

HYDRAULIC MACHINERY
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

INDICATORS
Duncan Electric Co., Lafayette, Ind.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

INSTRUMENT, Electrical
Duncan Elec. Mfg. Co., Lafayette, Ind.
General Electric Co., Schenectady, N. Y.
Norton Electrical Inst. Co., Manchester, Conn.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Inst. Co., Newark

INSULATORS
Brookfield Glass Co., New York City
General Electric Co., Schenectady, N. Y.
Locke Insulator Co., Victor, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

INSULATING MATERIAL
Brookfield Glass Co., New York City
Continental Fibre Co., Newark, Del.
General Electric Co., Schenectady, N. Y.
Moore, Alfred F., Philadelphia, Pa.
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

INSULATOR PINS
Southern Exchange Co., The, N. Y. C.

IRONS, Electrical
General Electric Co., Schenectady, N. Y.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMP CORD
Moore, Alfred F., Philadelphia, Pa.
Samson Cordage Works, Boston, Mass.
Standard Underground Cable Co., Pittsburgh, Pa.

LAMP GUARDS
McGill Mfg. Co., Valparaiso, Ind.

LAMPS, Carbon Arc
General Electric Co., Schenectady, N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Flaming Arc
General Electric Co., Schenectady, N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Incandescent
Boston Economy Lamp Div., Danvers, Mass.
Hygrade Lamp Co., Salem, Mass.
General Electric Co., Schenectady, N. Y.
National Lamp Works, Nela Park, Cleveland, Ohio
Southern Electric Co., Baltimore, Md.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Westinghouse Lamp Co., N. Y. City

LAMPS, Miniature
General Electric Co., Schenectady, N. Y.
Southern Electric Co., Baltimore, Md.

LAMPS, Vapor
Cooper-Hewitt Electric Co., Hoboken, N. J.

LANTERNS, Electric
Southern Electric Co., Baltimore, Md.

LEAD-COVERED WIRES
General Electric Co., Schenectady, N. Y.
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Roebling's Sons Co., John A. Trenton, N. J.
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co. New York City

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Schug Elec. Mfg. Co., Detroit, Mich.

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Delta-Star Electric Co., Chicago, Ill.
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Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LUBRICANTS
Calebaugh Self-Lubricating Carbon Co., Inc., Philadelphia, Pa.
Dixon Crucible Co., Jos., Jersey City.
Galena Signal Oil Co., Franklin, Pa.

MACHINERY GUARDS, Perforated
Erdle Perforating Co., Rochester, N. Y.

MACHINE SHOP Lighting
Cooper-Hewitt Electric Co., Hoboken, N. J.

MAGNET WIRE
American Steel & Wire Co., N. Y. C.
Hazard Mfg. Co., New York City
Moore, Alfred F., Philadelphia, Pa.
Roebling's Sons Co., John A., Trenton, N. J.
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co. New York City

MECHANICAL STOKERS
Westinghouse Machine Co., E. Pittsburgh, Pa.

MERCURY RECTIFIERS
Cooper-Hewitt Electric Co., Hoboken, N. J.

METAL, Perforated
Erdle Perforating Co., Rochester, N. Y.

METAL PUNCHING
Erdle Perforating Co., Rochester, N. Y.

METALS
American Platinum Works, Newark

METERS
Duncan Electric Mfg. Co., Lafayette, Ind.

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General Electric Co., Schenectady, N. Y.
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Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

MINING MACHINERY
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.

MOLDING, Metal
National Metal Molding Co., Pittsburgh, Pa.

MOTORS
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MOTORS, Small
Jewell Electric Co., Chicago, Ill.
Wisconsin Elec. Co., Milwaukee, Wis.

OILS
" See Lubricants.

OILS, Illuminating
Galena Signal Oil Co., Franklin, Pa.

OZONIZERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

PAINTS, Insulating
General Electric Co., Schenectady, N. Y.
McGill Mfg. Co., Valparaiso, Ind.
Standard Underground Cable Co., Pittsburgh, Pa.

PANELBOARDS
Adam Electric Co., Frank, St. Louis
Columbia Metal Box Co., N. Y. City
Cutter Co., Geo., South Bend, Ind.
General Electric Co., Schenectady, N. Y.
Krantz Mfg. Co., Brooklyn, N. Y.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

PATENTS
Geo. P. Kimmell, Washington, D. C.

PERFORATED METALS
Erdle Perforating Co., Rochester, N. Y.

PHOTOMETER Standards
Electrical Testing Laboratories, New York City

PINS, Iron
Southern Exchange Co., The, N. Y. C.

PLATINUM
American Platinum Works, Newark.
Baker & Co., Newark, N. J.

PLUGS, Flush & Receptacles
Adam Electric Co., Frank, St. Louis
Benjamin Elec. Mfg. Co., Chicago, Ill.
Cutter Co., Geo., South Bend, Ind.
Daum, A. F., Pittsburgh, Pa.
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

POLES, Ornamental Street
Brady Elec. & Mfg. Co., New Britain, Conn.

POLES, Brackets, Pins, Etc.
Brady Elec. & Mfg. Co., New Britain, Conn.
Brookfield Glass Co., New York City
Southern Exchange Co., The, N. Y. C.
Western Electric Co., New York City

POT-HEADS
Brady Elec. & Mfg. Co., New Britain, Conn.
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.

PRODUCERS, Gas
Westinghouse Machine Co., E. Pittsburgh, Pa.

PUMPS
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

RAIL BONDS
American Steel & Wire Co., N. Y. C.
General Electric Co., Schenectady, N. Y.
Roebling's Sons Co., John A., Trenton, N. J

RECEPTACLES
" See Sockets

RECTIFIERS
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" See Wires

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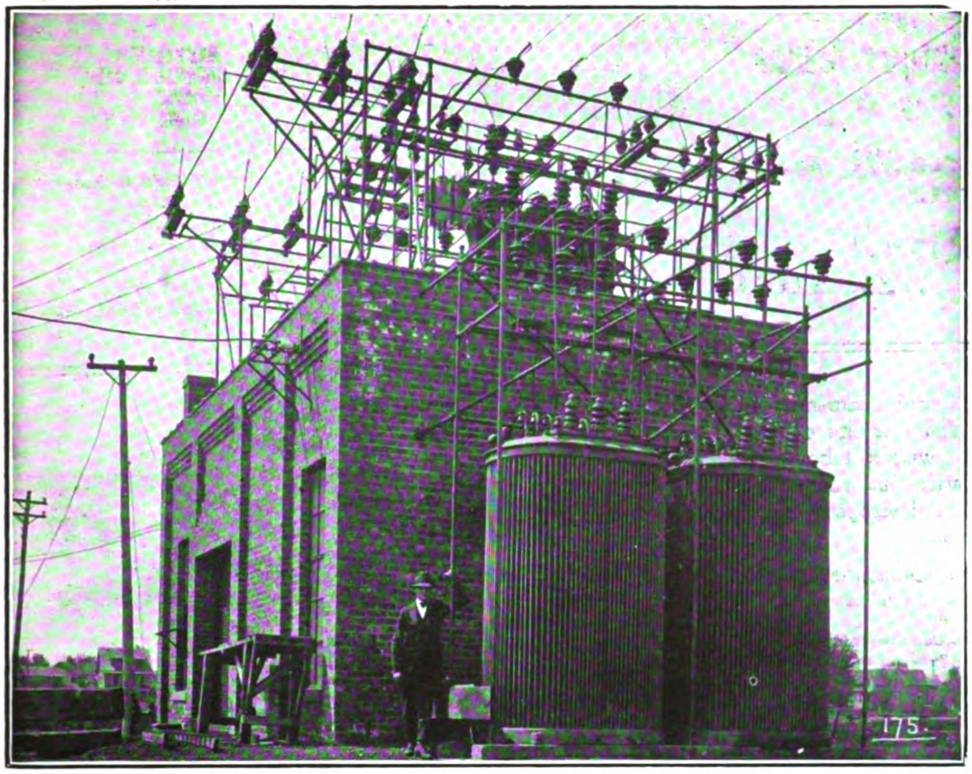

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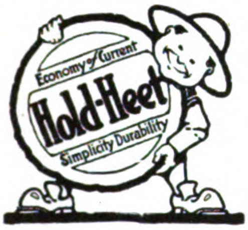

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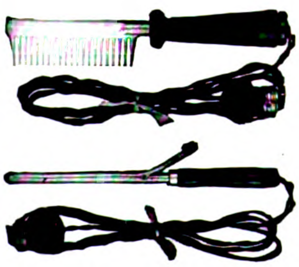

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Electrical Engineering

Tech. Div.

Features in This Issue

ELECTRICITY AND THE SHIP—Opinions of Naval Constructors; Ship Engineering; Electrical Drawings; Electrical Specifications; Draftsman and Drawings.

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EXTRACTING NITROGEN FROM AIR BY ELECTRIC POWER—The Conclusion of a Story on the Latest Method of Providing Nitrates for Use in Agriculture and Munition Work During War Time.

WINDINGS FOR ALTERNATING CURRENT GENERATORS AND MOTORS—Elements of Alternating Current Machine Design For Embryo Electrical Engineers.

OPERATING A ROCKY MOUNTAIN POWER HOUSE IN MID-WINTER—A Story that Tells of the Hardships Endured by those who keep Energy on the Line Despite the Snow, Ice, and Below Zero Temperatures that Swoop Down on Power House Operators in the West Country.

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1642 Woolworth Bldg., New York

Chicago Office, 814 Westminster Building

CHAS. B. THOMPSON, President

GEO. A. WARDLAW, Editor

Volume 51 **FEBRUARY 1918** **Number 2**

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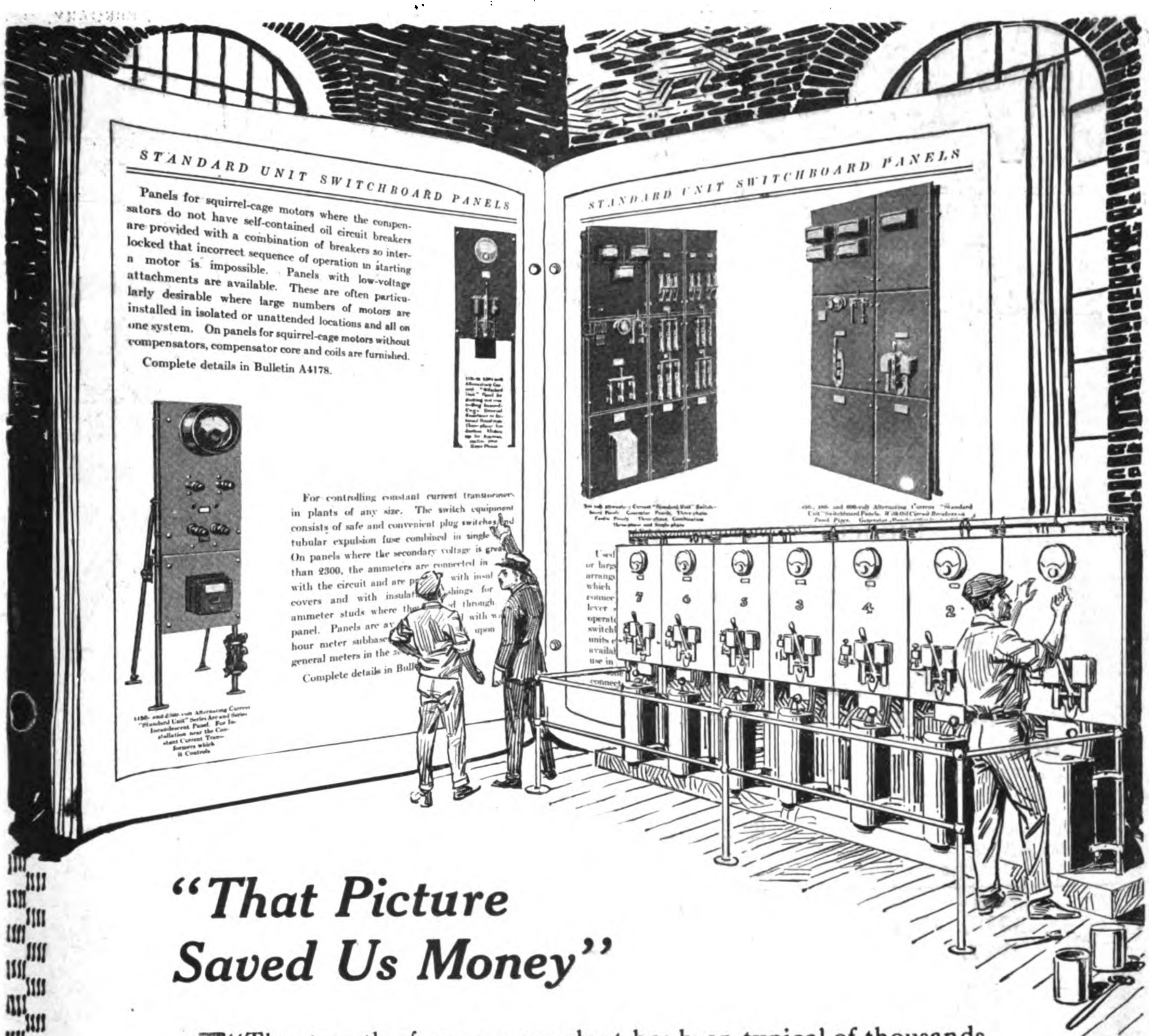

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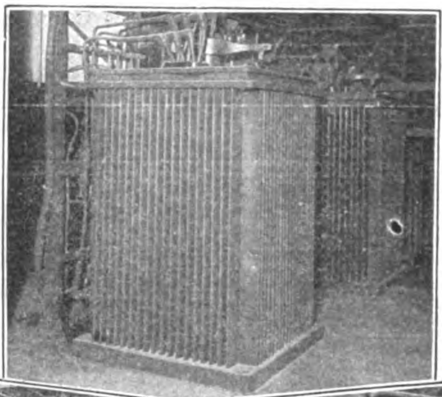

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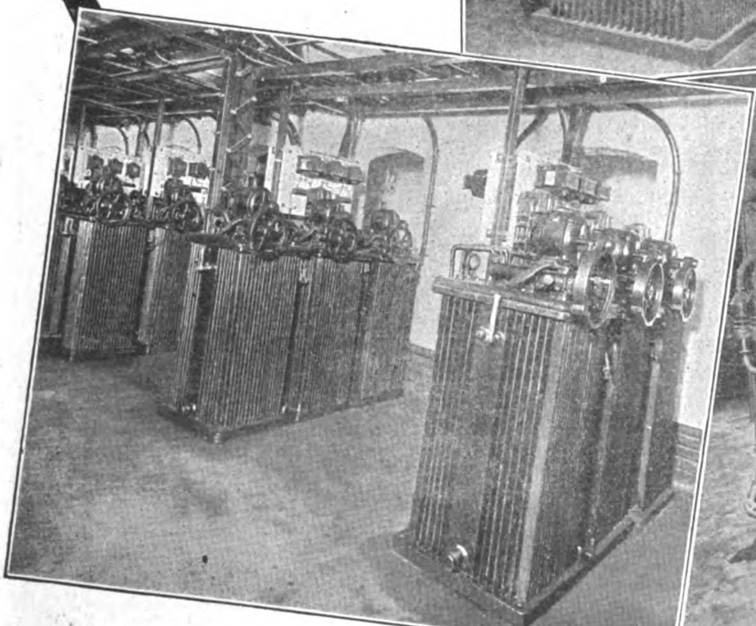
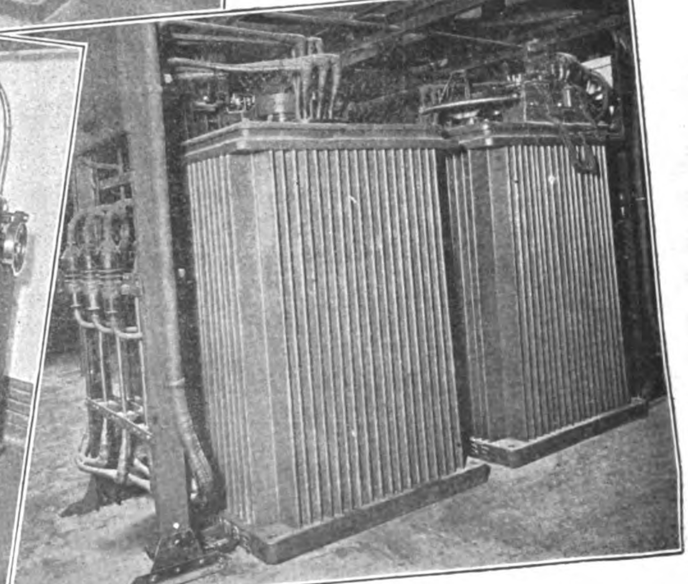




Electrical Engineering

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

Technical Journal Company, Inc., New York

Vol. 51 **FEBRUARY 1918** **No. 2**

OPERATING A ROCKY MOUNTAIN POWER HOUSE IN MIDWINTER

By H. A. Lemmon

We are all so fed up with war stuff these days that we have almost come to believe all the heroics are monopolized by the battling sailors on the high seas, the dough boys in the trenches, the airmen, and the ambulance drivers. Even more heroic are those who keep the big power houses going and the transmission lines open in zero weather in the big snowbound Far West. These men, too, suffer from hunger, exposure, and lack of sleep. No one knits sweaters and mufflers for them, no prayers are offered up for them in the churches, and no fatherly government provides them with warm clothing, yards of gold braid, and life insurance at ebb-tide rates. They endure all the rigors of war without war's glamor and exhilaration, and death peers at them from several angles instead of from one. What happens in the Rockies when winter swoops down is told here by a man who helps operate the Reno Power, Light & Water Co. in far away Nevada. We commend it to the intimate attention of those who are surfeited with war talk as well as with the peace manoeuvers of the Teutonic diplomats and the Bolsheviki.

It was morning. Superintendent Brown sat amidst his telephones which were connected to the five small hydro-electric plants, located along the river from one to 18 miles above. The telephone bells had been jangling incessantly for an hour.

During the night a snow storm has begun the havoc that was to follow. Main lines 1, 2, and 3 had failed and only the new 60-kva. line remained in operation over the mountains. The continued existence of the oldest town in the state, the financial disaster that would follow the freezing of the big furnaces of the copper smelter 70 miles away, and the electrical necessities of a dozen towns, and villages swung with the wires in the gale. The Capitol—30 miles distant by road—and 50 miles away by transmission line—was also without lights and the new governor was to give a reception to the members of the legislature that night.

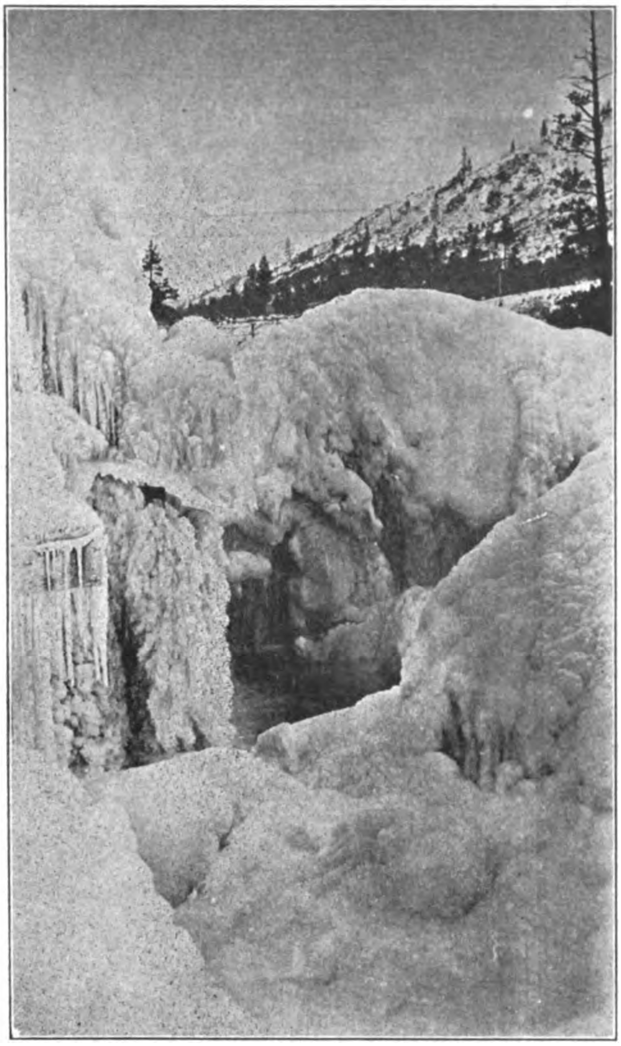
Fleish, Farad, Washoe, and Reno power houses—all reported a sudden falling off in capacity. Only Verdi was plugging along at her normal 2300. The weather bureau report predicted "snow to-day, colder to-night." The regular annual battle with ice was on.

First the superintendent called the U. S. Reclamation Service station at Lake Tahoe on the long distance 'phone; and gave a sigh of relief when he learned the line was still in use.

"Hello, hello, this is the power company. The river is going to make ice. It is snowing down here to beat the band. We must have more water. How much? Open the gates and let in 400 second-feet extra anyway. This line will probably go down to-day, so watch the weather. If it is colder to-morrow turn in another 400 second-feet."

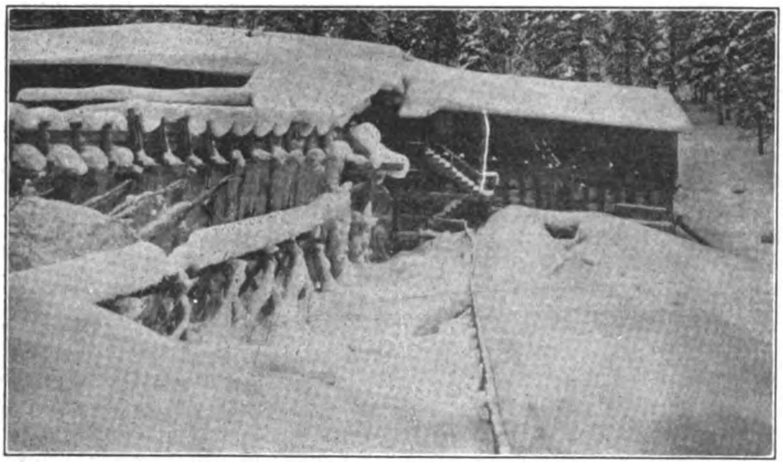
An hour after snow had begun falling, one of the company's autos—a powerful car—went on the road leading up the river. All night long it had kept moving, back and forth, to keep the road open, that means of swiftly transporting men and supplies to the plants might be available when the big fight started. The snow was falling so fast now, however, that another car was sent up. One might pull the other out when it stalled in any drift which a little breeze was certain to pile up. It was a wise precaution, for 10 miles out, after pushing and tumbling snow ahead of the radiator, the forward machine stopped while the engine raced momentarily and the rear wheels whirled helplessly. It had plunged into a deep bank, carried on by its momentum, until it was supported so high above the road by the press of snow beneath that none of its wheels came in contact with the earth.

The companion auto attached a steel cable and went into reverse, but although still on the road it could not gain sufficient traction to pull off its mate. The two drivers got out their shovels and with shovels and hands dug the snow



"Severe cold wave" reported the Weather Bureau. (Fleish plant).

from beneath the forward machine until it settled to the ground and they were finally able to get it out. Then they ran back and forth several times for a distance of perhaps a hundred yards, until a fairly secure road-bed had been worn. The big car hurled itself at the drift. Snow flew outward and upward, but again the machine floundered and stopped.



He wanted Farad in and he wanted her in badly.

The operation of shoveling out and bucking the drift was repeated until finally it was conquered. They went on.

While this was taking place additional reports began to come in from the power houses. They recited a further falling off in capacity to an alarming degree. Even Verdi had lost 500. The lamps which were lighted because of the darkness of the day, grew dimmer and dimmer, wavered, flashed up brighter than ever, and then went out entirely. The superintendent grabbed the telephone. Ting-a-ling went the bells.

"Hello Virginia Sub-station. Pull the deep mine pumps immediately. I must have a thousand off there right away."

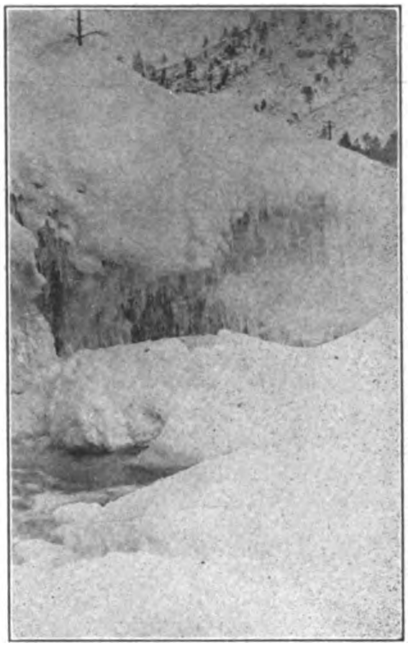
"Hello Thompson smelter. We don't want your furnaces to freeze and will do everything to keep you going, but it looks bad. Pull off everything except your blowers. Cut the mine entirely clear!"

"Hello Floriston. Cut the paper mill off immediately!"

The telephones in the main office were jangling a bedlam. People demanded to know if the limits would be on again by night. Small power users were anxious. Others were in the midst of ironing operations. Some were to have parties that night; others had sickness at home; a laundry could not finish drying in time for promised delivery; a newspaper could operate neither its linotypes nor its presses. Assured that every effort humanly possible would be made to resume service, many demanded that an hour and minute be set, and when this could not be granted, relieved themselves of threats. Others cajoled and entreated, and recited acts of friendliness which they preformed to the company in the past. Illogically many sought to override the impossible by hurling against it personal, and to them, irresistible reasons why service must be resumed.

Then came a ring on the power house line. Washoe—old reliable Washoe plant—had gone out entirely. She wasn't pulling an ounce and had cut off the lines. Politicians called in from the Capitol to impress the manager that the welfare of the State demanded lights for the governor's reception.

The two automobiles, and two more which had been sent up to rescue them when they did not return on schedule, honked on the street in front. The purchasing agent's drove of hastily recruited laborers were coming in in gangs of five and six. The warehouse wagon arrived with a load



As effective an obstruction, for the time being, as the skill of man could devise.

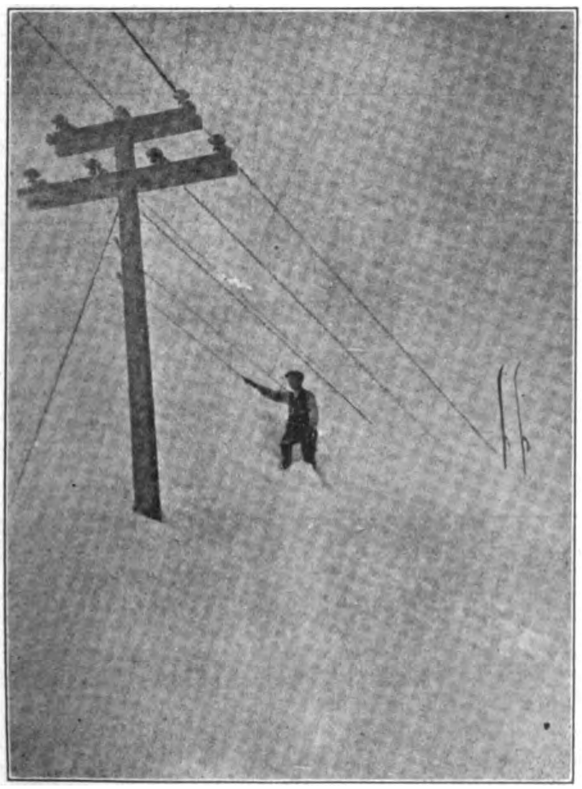
of shovels and boots. To-morrow its load would be pike poles instead of shovels if the weather prediction were correct. The men were located in the autos—thirteen each in machines built for five—with tools carried high in the air above their heads, and away they went.

The superintendent had given explicit instruction that he was not to be called on the telephone from the local exchange, but an insistent voice finally impressed the girl that its owner was of supreme importance.

"Hello, Brown! This is Hark, manager of the street cars. Your auto men have been running their machines in our tracks on Second Street all night and all morning, and they have pounded the snow down in them until it is ice. We can't get a car out on that line. They have got to keep off our tracks."

Despite all protection booms, the ditches would be swarming with it.

The superintendent hung up without answering and the autos continued to run on the car tracks. They had it to themselves after this, however, for the street cars didn't use that line again for some days. The several line crews, sent out hours before to locate the trouble on 1, 2, and 3 reported at intervals over their portables. They were making slow progress in the deep snow and had not yet found the breaks.



It took fourteen hours to get through on skiis.

By eleven o'clock in the forenoon the weather had grown colder, with the temperature dropping every hour. The fall of snow had ceased, or rather given away to a cutting wind, which filled the air with a swirling, blinding, stinging, cloud of frozen particles. The automobiles kept up their regular trips, taking men and tools, and, later, lunch and hot coffee.

Not a drop of water reached Washoe penstock, and before the first division of laborers arrived at the power house the ditch patrol staggered in with explanations of the reason. Two miles above the ditch was completely filled with snow. Snow had been falling in the river several hours, until that stream ran thick with it. The gentle grade of the canal contributed to the general sluggishness. The blizzard, rushing down a canyon, picked up thousands of tons of snow in its relentless course and swept them into the ditch. The addition of this snow made a mixture of snow and water which could not flow and in a few minutes a 24-ft. waterway contained a snow dam—as effective an obstruction for the time being as even the skill of man could devise.

Then the surface ice would begin to break loose.

There was nothing to do but to shovel it out by main strength, in the meantime improvising a spillway above it to keep the water moving, if possible, and thereby prevent the filling of the ditch all the way to the intake. The men, often encased in ice-bound garments, worked desperately, spurred on by the offers of bonus, and also because to cease work was to freeze. Several of them became exhausted and required assistance. It was evident that nothing could be expected of the Washoe plant for many hours.

The unusual amount of snow in the river was bringing the other plants down rapidly. Apparently Farad was suffering most and was pulling hardly enough to justify considering her on the job. Verdi, which usually was one of the first to go bad in ice weather, was doing the lion's share of the work, or such of it as still remained on the lines. Reno went out completely for a few minutes but was coaxed into commission again. As she did so the test lights flickered dismally. The superintendent rang vigorously for Fleish, the central operating station.

"Hello, Fleish! What's the matter now. Can't you get Reno in? What? The syncroscope is out of order! Well you fellows are some operators! When I operated we didn't have such things as syncroscopes. Take a couple of potentials down and connect across the jaws of your main switch and synchronize with a dark lamp."

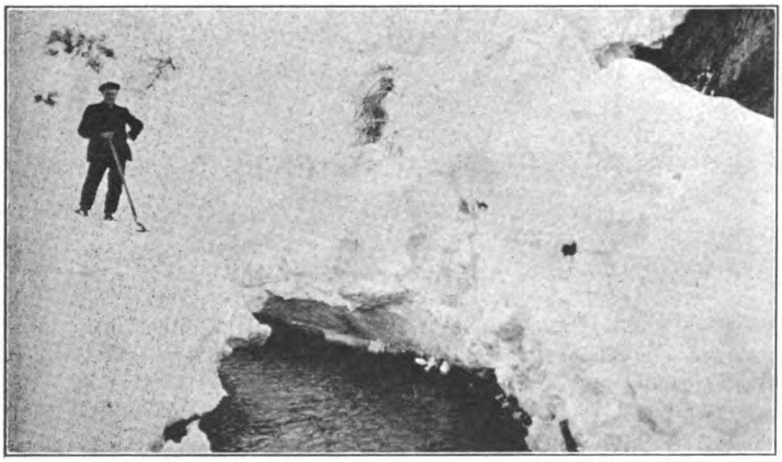
After a time the lamps burned steadily. The jangle of bells grew fiercer as the day went on. Along about 4 o'clock a line crew came up with the trouble on line No. 1 in the form of a magnificient horse which had touched his nose to a low wire. An insulator had given away allowing the wire to sag, and this in connection with a gigantic snow bank brought it within the realm of equine curiosity.

The Virginia City mine superintendents were frantic. The water was rapidly rising to the 2500-ft. level where the lower pumping stations were. It was within a few feet of them now. Once it flooded the motors and pumping ceased, if only for one day, the entire district would be irretrievably ruined, and the mines would never reopen. An official of the pumping association phoned in that the water was within 8-ft. of the station, and asserted if he could not have power in half an hour all would be over there. At any rate he wanted to hoist the pumps and motors and save what machines they could out of the impending wreck. The power superintendent shot back.

"We will start the pumps in time. Let me know when the water is within 6 in. of the station, but don't call me up one minute before it is. My men are watching things there, and the water is a good 12-ft. below right now."

From both ends crews were struggling in the blizzard to find the short circuit on the line to the Capitol.

Apparently about seven miles separated them. It was growing dark now, at 4 o'clock in the afternoon, and if the governor's reception was to be lighted the trouble must be located

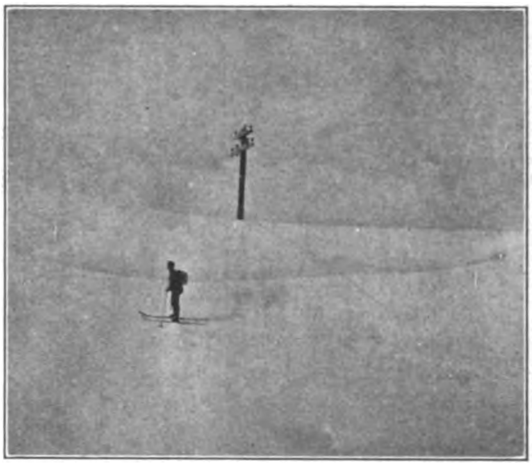


At noon of the second day a tunnel had been cut through.

quickly. The next time boys reported in, they were ordered to keep clear of the line and watch for the flash. An attempt was to be made to burn the short clear. The circuit was plugged in at Virginia sub-station. Ordinarily it would have been a simple matter to burn down that line, but with no effective assistance from the other plants, Verdi groaned and grumbled, and the wheel slowed up, the generator protested, until it was certain something must give. And it did; but it was the short 40 miles away.

In a few minutes one of the line crews reported it had seen the flash within a half mile and they would soon be on the ground. They struggled to it and found it was caused by a wild-cat which had climbed the poles and managed to get himself across two legs of the inadequate triangle of the old 23,000-volt line. This repair promised lights for the governor's party, provided nothing else happened in the next few hours.

The autos were still rushing men and supplies to the various plants. The weather had changed. The blizzard had abated until there was only occasionally a gentle puff of wind, but the temperature had dropped to zero. The river had begun



So the superintendent mounted skiis and started out.

to clear in the meantime and the plants were picking up. When the water was within a few inches of the pump station of the Virginia deep levels the juice was shot into them and the Comstock heaved a sigh of relief. It meant another respite for the old but ever-optimistic camp.

This overloaded the system and the lights, such as were on, were very dim, but the snowfall had entirely ceased. All now depended upon whether the dropping temperature or the extra supply of water from Lake Tahoe would first become effective at the power house.

The overload on the crippled plants caused a drop in frequency and the synchronous motors at the smelter refused to run. Excited appeals came in to give them power enough to empty their furnaces of the molten rock, and just as it seemed hopeless, Fleish came in with over three-quarters load. The day was saved, temporarily at least.

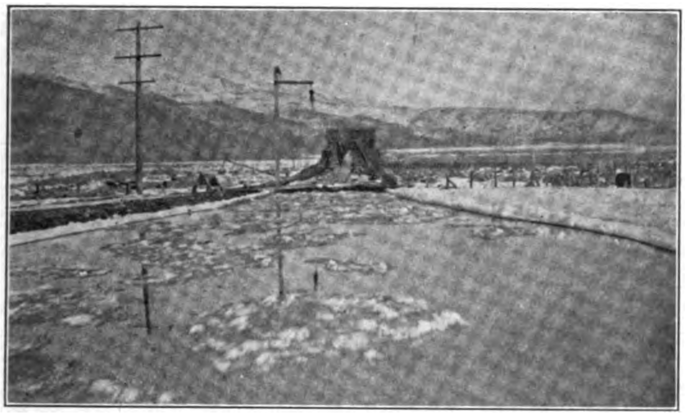
"Severe cold wave" reported the weather bureau. The telephone line to Tahoe had gone down many hours before. It was not until 9 o'clock at night that lights were turned on throughout the system, and no street lights and no small power at that.

At 11 o'clock Farad reported 8 degrees below zero and needle ice just making its appearance. At 1 o'clock men were stationed at the racks in the various penstock houses with specially constructed rakes, and were frantically raking out needle ice that the water might strain through to the pressure conduits. No use to attempt to spill this ice for it permeated the entire flume line.

Additional crews were sent up the river as fast as they could be obtained to relieve the exhausted laborers, and a campaign formulated for the morrow, for then other things would occur. They fought the long, dreary, freezing night through, and when morning dawned it found all plants but Washoe at half capacity.

Next morning 6 o'clock was as clear as a bell with the thermometer standing at 14 degrees below—or four degrees higher than it had been at 4 o'clock. The power house for-men began to take stock, for by this time their charts showed a rapid decrease again. They didn't need to be told the cause, for they had had the same experience in previous years. The capacity of their flumes had been reduced until the wheels were getting only a much diminished supply of water.

Needle ice is sufficiently well described by its name. It shoots through the water in long crystals of cobweb-like fineness at first. Then these needles take on diameter until they resemble glass straws. These in turn form in masses which interweave until they seem some waste product of a fabric loom. They can be kept off the racks at the penstocks by laborously raking them out, but no



Each individual cake must be personally escorted.

way has been devised to prevent the more serious affinity this form of ice has for the sides of the flumes. Immediately the water temperature reaches the proper degree these needles begin adhering to the planks. They are not partial to the bottom but dearly love the sides. This morning they had formed to a thickness of over 3 ft. on either wall of the Fleish flume, leaving but a narrow channel for water. None of the operating force had been abed during the night and full well they knew there would be no sleep for them the forthcoming one.

The rocks in the river, as well as the gravel, were covered with needle ice and snow which had adhered to them. Just as soon as the temperature of the water raised a few degrees this would break loose and come down upon the plants like an avalanche. But that was some hours ahead, and so far was only another detail of the enemy's strategy to be anticipated. The extra water from the lake must arrive in time to float off this mixture—which is now called slush ice—to keep it from blockading everything. This is the annual winter race between the water from the lake and the breaking-loose period of the slush ice.

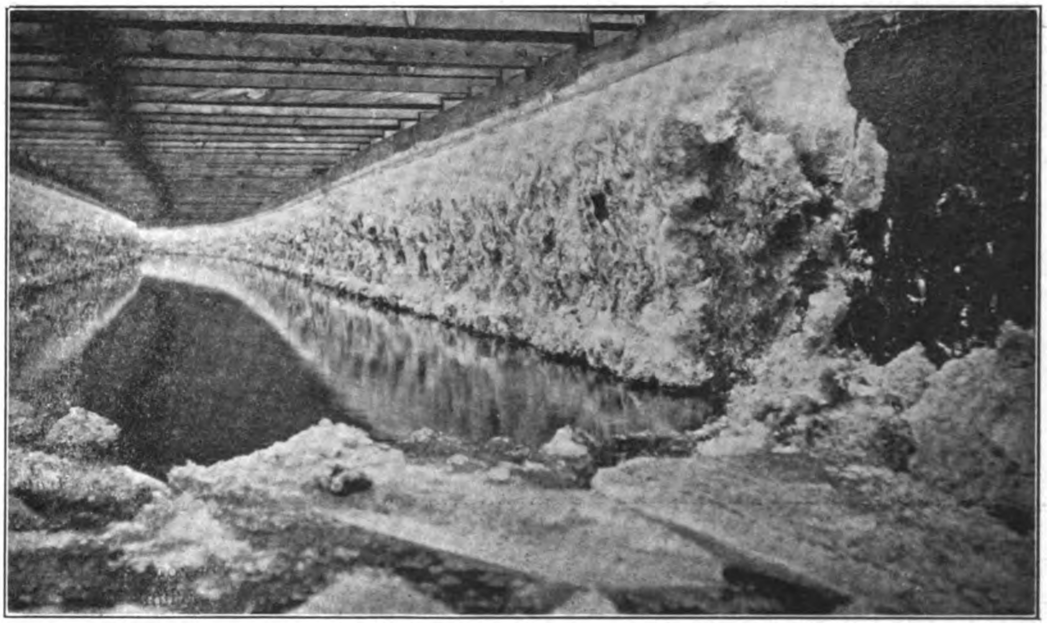
With the dawn of the second day the superintendent was out and doing. The difficulty with No. 3 had been located. It was an old aluminum line and the swaying in the wind weakened it at every insulator. It simply broke and fell. One hour would have had a repair gang on the ground in summer time: it required fourteen hours to flounder there on skiis.

No road led from Fleish plant to Farad, some 8 miles above, so the superintendent mounted skiis and started out. He wanted Farad in and he wanted it in badly.

At noon of the second day a channel had been cut through the filled section of the Washoe ditch, and by 2 o'clock Washoe chart indicated she was pulling 500. This would have been scorned in normal times but almost caused cheering now.

At 4 o'clock all plants except Farad were pulling better than at the corresponding hour the day before. Tired, half-frozen men were sent back. The big fight was yet to come but that was 10 or 12 hours away and required skilled handling rather than the force of numbers.

Every man on the job knew that on the following afternoon at the latest, unless the weather continued colder, the real combat would take place. At that time the surface ice and the anchor ice would begin to break away in cakes, and despite all protective booms the ditches and flumes would be swarming with it. Each individual cake must be personally escorted to the spillways provided for this purpose, and induced to tumble over and out of the way. During the summer the caps had been raised and some of the flume widened in anticipation. Each winter's experience suggested changes from the original design, and each winter found the handling of cake ice simplified. And yet it was the simple things that were the last to be accepted. It was a tired, sullen laborer who taught the engineers to place their ice-spills all on one side of the flume instead of alternating them. This ice brings good size boulders with it, but the racks protect the wheels



This morning needle ice had formed thickness of over three feet on either wall of the Fleish flume.

except when they are pulled out, as they sometimes are during the run of slush ice.

At 7 o'clock Fleish reported that Farad had come in on the line. Three hours after midnight, the superintendent who had been struggling in the snow along the Farad ditch and flume, almost tumbled into his office, looked at the voltmeter above his desk and picked up his telephone.

What he heard seemed to please him for as he sank back in his chair a faint, weary, satisfied smile stole over his face to be quickly chased away by a twitch of pain as one hand found its way to the region of his back and he remarked:

"Boys, I don't believe the old man is as young as he was 20 years ago."

EXTRACTING NITROGEN FROM THE AIR BY ELECTRIC POWER

By E. Kilburn Scott, Consulting Engineer, London

(Concluded from page 42, January issue)

Ammonium nitrate is a unique compound in containing a very high percentage, 35% of nitrogen in two forms; namely, ammonia-nitrogen as it exists in sulphate of ammonia, and nitric-nitrogen as it exists in Chili nitrate. In the near future it will probably be used as a fertilizer, because when it has parted with its oxygen it only leaves water behind, whereas sulphate of ammonia leaves the sulphate, and Chili nitrate leaves sodium compounds, both of which are deleterious to soils.*

The following gives a comparison of various fertilizers:

Symbol	Name	How obtained	Usual % of Nitrogen
$NaNO_3$	Nitrate of soda......	Natural product from Chili	15.5
$(NH_4)_2SO$	Sulphate of ammonia	By-product of coal	18
$Ca(NO_3)_2$	Calcium nitrate ...	Made from atmospheric nitrogen by electric power	13
$CaCN_2$	Calcium cyanamide		18
NH_4NO_3	Ammonium nitrate.		35

Calcium nitrate is made by running the dilute nitric acid from the absorption tower direct on to pure limestone. Large quantities of carbon dioxide gas are given off according to the following equation:

$$CaCO_3+2HNO_3=Ca(NO_3)_2+H_2O+CO_2$$

The solution of calcium nitrate, $Ca(NO_3)_2$, is run into iron vats and evaporated by steam. This goes on until the temperature reaches 145 degrees Centigrade when the solution contains about 80 percent. of anhydrous calcium nitrate and less water than corresponds to the composition of crystallized calcium nitrate. From the vats the calcium nitrate passes to sheet iron cylinders, which, on account of the hygroscopic nature of the salt have the covers soldered on. After it has solidified it contains 13.5 percent. of nitrogen.

If the crystallized salt contained four molecules of water, $Ca(NO_3)_2+4H_2O$, is desired, the evaporation is stopped at 120 degrees Centigrade and the solution allowed to crystallize. It then contains 11.86 percent. of nitrogen, and after being dried in a hydro extractor is packed in air tight drums

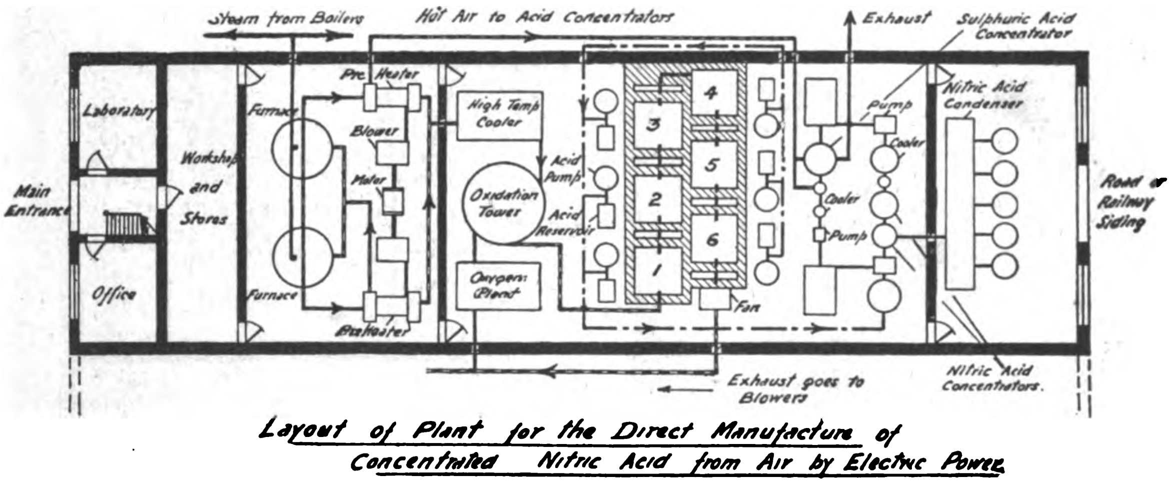


Fig. 12.

Fig. 12—Diagram showing arrangement of plant for manufacturing concentrated nitric acid from air by electric power.

Calcium Nitrate

Of those made by electric power, calcium nitrate is made in the largest quantity. It will therefore be of interest to give some particulars.

and sold for the preparation of barium nitrate for the manufacture of fire works and barium peroxide.

Calcium nitrate can be used to replace Chili nitrate as a starting point for the preparation of other compounds, the most important being potassium nitrate, barium nitrate, and sodium nitrate. It is a notable fact that sodium nitrate produced by the electrical process easily competes with Chili nitrate, many manufacturers preferring it because of its greater purity.

*In this connection it is interesting to note that ammonium nitrate explosives are now used in farming for breaking up the soil instead of digging and ploughing. The method is especially useful for making holes for fruit trees because the explosion loosens the soil so thoroughly.

In the case of a water power only able to give power for part of the year, as is often the case, it is convenient to make a compound like calcium nitrate which can be worked up during the rest of the year.

When required as a fertilizer, the calcium nitrate solution is evaporated until about half the normal water of crystallization is driven off, then a certain amount of slaked lime is added in the form of a fine powder. The basic calcium nitrate is therefore a mixture of the partly dehydrated normal salt with the basic nitrate Ca (NO_3) (OH), and being only slightly hydroscopic it is suitable as a manure. Nitrate of lime fertilizer contains 13 percent. of nitrogen, and has approximately the following analysis:

N_2O_5	50.21
CaO	25.94
H_2O	23.60
SiO_2	0.25
	100.00

Nitrate of lime has become firmly established as a fertilizer, and it is sent to countries bordering on the Pacific Ocean, which might be considered as the special reserve of Chili nitrate. It is specially suited to such crops as tobacco, citrous fruits, etc. It is preferable to Chili nitrate and sulphate of ammonia, because it only leaves lime in the soil, and so can be used continuously without detriment.

Sodium Nitrite

This compound, which is a by-product of the air nitrate process, is of special interest at the present time because it is essential in coal-tar color manufacture for the production of diazo compounds. The mixture of nitric oxide and nitrogen peroxide passing over from the acid towers combines with a boiling caustic soda, the reaction being as follows:

$$NO+NO_2+2NaHO=2Na\ NO_2+H_2O$$

The sodium nitrate is concentrated by evaporation in open vessels and allowed to crystallize, the crystals being then dried in a hydro extractor.

Hitherto sodium nitrite has been made by treating metallic lead at 450 degrees Centigrade with solium nitrate, but with the introduction of the electrical process this use for Chili nitrate has disappeared. The Badische Anilin und Soda Fabrik erected a large electrochemical factory in Christiansand in Norway, specially for the manufacture of sodium nitrate, and in this case the mixed gases nitric oxide and nitrogen peroxide are passed from the furnaces without special cooling directly into caustic soda.

The outlet of sodium nitrate is limited, but as the aniline dye industry develops in this country, we shall require a good deal of the compound, and to make this industry entirely independent of foreign imports sodium nitrate must be made here by the electrical process.

In addition to the above, there are many other products, some of which are of special interest to ironmasters. In concluding this paper I will make some reference to the question of power, which is, of course, a principal requirement of the direct electric process.

Power Supply

One often hears that we cannot make electro-chemical and metallurgical products commercially in this country. The reason generally given is the lack of water power, but as a matter of fact we have water power, and one may hope that one of the results of the war will be to facilitate the harnessing of same by putting a stop to the enormous waste of money in legal fees and trips to London by witnesses when a power bill is before parliament.

I am convinced that some day Nobel's Works at Ardeer will be drawing its nitric acid supplies from an electrochemical plant in this country, and whether it is made with electricity from a water power or from a fuel power station is immaterial. I do want to combat the idea, however, that water power is essential to the process, for it most certainly is not.

In this country we are in the fortunate position of being able to build an electric power house almost anywhere at a cost of $50 a kilowatt of plant installed; for example, the last one built in Birmingham cost under $50 a kilowatt, even at war prices for plant. On the other hand, a power house driven by water power must necessarily be placed in mountainous and difficult country, and its cost is very considerable because of the hydraulic works, dams, pipes lines, etc. Hydroelectric power plants take years to build, whereas a steam power station is built in a few months. In the establishment of an electrochemical plant the factors which really count are: (a) Convenience of site as regards erection and maintenance of plant; (b) Supply of suitable labor; (c) Accessibility to raw material; and (d) Proximity to a good market for the product.

It will be noticed that the direct-electric method of making nitrates is unique in that one raw material, namely, air, is without cost, and the other—water—is a very small charge. Therefore, so far as the raw materials are concerned, the factory can be built anywhere. The particular product which is under consideration in this article; namely, ammonium nitrate, requires the additional raw material ammonia, but this is available all over the country. Proximity to a coke oven plant or Mond gas plant would, however, be an advantage, because the gas which contains the ammonia can be used to generate the electricity required to make the acid to combine with the ammonia. This method presents an interesting and ideal combination.

A battery of modern coke ovens gives off about as much gas as it consumes for coking, and if this waste gas is harnessed by gas engines or steam turbines a large amount of electric power can be generated at a very low cost per unit. If this electric power is utilized on the spot in furnaces, such as I have described to make dilute nitric acid, then this acid can be used to combine with the ammonia in the gases to make ammonium nitrate. This is much better than purchasing sulphuric acid to combine with the ammonia, especially now that sulphuric is in such demand for other purposes. Also the value per unit of fixed nitrogen in the nitrate is very much higher than it will fetch in sulphate.

Of course any gas or source of power will do; for example, it will pay very well to lay down a Mond producer plant specially to make ammonium nitrate in this way. Even if the gas does not contain ammonia, as in the case of blast furnace gas, it is easy to purchase ammonia from the nearest gas works. It will be useful before closing to point out that these electrochemical processes can be carried out on quite a moderate scale and that the cost of carriage for many of the products is a much more important consideration than cost of electric energy.

Carriage

Because the production of nitrogen from air has grown to very large proportions abroad it must not be thought that the process can only be carried on commercially on a large scale. It must be remembered that all the foreign plants have had to grow from very small beginnings, and the fact that this particular industry has been built up within the last dozen years shows what great possibilities there are if it is boldly tackled.

One reason why the plants are large in Norway is because the energy is centered at particular water powers in the mountains. In this country the case is quite different, because our power is very widespread, and the fact that it is so is an enormous advantage.

By having a number of plants in various parts of the country there would be a considerable saving in cost and time of transport, and it would further be an additional assurance against stoppage of supply by hostile action.

Nitric acid is especially difficult to carry, and on that account it should always be made as near as possible to the place where it is to be used. That is partly why most of the large explosive factories in this country make their own acid. To show what this mean, let us consider for a moment the cost of carrying nitric acid from Norway to this country. As a matter of fact it has not been done, because the boats will not carry it, but from time to time proposals have been made to bring it over.

The route from the factory to the sea is 86 miles. First of all there is the journey from the electrochemical factory at Saaheim to Skien, necessitating three separate transportations, namely, by railway, by ferry boat, and by steamboat. The cost of this, including the charges for railway trucks, and especially handling on the ferry boat and steamboat, would probably be over $6 a ton. From Skien to the West Coast of Great Britain is about 1,000 miles, and the acid would have to be carried in especially built steamers. The acid would need special steel drums, each containing, say, half a ton, and as these would only last a very few journeys, the cost of steel would be considerable. In addition there is the cost of carrying the steel drums, the charges for special insurance, and the interest and depreciation cost on the special steamers employed in the service.

I think, therefore, that the total cost of transport could not possibly be less than $20 a ton, and might be much more. In other words, the cost of transporting the product from a water power plant in Norway would cost more per ton than the electric energy required to produce a ton.

This will serve to show how ridiculous it is to keep up the parrot cry that we cannot produce electrochemical products in this country because we do not happen to have large water power. As a matter of fact we have something very much better than high mountain ranges and very large waterfalls. We have a marvellously fertile country covered with hundreds of thriving industrial centers, and we have also fuel at our doors which will not only give power but also a most remarkable series of valuable by-products—ammonia, toluol, benzol, and aniline dyes, etc.

Electric power is going to play a tremendous part in electrochemistry and metallurgy, dwarfing everything yet accomplished in traction and factory driving. Of these electrochemical products, nitrates from air must necessarily be one of the most important.

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ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

By H. A. Hornor, Electrical Engineer

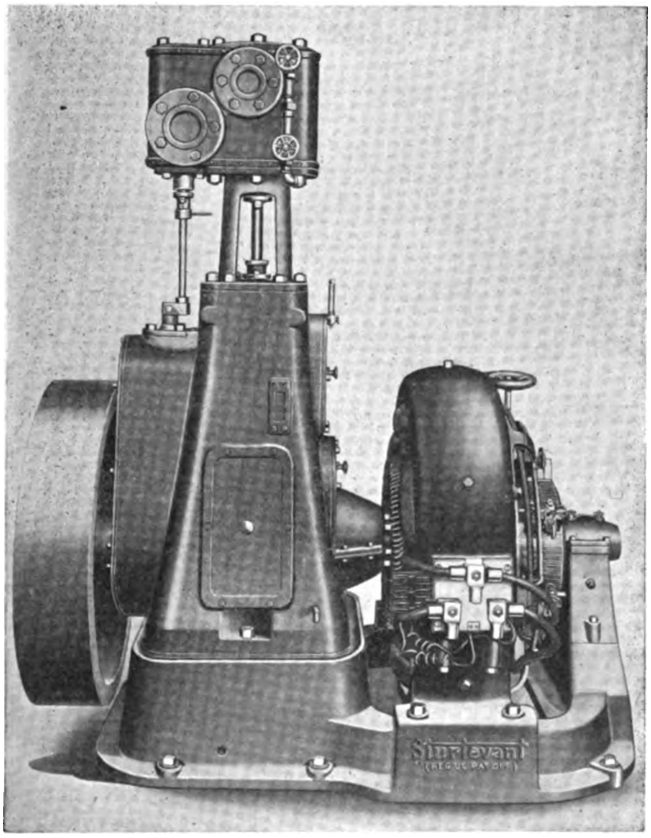
A well-known naval architect and practical shipbuilder once made the witty remark that the electrical engineer should really design the ship because after it is built he goes all over it and bores holes in it. Like good humor, there is truth in this. However, naval architecture became a distinct science a century ago and doubtless will remain so. This will forestall any claims that electrical engineering may wish to make in an effort to purloin the achievements of naval architects. The same authority was fond of repeating the aphorism "that a ship is a complicated combination of engineering compromises." There is a good deal of common sense in that definition, for without a liberal co-ordination of the different branches of applied science ship design would be far behind the times.

Opinions of Naval Constructors

Chief Constructor, Admiral D. W. Taylor, U. S. N., makes this statement: "—— modern ships have been made possible by the development of the science of naval architecture. This science, alone and unaided, without parallel development in practically all of the arts, sciences, and trades could not have produced these ships; but, so far as the ship itself is concerned, all the great progress in very branch of science and industry could not have produced this *concentrated embodiment of human intelligence* without the development and advancement of naval architecture or the theory of shipbuilding, a branch of applied science which calls upon and draws from an exceptional number of the arts and sciences. The modern battle cruiser, whose building is just being undertaken in this country, is an excellent example of the mutual agreement and co-ordination necessary between all the arts and sciences in the work of the naval architect. These vessels of ours will be of 35,000 tons displacement, and will be capable of a speed through the water of some 35 knots, or a little over 40 statute miles per hour. To drive this mass at this speed, there will be required a machinery installation capable of delivering 180,000 hp. The vessels are 850 ft. in length; they will carry 10 high-powered 14-inch guns as a main battery, with the addition of a large number of guns of smaller calibre, to say nothing of torpedo tubes.

"Before the development of naval architecture, in its modern sense, the necessity usually involved rather slow step-by-step progress from one ship to another. Naval architecture has now taught us how to make these steps much greater, so that during the last quarter of a century advances which would have been bold to rashness at an earlier time have become almost routine. The rule of step-by-step progress referred to above has at least one remarkable—we may almost say—astonishing—exception. Some 65 years ago a famous English civil engineer and bridge builder turned to shipbuilding. Maintaining that the larger the ship the more economical and efficient her operation, Brunel attracted large capital and in association with Scott Russell the ship builder and naval architect, finally produced the 'Great Eastern', which was indeed a giant by a pigmy when compared with the other iron steamships of her day. Her keel was laid in 1854. She was launched in 1858 after many difficulties, and put in service in 1859.

"The 'Great Eastern' was not a commercial success. She fell short of the expectation of her designers in many respects. The successful completion even in five years of such a vessel was truly a remarkable accomplishment, but her size was ahead of her day, and it was not until 1899 that we find it again reached. As already stated, progress is more rapid nowadays than heretofore, but even now naval architecture would hardly enable us to take, with confidence, such a leap as the 'Great Eastern' promoters undertook. . . . . Naval architecture, as a whole, and its branches, like engineering generally, has not yet become an exact science, and in some respects it appears impossible that this will ever attained. The strength and stability of ships, for example, should be such as to enable them to withstand, under all conditions, the waves of the sea, but the latter are infinite in variety, and the attempt must be to provide for any manifestation arising from this variety. It is, therefore, not possible in a new problem to lay down an exact condition of water surface, and say that if our ship can stand this condition it can stand all others. The best we can do is to make an approximation of the most severe condition, based on previous



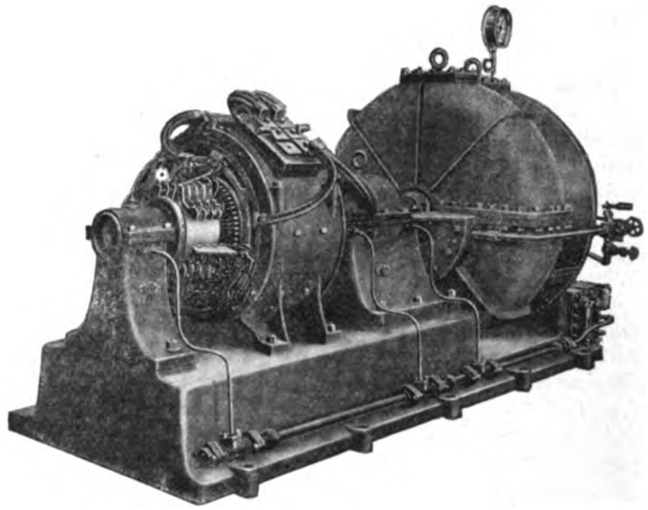
Marine generating set. B. F. Sturtevant Co., Hyde Park, Boston, Mass.

accumulated experience and observation. There have been made many thousands of observations on sea waves, but there is yet no complete agreement in regard to their limiting characteristics, such as length, height, and the relations existing between these dimensions."

An authority, Sir Wm. H. White in his book on "Naval Architecture" has a like opinion. "The structural arrangements now adopted in various classes of ships are the results of long continued development," he says. "Their origin is lost in antiquity, and many of the succeeding steps cannot be traced. During long periods, under the same conditions, methods of construction have remained unchanged; but altered circumstances and fresh requirements have produced great and rapid changes. From the canoe hollowed out of a single tree, or a coracle with its light frame and flexible water-tight skin, on to the enormous floating structures of the present time is a very remarkable advance; but the steps have been gradual, and ***not infrequently unintentional.*** In many instances the full value of a new feature has not been recognized until long after its introduction. The history of progress, change, and improvement, culminating in the wonderful progress of the last half century—into which have been crowded the development of ocean steam navigation, the introduction of iron and steel sea-going ships, and the use of armoured warships—constitutes a most interesting field of study."

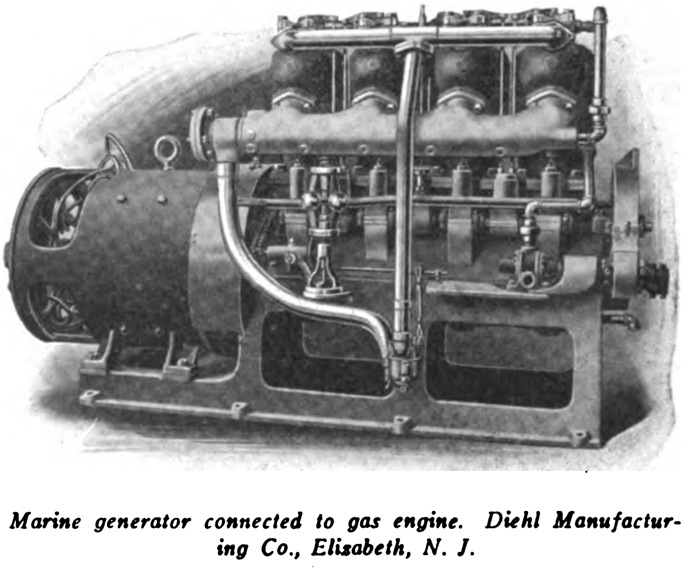
Ship Engineering

These quotations from distinguished technicians are considered necessary for an introduction to the application of electricity to ships, because the design of the vessel is requisite before the electrical engineer may presume to advise on the type or character of the installation. In the second place the opinions



100 *kilowatt marine turbo generator. Diehl Manufacturing Co., Elizabeth, N. J.*

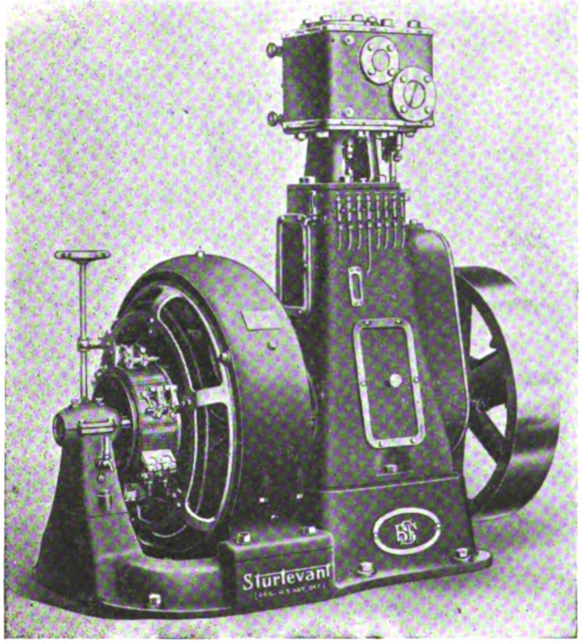
of the naval architect are of great importance to the electrician in the advancement and progress which the co-ordination of these two branches of engineering may produce. It is also particularly necessary to-day that a clear preception may prevail as to not only the present development of ship design but also the logical course of future development. As has been quoted, naval architecture is not an exact science, and this must be fully understood when endeavor is made to apply the progressive and even well-tried applications of electricity. This lack of



Marine generator connected to gas engine. Diehl Manufacturing Co., Elizabeth, N. J.

exactitude produces, or is a party to, the conservatism that surrounds the marine business, permeating not only the design of the ship but also the manufacture, operation, and, in some cases, the usefulness of the completed ship. This power of conservatism is such as to blind the vision of those whose responsibility it is to advance the shipbuilding art, and to astonish the progressive electrical engineer when for the first time he encounters it. No arguments can persuade when "what has been done" is asserted as settling the question of "what is to be done"; and no advancement, whether slow or rapid, can be hoped for except by the patient method of gradual co-ordination. The marine engineer has devoted his life to the study of his own problems. He has little time to look about him for the development that may be applicable in any other branch of engineering. To be fair, the electrical engineer is in much the same situation. Both parties must look into each other's field of work, study each other's problems and together co-operate on the only safe basis of progress—a full comprehension of the conditions to be met and the obstacles to be overcome.

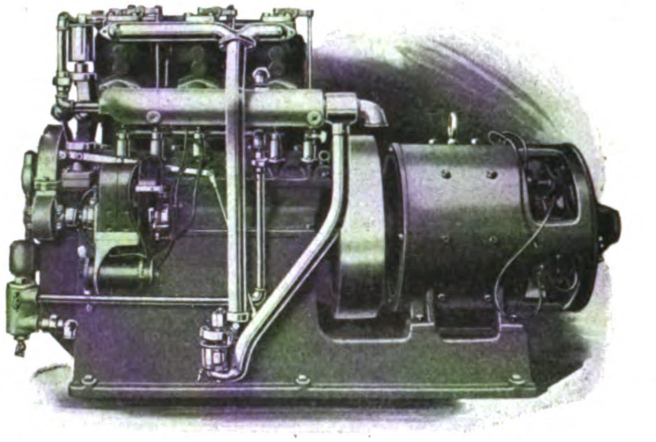
Engineering conservatism is not the only limitation put upon the progress of marine applications. Commercial and national supervision, by-laws, rules and requirements of service, add greatly to confine the boundaries of established practice. The trader of our Colonial days was the owner of his ship and suffered a complete loss of his cargo and his ship if by some mishap the vessel were lost at sea. As commerce grew in volume and ships increased in size and value of cargo, there came into existence insurance societies that for a premium would lift from the owner the burden of responsible safe passage of the vessel and her lading. These societies are of importance to-day and because they class the vessels under their cognizance, are called classification societies. These classification societies have, after years of experience inspecting ships under construction and surveying them from time to time, compiled rules for the construction and installation of equipment in various types of ships. When the owner has settled upon the classification society which he selects to underwrite his ship the electrical as well as all installations must conform to those rules, or the owner receives no insurance from that society. The great majority of the merchant vessels built in this country in the last twenty years have been classified either under the American Bureau of Shipping, or Lloyd's Register of British and Foreign Shipping. The basic principle of the rules of these societies is for the prevention of fire and for safety of life at sea. In this way they give the engineer great latitude



Marine generating set. B. F. Sturtevant Co., Hyde Park, Boston, Mass.

in the performance of good work and in the progressiveness of the installation. It is to their credit that as far as the electrical installation is concerned they are most liberal in their approvals of advancement in the art and generous in their co-operative spirit for the betterment of the work.

The classification societies do not enter the field of navigation. Their rules are solely for the building of the ship. They refer the navigation rules to the national governments. So the electrical engineer in planning his installation must become conversant with the Navigation Laws of the U. S., The Pilot Rules and the Steamboat Inspection Rules—all of which to-day are issued by the Bureau of Commerce. These rules are formulated for the prevention of collision, guidance of the captain in relation to his crew, his relations to the owner of the vessel, to his country, and his conduct in foreign countries. It establishes uniformity as regards visual and audible signals by day and night under all conditions whether the ship is under



Marine generator connected to gas engine. Diehl Manufacturing Co., Elizabeth, N. J.

way or at anchor. It further provides for those important accessories and preventatives that pertain to the safety and comfort of human life at sea. These are laws backed by the authority of Congress, and if not complied with the owner would not simply lose his insurance, as in the case of the Classification Society, but would lose the use of his ship, as the custom authorities would not grant the captain his permits and therefore he could not in the lawful sense "clear the port." The enforcement of these laws is extremely rigid, and it is not unusual for a ship to be held in port for a very simple omission or inadvertance. These laws are also framed for various types of vessels from small motor boats to ocean going steamers, and they cover every possible condition that might arise in the confused and crowded navigation of congested harbors and rivers.

(To be continued)

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THE DYNAMO

The mightiest things seem simple
And easy to understand;
When Genius has mastered their secrets,
And put the key in our hand.

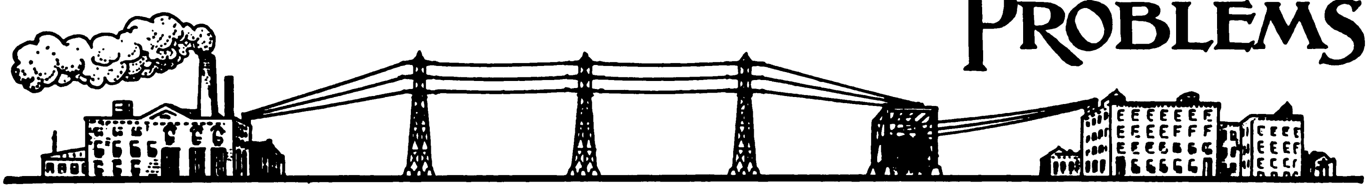
Everyone knew the magnet,
And everyone knew the coil;
But Genius wove them together,
And eased mankind of its toil.

Man was afraid of the lightning—
Awed at the cataract's roar;
But Genius bound them in harness,
To work for man evermore.

But Man scarcely deems it a wonder,
So simple the dynamo looks;
Genius he thinks a mechanic,
Romance he looks for in books.

Waldo T. Davis in *The Edison Monthly.*

POWER PLANT, LINE AND DISTRIBUTION PROBLEMS



A Record of Successful Practice and Actual Experiences of Practical Men

WINDINGS FOR ALTERNATING CURRENT GENERATORS AND INDUCTION MOTORS

By T. Schutter

The windings for the armature of an alternator and the field or stator of an induction motor are put on and connected in the same manner. In general they are similar to the windings for direct current armatures, only no commutators are used.

When a set of coils has been placed in the slots and tested for opens, shorts, and grounds they are paired in groups and connected according to the style and phase of the winding.

In any alternating current winding the number of poles, phases, and poles times phases must be a multiple of the number of coils to be placed.

In an alternating current generator there are two windings: the field windings, which are excited from a direct current source, so as to main a constant flux and polarity; and the armature winding, in which an alternating current is produced by having the armature conductors pass through the field flux. In most large alternating current generators the armature

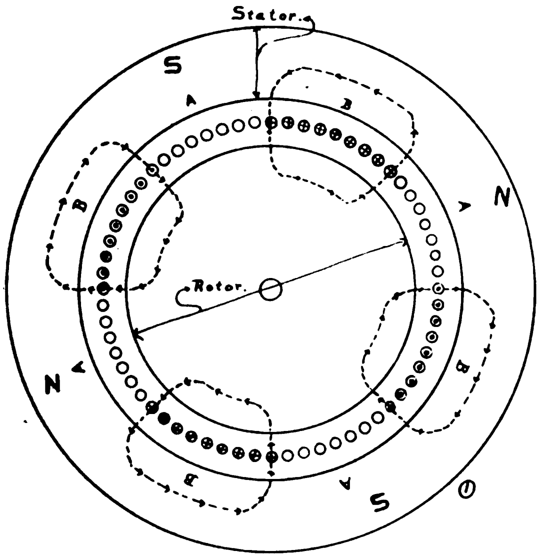


Fig. 1

winding is stationary, while the field coils are fastened to a shaft and revolved by some mechanical power. The principle of the generation of current is the same as in any direct current generator.

In an induction motor there is but one winding, which is called the field or stator winding. This winding produces a rotating magnetic field by applying an alternating current to it. The moving or revolving element of an induction motor is called the rotor.

Before considering the details of the windings and connections of the windings the reader should have a clear conception of how the rotating field is produced. The following explanatory text and illustrations make this clear, but require some study. Once the principle of the rotating magnetic field is understood the rest is comparatively easy.

The reader is no doubt more or less familiar with direct current motor practice. He knows, for instance, that a short circuited coil in the armature will result in a very heavy back drag and cause the armature to run very slowly, as if under a great

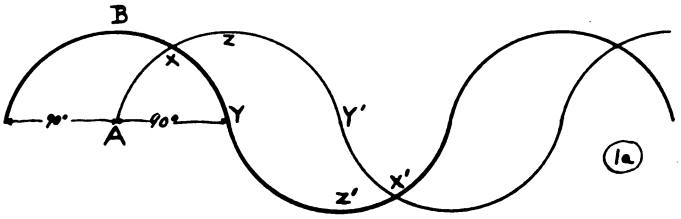


Fig. 1A

strain or load. The larger the number of coils short circuited in the armature the heavier the drag and the slower the speed of the armature. If the armature were held stationary under the above conditions and the field frame revolved the same strain and slow speed would be result. If now the armature winding were entirely short circuited by placing a metal band around the commutator (brushes removed) and the field frame were revolved by some mechanical force, the armature would revolve in the same direction but somewhat slower. The rotating field drags the armature after it.

This is the principle on which the induction motor is based.

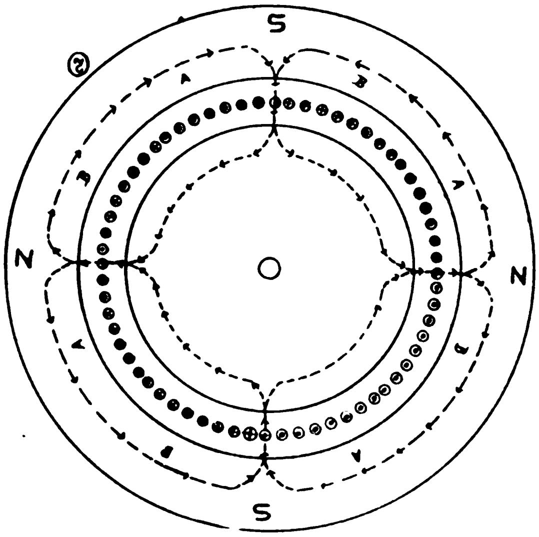


Fig. 2

If, however, instead of turning the field frame we should hold it stationary and produce a rotating magnetic field by applying a two phase or three phase alternating current to it; and if the armature (which is called the rotor) instead of being wound and connected to a commutator has copper rods or bars inserted in its slots and they are all connected to the end rings either by soldering, riveting or brazing, then the same effect would be produced—the rotating magnetic field would cause the armature to rotate with it.

One point that the reader should keep in mind is that only polyphase induction motors are self-starting. All single-phase induction motors must have some special wiring arrangement in order to be self-starting.

The stator or field frame of an induction motor is similar to an inverted ring armature; that is, it has its slots on the inner circumference instead of on the outer.

In Fig. 1 the stator is shown without slots on the inner circumference so as to make the illustration as simple and clear as possible. The small circles between the rotor and stator are the field or stator windings. The usual symbols are used; that is, the x mark represents the current flowing away from the reader and the (.) mark the current flowing toward him.

It will be seen in this figure that the conductors are arranged in two groups, A and B, which will represent a two-phase induction motor winding. The conductors belonging to group or phase A have no indication of current, since in a two-phase circuit there is a difference of 90 electrical degrees between phases. This is shown in Fig. 1a, phase B being at its maximum and phase A at its minimum value.

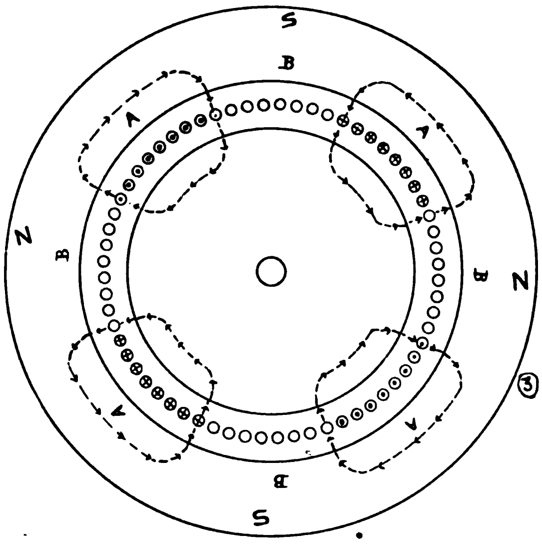


Fig. 3

Assuming the above condition to exsist in Fig. 1, the current which is at full pressure in phase B will create 4 poles as shown by N, S, N, S. As the current in phase B begins to drop back toward its minimum position Y, Fig. 1a, phase A is rising in value toward its maximum position Z. When both phases A and B reach point X, they will each produce half pressure and the current will be flowing through the windings as shown in Fig. 2. By noting the position of the poles in Figs. 1 and 2, it will be seen that they have advanced 45 electrical degrees.

It should be remembered that this advancement of 45 electrical degrees does not happen in one bound but is gradual.

When phase A has reached point Z in Fig. 1a, phase B has reached point Y, then from Fig. 3 it will be seen that the conductors in phase B carry no current, while the conductors are carrying full pressure and the poles have advanced 45 electrical degrees again. When phase B has passed from Y to X' and phase A has passed from Z to X', the current will again be at half pressure in each phase as the current indicated in Fig. 4, and the poles have advanced 45 electrical degrees again.

The reader in studying this explanation will notice that at times only one phase or winding is energized and produces a pole, while at other times both phases or windings are doing so. This, however, does not produce a pole twice as strong at one time as at the other, as the strength of a pole depends on the ampere-turns, (turns times amperes) and it will be seen that when but one winding is active it is carrying only as much current as when both are active but at half pressure.

In Fig. 1a when phase A is at point Z phase B is at Y; phase

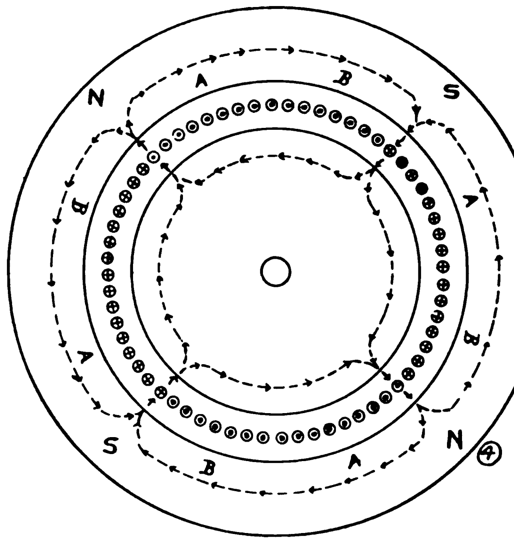


Fig. 4

A will then carry full pressure, and phase B zero pressure, but when they both are at X each carries one half full pressure.

Assume that in each phase there are 100 turns of wire and the full current per phase is 2 amperes, then at point Z, phase A would produce 100 × 2 = 200 ampere-turns, and phase B is zero. At X each phase is receiving one half current, or 100 × 1 = 100 ampere-turns per phase or 100 × 2 ampere-turns for both, showing that in either case the pole will be of the same strength.

(To be continued)

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STEEL FOR ELECTRICAL PURPOSES

By G. M. Verity

In the 80's and early 90's, when the alternating current transformer was a novelty, many experiments were conducted to give the proper characteristics from a magnetic standpoint. Cast iron was tried, but on account of certain actions due to the alternating current getting up cross magnetic lines, solid iron or steel were found to be poor magnetic mediums. It was necessary to resort to a laminated core so as to reduce the cross currents and consequently the heating of the electrical apparatus.

Bessemer iron was next tried and very much better results were obtained, but on account of certain heating of the coils there was what is known as an aging or fatigue of the metal, and with the Bessemer sheets this was found to be a very large factor, especially if the apparatus overheated.

The aging loss on sheets made by the open-hearth process was found to be considerably less than with the Bessemer sheets, and as improvements in the design of the transformers were made a gradual reduction in the iron losses of the apparatus was obtained.

About the year 1903, Sir Robert Hadfield, of Sheffield, England, took out a patent on what is known as "silicon steel." He claimed that the addition of silicon to steel of certain analysis would reduce the iron loss when subjected to an alternating current or rapidly reversing magnetic field. About this time much experimental work was successfully carried on through special co-operation with steel mills. It was found that it was quite difficult to make this grade of steel on account of the increased thermal effect of ferro-silicon which was added to the hot metal, but after many trials the steel mills succeeded in pouring the steel into the molds in the form of ingots. These ingots were then rolled into bars for sheet purposes, which were later punched into certain forms for transformers or other electrical apparatus.

Sheets made from material known as silicon-steel have very low iron losses and practically a non-aging characteristic.

Comparing silicon steel with Bessemer steel, used in the very early development of this work, as well as ordinary open-hearth steels, the aging losses in Bessemer steel would often show as high as 100 percent. increase over the original test when subjected to a temperature of 100 degrees centigrade for a period of 600 hours. The average open-hearth steel would show an increase of anywhere from 10 to 25 percent., while the silicon steel is non-aging during the same period of time and at the same temperature.

The iron loss of silicon-steel as compared with that of either Bessemer or open-hearth is very much lower, the improvement for a given magnetic induction alone being approximately 40 percent. This does not mean that there is a 40 percent. saving in the electrical apparatus, but indicates what has been done in development of the steel through co-operation with steel makers.

TESTING CABLES TO DETERMINE IF THEY ARE ALIVE BEFORE WORKING ON THEM

By C. A. Dalrymple

From time to time it becomes necessary to make repairs to underground cables. In order to make it absolutely safe for the employees who are to work on the cable considerable precaution must be taken to determine whether or not the cable is alive before working on it.

The first step is to notify the power director or load dispatcher that you want to work on a cable, giving him the proper designation of the circuit. He will then take the cable out of service, if not already out of service due to a failure, properly ground it in the station, block the switches, and place a red tag on the switch indicating that there are men working on the cable and that the circuit is not to be cut in until released by the foreman in charge of the repair work. After the power director has notified you that the cable is ready to work on, the next step is to proceed to the manhole where the repairs are to be made and find the proper cable. It is advisable to check the cable designation in the manholes each side of the one in which you are working.

After these precautions have been taken it is not advisable for the cable splicer to cut into the cable without first testing it to determine if there is chance that some mistake has been made and that the cable is alive, which would prove serious if not fatal to the cable splicer who is to cut the cable.

A good method of testing the cable is by using a grounding tool as shown in Fig. 1. This tool consists of a long insulated stick with a spear point on one end which is made of steel and is provided with a piece of wire and a clamp for attaching to the cable sheath or some other good ground. This will insure the passage of current through to ground if the cable is alive when the steel point is driven into the cable. The handle is sufficiently long so that the pointed end may be driven into the cable from the top of the manhole. A grounding tool of this kind costs approximately $7.50. Operating companies that believe in "Safety First" should not be without a device of this kind or something similar to protect the lives of their employees who have to repair underground cables.

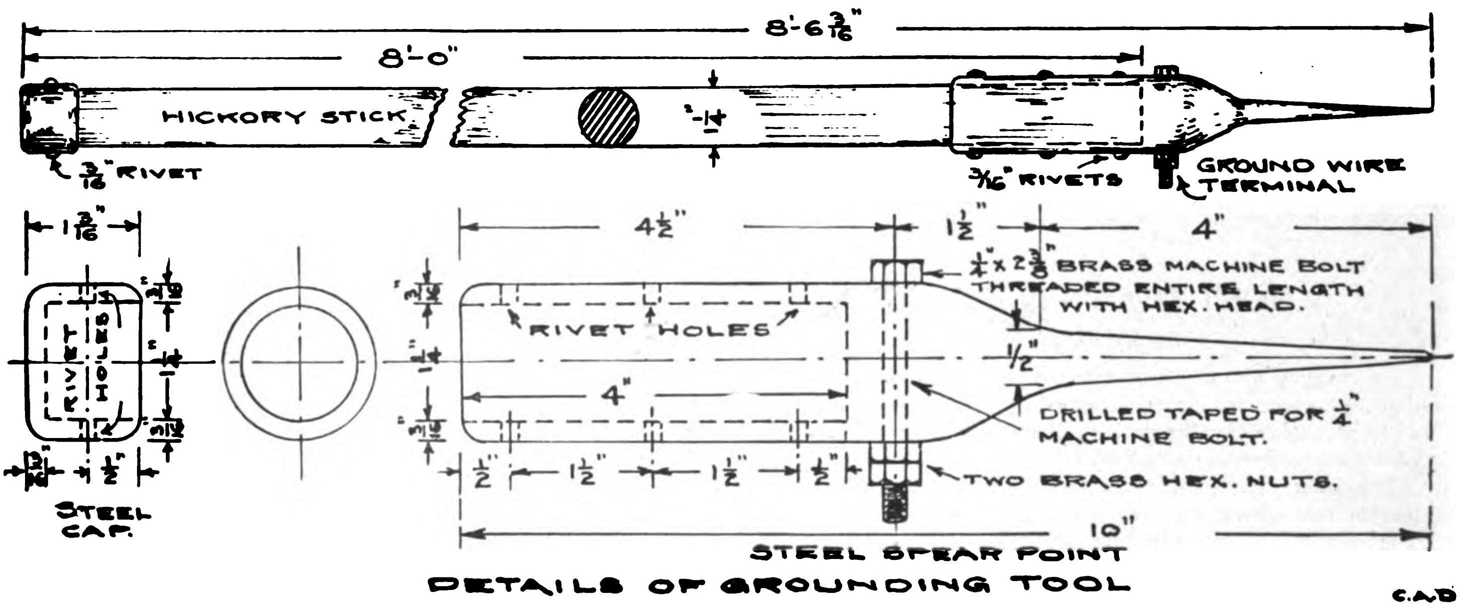
MISSOURI RIVER POWER SITES

A pamphlet recently issued by the South Dakota Department of Immigration contains a map of that State showing some of the more important potential power sites along the course of the Missouri River.

South Dakota is peculiarly fortunate in the natural formation of the Missouri river valley which makes it possible to construct a considerable number of water powers upon that stream. This is a resource peculiar to South Dakota, where at frequent intervals the rim walls of the immediate valley of the stream approach each other so closely as to make the erection of dams feasible. Examination of the section was made many years ago by General George W. Davis, the notable engineer of the Panama Canal, who in the beginning of his military career was located at Fort Sully. He was perhaps the first to suggest the vast power potentalities of the middle Missouri reaches.

Engineers survey maps are included showing in outline the topographical conditions existing at such places as Big Bend, Little Bend, Mulehead, Chamberlain Site, Reynolds Creek, Medicine Butte and Bad Hair.

The combined minimum effective power developable by



Details of grounding tool showing dimensions of each part and overall dimensions.

these plants is 242,000 h.p. The average flow of the stream will produce at the same heads 552,000 h.p.

The minimum discharge of the Missouri in the northern part of South Dakota is 10,000 second-feet. It rarely if ever reaches this minimum. The average discharge is 24,833 second-feet, for the entire year and the average for the growing season is 37,500 second-feet.

That the markets for current will develop as rapidly as the power plants can be constructed seems certain.

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BALANCING THE LOAD ON A TWO-COMMUTATOR PLATING GENERATOR

By H. H. Wikle

Considerable trouble occurs, due to a circulation of current through the two windings on plating generators where the two windings on the same armature are connected in multiple. This trouble is due to a wrong setting of the neutral and is not so easily remedied as it at first seems.

The following method of balancing the load equally between the two windings has been used with success by the writer. The brushes are first set on the mechanical neutral. Fig. 1 shows the brushes on such a machine set in this position. If the two windings are generating the same amount of current no current

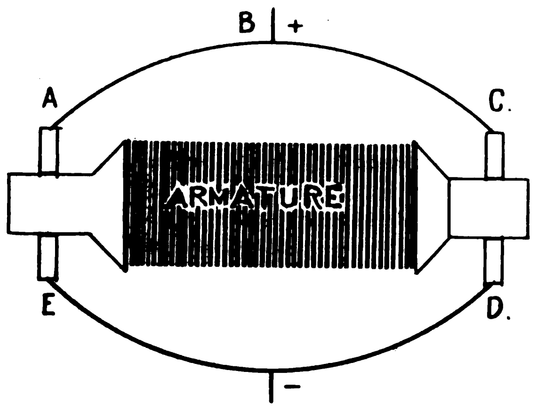

Fig. 1

flows in the circuit ABCDEA. A milivoltmeter is then placed across AC or DE to indicate if such a current is flowing. If it is found that a current circulates through the two windings, the brushes on both commutators are shifted until no current flows.

This setting of the brushes is marked by means of a chisel on the rocker arm.

The electrical neutral is then found for each winding by the "point to point method" and this brush setting marked on the rocker arm. The true neutral is of course between these two chisel marks, and is found by shifting both rocker arms until minimum current flows between windings and there is minimum drop in the coils under commutation.

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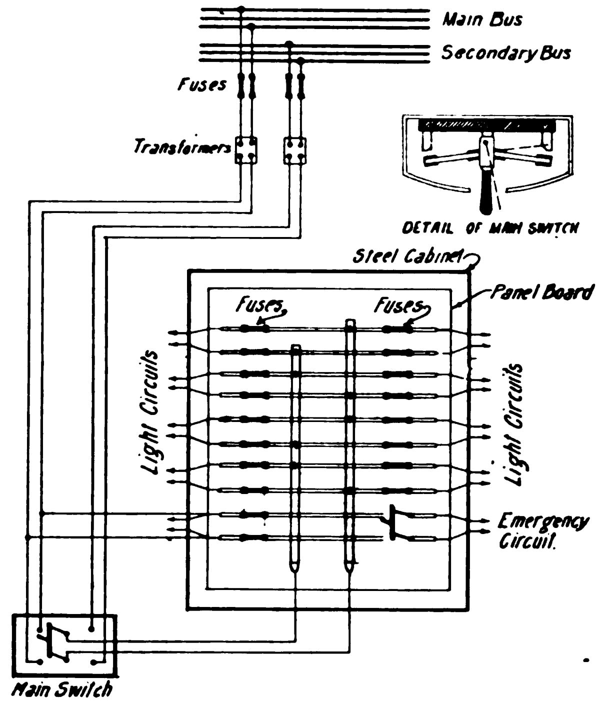
LIGHT THAT NEVER FAILS

By M. W. Ehrlich

In traveling around the country, visiting different power stations, the observer may find many details that could be employed to advantage in other stations. One such instance is illustrated by the accompanying sketches.

The plant in question is a small central station with high tension three-phase alternators arranged to operate in parallel. The switchboard has two sets of bus-bars. The main bus is for regular operation; the secondary bus is for transfer of the load. To insure that positive source for lighting the plant will be always available, an ingenious arrangement was devised.

A regular panelboard enclosed in a steel cabinet is provided for the eight lighting circuits required for the illumination of the plant. When lighting is at all required then the entire system must be on and for this reason fuses only have been pro-



Details of panelbroad and main switch, showing relative location of fuses, transformers, light circuits, emergency circuit and bus-bars.

vided for the protection of the circuits. In addition, an emergency circuit has also been installed. This combined load of two circuit systems is served through transformers, as shown in the illustration.

From the two sets of bus-bars, fused feeders are brought to the transformers. The voltage is here stepped down and changed to 120 volts single phase to fulfill the lighting requirements. From each transformer, leads are taken to a double-pole, double-throw main switch which controls the regular lighting circuits of the system. This duplicate arrangement insures a certain supply of current when either one or both of the alternators are in operation.

The distinguishing feature is the main switch. This is of special design, as shown in the detail cross-section. A slate mounting is provided for it and the whole is enclosed in a steel casing which has a removable cover. It is a safety switch by virtue of all working parts being concealed: only the operating handle is exposed. The blades of this double-throw switch are set at a slight angle, so that when the handle is in the center position, all circuits are dead. Throwing the switch slightly to the right or the left, gives a contact with the current supply from one of the transformers, thus completing the main circuit and turning on all the lamps.

When operating alternators in parallel there may be a time when the machines will not be in step. At other times in transferring the load there may be a short period in which the lighted lamps in the station would flicker or possibly be extinguished. Especially is this true when throwing in the ordinary double-throw switch from one source of energy supply to the other, according to the particular machine that may be set in operation. To obviate this the main switch in this case was made as shown, so that only a slight move will give contact with the desired side of the current supply. In effect it is a "quick-break" switch that eliminates momentary darkness when light is required.

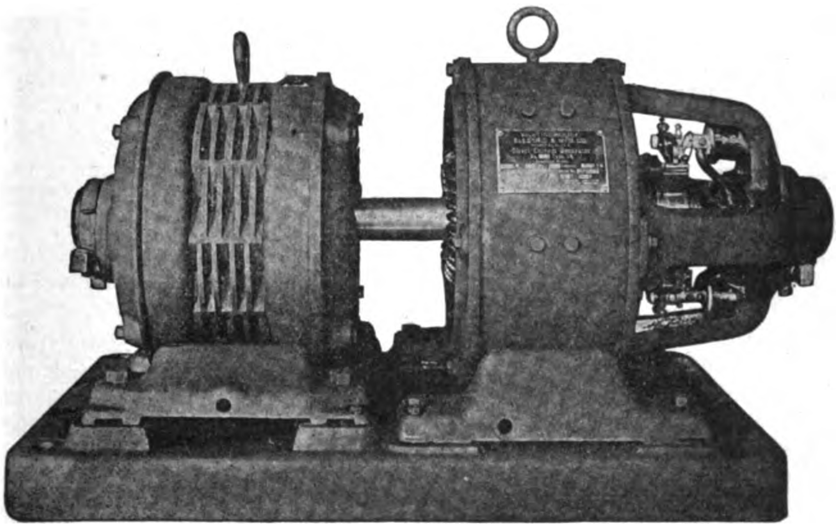
This provision is, however, reinforced by the emergency lighting circuit. The current supply from the main bus, which is the usual operating bus, is tapped to supply this special circuit as indicated. A double-pole, single-throw knife switch on the panelboard provides the necessary control.

When the alternators are being changed over during the course of operation, this switch is thrown in so that there is always sufficient light at the desired or most important points, according to the arrangement of the lamps. The emergency circuit has no connection with the bus-bars of the panelboard, and it is entirely independent of the main lighting switch. As soon as the generators are in step and everything else in good operating condition, then the main switch is closed and the regular lighting circuits are thrown in.

With this arrangement operation is never interfered with, even though the other circuits may have given out. The emergency lights never fail.

MOTION PICTURE MOTOR-GENERATOR

There are certain classes of service for which direct current gives much more satisfactory results than alternating current. Among these may be mentioned passenger elevators where high speed and accurate control of the car is desirable; motion picture machines, for which direct current gives a steadier, more reliable illumination for the film; for charging storage batteries, which require direct current; and for many industrial applications where good work is dependent on perfect control of the motion.



Motion picture motor-generator set. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Where the only available circuits are alternating current, a most satisfactory method of obtaining direct current for such applications is by using a motor-generator. Operating expense is reduced to a minimum, as efficiency of both motors and generators is high and therefore the cost of power lost through internal losses is small. Maintenance cost is very low, as no skilled operator is necessary.

SOME FACTS ABOUT DIRECT CURRENT MOTORS

In choosing a motor for any application careful consideration should be given to the motor's characteristics, that it may be best adapted for the service required, says Catalogue 30, issued by the Westinghouse Electric & Mfg. Co.

Direct-current motors are classified according to the field windings as series, shunt, and compound.

Series Motor

In a series-wound motor, the field winding being in series with the armature winding, the motor speed will vary inversely as the motor load.

Series-wound motors are inherently varying-speed motors. They start with very powerful torque and low starting current, the torque increasing considerably faster than in direct proportion to the current. They are capable of starting and accelerating heavy loads with lower current consumption than any other type of motor. On reduced loads the speed may become dangerously high, hence such motors can be employed only where the load is never entirely removed or where close supervision is maintained. A series motor should never be connected by belts to its load, but always by gear, chain, or coupling.

Series motors are used chiefly for widely varying loads where extreme speed changes are permissible, and where the operator is always on the job; as hoists, cranes, winches, and trolley cars.

Shunt Motor

In a shunt-wound motor a small portion of the line current is shunted across the armature and used for exciting the field. In this manner the field excitation is kept uniform, giving a constant speed to the motor irrespective of its load. Such motors are used in the majority of direct-current motor installations; such as machine tools, centrifugal pumps, line shafting, printing presses, grinding and buffing wheels, and automatic lathes. Adjustable speed motors are shunt-wound motors in which a field rheostat is used to adjust the motor speed, which, when once adjusted, is practically unaffected by the motor load. These motors are used where the speed requirements vary for different classes of work, particularly in machine shops, on lathes, boring mills, drills, and milling machines.

Compound Motors

Compound-wound motors are varying speed motors, having both a shunt and a series winding for field excitation. They are intermediate in characteristics between the shunt and the series motors, resembling more closely the one which the field winding most nearly approximates. These motors are used where the required torque varies considerably, being high at starting or during some part of the cycle of operations, and where at the same time limiting characteristics of shunt motors is desirable. A compound-wound motor should be used in preference to a shunt-wound motor where either the motor or the machine is to be started or reversed at frequent intervals, also where the load fluctuates and a fly-wheel may be used to advantage. In the latter case, the motor speed drops off as the load comes on, allowing the flywheel to give up some of its stored energy.

For severe mill service such as bending rolls, etc., the motors are heavily compounded, having only enough shunt winding to limit the light load operating speed. At heavier loads these motors have all the operating features of series motors.

Service Conditions

All motors are built and rated for either continuous or intermittent service. In many cases motors are rated for both continuous and intermittent service. The intermittent service rating is always given for a specified duration of time.

Starting and Speed Adjustments

For starting direct-current motor, a low-voltage release starting rheostat, or starting box, is generally used. Fuses or a circuit-breaker should also be installed to protect it from injurious overloads.

Speed adjustments are obtained in two ways:

(a) By adjusting resistance in the armature circuit. By this method all speed adjustments are below the normal rated full-load speed. This method is satisfactory for intermittent service, such as operating cranes, hoists, etc., and also for continuous service where the required torque varies with the speed, and where the torque at any given speed adjustment remains constant as in driving fans, blowers, and centrifugal pumps. It is not economical where the torque remains constant or nearly so at all speeds, because of the high resistance loss at reduced speeds. Nor is it satisfactory where the torque varies at any given speed adjustment, as in machine tool service.

(b) By adjustable resistance in the shunt field circuit. Speed adjustments obtained by this method are always greater than the minimum rated full-load speed. This method is very economical and satisfactory for most applications, especially where adjustable speed is required with varying load at the different speed adjustments, as in machine tool service. Caution is necessary in using field control with compound-wound motors in varying torque service. At high speed adjustments such motors operate practically as series machines, and on light load, the speed may become excessively high.

Some controllers combine these two methods, so that speed adjustments may be made either above or below the normal rated speed.

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BOSTON MEZZANINE SUBSTATION

Up until a few years ago, the supply for the entire traction system of Boston was direct current. It was then decided to change over to alternating current and make the change gradually. This is now being accomplished at the rate of approximately one substation each year. In the year 1911, approximately 40% of the equipment was changed. When the time came to locate the substation to feed that part of the city located near the South Station where real estate is naturally very high priced, a solution was afforded when The Rapid Transit Commissioners built the South Station depot of the subway. It was decided to locate the substation in the space between the subway tracks and the surface, a space that otherwise would have to have been filled in. It was really more economical to build a station than to make the fill. Accordingly, a station having a floor space of approximately 83 x 56 ft. with a height of approximately 16 ft. was erected in this space.

As may be seen by inspecting the station, the apparatus is compactly arranged, and yet there is ample room for three 3000-kilowatt rotary converters which is the ultimate capacity of the station, although only two converters have been installed so far.

The apparatus was put on flat cars, brought in on the subway tracks to a point under the station, and lifted up by a crane through openings provided in the station floor.

Three 25-cycle, 132,000-volt, three-phase high tension lines enter the station, two of them being used as feeders for the supply circuit. The third line is used for feeding out from the station. There are two sets of three 1050-kw. Westinghouse air-blast transformers by which the high tension current is stepped down to rotary voltage, 452 volts. The conversion to direct current is effected by two 3000-kw., 25-cycle, 600-volt, 250- rev. per min., six-phase Westinghouse rotary converters.

The incoming and outgoing lines are controlled by a 33-panel slate switchboard mounted on the same floor with the converters. The oil circuit-breakers for the control of the high tension circuits are located back of the transformers on the same floor level, and controlled from the panelbroad which is equipped with the usual complement of meters, switches and relays.

At the present time there are nineteen direct current feeders but eventually about thirty feeders will be required to take care of the rapidly growing load carried from this station. Ample ventilation is provided, also lockers and shower baths.

MOTOR REPLACES STEAM ENGINE

The successful replacing of a steam engine by an electric motor is to be found in the plant of the Cleveland Hardware Company, Cleveland, Ohio, manufacturer of drop forgings for automobiles and similar classes of service.

For the last 35 years this company has been operating a 9-in. Merchant rolling mill belted to a steam engine, but frequent breakdowns compelled them to install a new driving unit. Like many other enterprises of a similar nature, it was decided that electric drive was the only logical solution of the problem. The wisdom of this choice is shown by the absence of drive troubles since the motor was installed.

Power for the drive is supplied by the Cleveland Electric Illuminating Co., at a much lower rate than could be obtained by means of a private plant.

A simple drive is employed. The motor is placed close to and connected by gears to the rolls, and this, with the transformers and control, constitutes all the apparatus necessary.

Current is obtained from the power company at 11,000 volts, 60 cycles, three-phase and is stepped down by means of a three-phase oil insulated self-cooling transformer to that for which the motor is wound, 2,200 volts.

The motor is of the wound-rotor type with a rating of 450 hp. at 900 rev. per min. and 560 hp. at 720 rev. per min. These synchronous speeds are obtained through a double winding designed to give the motor either 8 or 10 poles, according to the speed desired.

The synchronous speeds of the motor are reduced to speeds of the mill shaft of 240 and 192 rev. per min., respectively, by means of a herring bone type gear drive which is operated in oil in a completely enclosed case.

The control of the equipment is handled by a two-panel block enamel switchboard mounted on angle frame iron frame work.

The switches for changing the windings on the motor from 8 to 10 poles are oil immersed, one in the primary and one in the secondary circuit. Proper markings are placed thereon so the mill operator can easily manipulate them. The primary breakers are mechanically interlocked, so but one can be closed at any one time.

In case it is necessary to stop the mill quickly, as in an emergency, the running breaker is tripped, which causes all the secondary breakers to open. The operator then closes the reverse breaker which quickly brings the motor to rest.

All the electrical equipment is of Westinghouse make, installed under the direction of Howard R. Taylor, mechanical engineer of the Cleveland Hardware Co.

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GIRLS TO READ METERS

The Binghamton Light, Heat & Power Co. employs girls to read meters and deliver bills. It has been found advisable to do this on account of general labor conditions, and it is in line with the policy adopted about six months ago of employing girls in all branches of the work where it is feasible to do so, thereby releasing as many men as possible for Federal service.

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Electric heaters are in big demand and about as scarce as coal. During the recent cold snap none were to be found in the shops of electrical jobbers and dealers. Department stores carrying them did a big business. Local dealers report being advised of shipments of these heaters by the factories but no one can tell where they are. Due to storms and railway embargoes the heaters are sidetracked for the time being.

EDITORIAL

FANS FOR 1918

No changes of moment are reported in the design of electrical fans for the coming season. On account of labor and material shortage, caused by the war, the chief change is in the elimination of certain types, the demand for which has never crowded hard on the supply. In this way the labor and material available have been assigned the task of turning out the types of fans that are needed most. Those fans which are needed most are those which have become a standard product during recent years, only minor changes in the design and manufacture occuring from year to year. They can be seen by the thousand in home, office, and shop; and they are too well known to require re-describing in detail at this time. As with all other kinds of electrical goods, what besets fan manufacturers to-day is not changes in design but the problem of getting the raw material, the labor to fabricate it, and the delivery of some or all of the goods ordered within a reasonable time after delivery is due.

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CATCHING THE THIEF

After six years of effort on the part of the electrical association that represents the great Southwest, the Texas Legislature has been prevailed upon to pass an efficient and equitable law to thwart the stealing of electricity. Under the old law, no matter how incriminating the circumstances, proof was required of the intent to cheat or steal. Though everything pointed to the intent to steal current, it was next to impossible to prove it. Under the new law any physical evidence of circumventing the meter will be considered as prima facie evidence of intent to cheat or steal and will be treated accordingly. This will serve to make convictions less hard.

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SAVING ELECTRIC CURRENT

Someone in temporary authority in a political way down in Washington says that a wide margin exists for the reduction of household consumption of electricity, in furtherance of fuel and freight saving. For instance, despite the remarkable development of cheap, durable, metallic-filament incandescent lamps the past few years, there has been no reducton whatever—in fact, an increase, rather—in the use of old-fashioned carbon-filament lamps, which the modern lamps should have displaced. Carbon-filament lamps give less light than modern lamps and consume more electricity. The chief element in their continued use is the fact that they are given free to householders by many electric light companies, whereas metallic-filament lamps are sold. It would pay every consumer of electricity many times over to purchase modern lamps and economize by reductions in electric-current bills.

The statement about no reduction in the use of old-fashioned carbon-filament lamps is, as someone recently remarked about another offhand statement, "important if true." Unfortunately for the political statistician, it isn't true. As a matter of fact the non-political statistician of the Lamp Committee of the National Electric Light Association tells us in a recent report that the following table represents the relative percentages of incandescent lamps manufactured in 1907 and 1916:

	Carbon	Gem	Tantalum	Mazda
1907	93.27	5.88	0.75	0.10
1916	16.32		0	83.68

This indicates that the carbon-filament lamp instead of increasing in volume is fast following in the wake of the landscape in Gray's immortal elegy. Some other means will have to be found for saving electric current. It can't be saved by substituting tungsten lamps for carbon lamps, for the carbon lamp, like Deutschland Ueber Alles, is fast approaching extinction. And it wouldn't hurt the above mentioned statistician if he would take to heart Josh Billings admonition that it is better not to know so much than to know so much that isn't so.

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THE THIRD LIBERTY LOAN

The present serious business of the United States is war. Irrespective of every other condition this war must be carried to a successful conclusion and the only way that this can be done is to spend money. Millions of Americans stand ready to fight and the question of men for this service is not a problem. The only need is money. The last two loans have demonstrated that Americans have been fully conscious of this need, and each loan has been largely oversubscribed. It should be borne in mind, however, that a great majority of the money invested in Liberty Loans so far has come from the liquid capital of the nation. The Third Liberty Loan must come largely from money **saved** by the American people through the practice of economies and self-denial. If this loan is to be immediately successful, everyone must realize the responsibilities ahead and begin to plan the necessary economies at once. All business should be conducted with this main idea in view. In order to secure money to finance the nation, business must continue "as usual," but in a much more economical way. Business must be reorganized on a basis of the greatest efficiency in order that the necessary money may be **saved**. We urge upon all of our readers therefore, to go over their business affairs most carefully and reconstruct same on an economical basis. As with individuals, it is really surprising how little a business can get along with when it has to. Practically every organization can be "speeded up" to higher efficiency and operated at less cost. Likewise there are numerous systems that can be eliminated for the sake of economy. Things that are perfectly sensible in the conduct of a business in normal times are frequently wasteful in times of war. Begin to study your business with this end in view now. Don't allow yourself to believe that the "other fellow" is going to put up all the money to carry on this war. Every individual, however lowly, must do his bit.

The Third Liberty Loan will undoubtedly exceed in amount, not only its two predecessors in this country but any single war loan or any other loan ever offered in the history of the world. No loan of such proportion can be successfully absorbed unless the entire nation responds. To some the task may at first seem difficult but later it will be found that the lessons of thrift now being forced upon all will become a boon to every American. The Bond buyers of the country will have expanded from a small minority of its inhabitants to the majority of its adult population. We shall have become familiar with safe investments and have learned the language and practice of economy as a nation for the first time in our history. And for the first time we shall practically all of us have had a direct stake in the conduct of the Federal Government, with an incalculable effect on the progress of the good and economical government in the future. Individually we may be transformed in great part from a nation of spenders and borrowers into one of savers and lenders. No one can escape the obligation which now confronts him. If you have not done so already, get out your pad and pencil and begin to figure.

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ELECTRIC RAILWAYS IN WAR TIME

All told, there are about forty thousand miles of electric railway trackage in the United States. The War Board of the American Electric Railway Association is now planning to utilize this trackage to transport food and to relieve the steam railways of local traffic between towns. This will take the burden off the steam railways, allowing them to concentrate their energies on through train service. It is also planned to arrange for interchange of traffic between the electric lines, most of which are now operated independently. This will help relieve the present congestion at steam railway terminals and insure quick transportation of perishable goods.

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SERVICE INSURANCE

The Treasury Department is making every effort to have every member of America's fighting forces take advantage of the Government-insurance plan, which is said to be the most just and humane provision ever made by any nation for its soldiers and sailors. The purpose is rapidly being achieved, the insurance having passed the third billion mark in the total of policies written. There are many military units in which every member has taken insurance. The automatic insurance provided by the law is only partial and limited protection, payable, only to wife, child, or widowed mother and ceases after February 12, 1918. It is important, therefore, not only to the soldiers and sailors of the country but to their families and dependents, that before that date they avail themselves of the full Government protection, which can go as high as $10,000 and is payable to a wife, husband, child, grandchild, parent, brother, or sister. The law also provides for the reeducation and rehabilitation of the totally disabled and monthly compensation of those disabled.

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WAR SAVINGS

Thrift Stamps and War Savings Stamps are the most democratic of investments and America expects every American to invest in this security. They afford every person, however humble and however small his means, the opportunity to contribute his part, to do his bit, in this struggle against the military masters of Germany who are out to dominate the world. Those who have been reared under German military methods know what German domination means. It means first to break the will, second to put on the yoke of submission, and then to exploit under the guise of beneficient paternalism. German rule doesn't mean kindly firmness but cowardly brutality, as those of us who have endured it can testify. Every Thrift Stamp bought helps to block the path of this creature, who would, if he could, subject the rest of the world to social and economic slavery. If you can't serve, save, and seek to put all your savings into interest-paying Government securities.

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SHADES OF BEN FRANKLIN

About 1790, just before his gentle, persuasive, and philosophical spirit was wafted over the border, the greatest man America has produced said he wished he could be preserved in a cask of wine so he could emerge a hundred odd years hence and note the state of his country. Could his wish have been fulfilled what a Ben Franklin of conflicting emotions we would have with us to-day. How he would glory in the host of electrical devices that have followed in the wake of his lightning-enticing kite! How he would glory, too, in the host of educational magazines that have following in the wake of the **New England Courant** and **Poor Richard's Almanack!** And what reason he would have for such rejoicing! How astonished and depressed he would be, Ben Franklin the Postmaster-General, the signer of the Declaration, the statesman, the advocate of flat-rate postage that helps more than anything else to bring his countrymen into intellectual accord—how astonished and depressed he would be, we say, to find in the midst of another war for political independence some of his nearsighted political descendants bent upon penalizing their fellow citizens by enacting a law that would increase the postal rates on newspapers and periodicals by from 50 to 900 percent! What, we wonder, would he think. What would he say?

CONTEST OF THE FREQUENCIES

By B. G. Lamme

In presenting this paper before a meeting of the American Institute of Electrical Engineers last month, Mr. Lamme said that the outcome of the battle of the frequencies was determined far more by the conditions in the operating field than by the exploitation of any particular system by designing engineers. As a consequence, the energies of the engineers were directed exclusively towards overcoming the defects and limitations of the systems and not expended in fighting each other. In what follows the various frequencies used in alternating-current work in America are first mentioned, and the primary reasons for their introduction are given. It shows that there was an apparent need for two standard frequencies in the region of 60 and 25 cycles, and, further, why 60 and 25 cycles have prevailed. The special fields of application of each one are discussed fully, and it is shown why 25 cycles tended to dominate the field to the exclusion of all other frequencies.

The story of how and why the various commercial frequencies came into use and then dropped out again, in most cases is not primarily the story of the frequencies themselves, but of the various uses to which the alternating current has been applied in American engineering installations. In other words, fundamental changes in the application of alternating current have led to radical changes in the frequencies. Some of the applications which have had a determining factor on the frequency of the supply system are as follows: incandescent lighting, transformers, transmission systems, arc lighting, induction motors, synchronous converters, constructional conditions in rotating machinery, and operating conditions. A brief consideration of these items individually, from the present viewpoint, indicates that while some of them had, at one time, very considerable influence in determining frequency conditions, yet, in a number of cases, the original reasons have disappeared through improvements and refinements, as will be described later.

At various times the following standard frequencies have been in use in this country; namely, 133 1/3, 125, 83 1/3, 66 2/3, 60, 50, 40, 30, and 25 cycles per second. These did not appear chronologically in the order given above, and a few odd frequencies in a few applications are omitted.

In the following, the various frequencies will be considered more or less in the order of their development and basic reasons will be given for their choice, and the writer will endeavor to show why certain of them have persisted, while others have dropped out. It will also be shown why the commercial situation has first tended strongly toward certain frequencies and afterwards swung toward others.

133 and 125 Cycles

In the earliest alternating work, the whole service consisted of incandescent lighting, and the electric equipment was made up of small high-speed belted single-phase generators and house-to-house distributing transformers. As the transformers were of small capacity and as their design was in a very crude state, it was believed that a relatively high frequency would best meet the transformer conditions. A choice of such an odd frequency as 133 1/3 cycles per second is due to the fact that in those early days (1886 to 1893) frequencies were usually designated in terms of alternations per minute. One of the earliest commercial generating units constructed had a speed of 2000 rev. per min. and had eight poles. This presented a fairly convenient constructional arrangement for the surface-wound type of rotating armature, which was the only one recognized at that time. The speed of 2000 rev. per min., with eight poles, gave 16,000 alternations per minute, or 133 1/3 cycles per second, according to our present method of designation. Thus the earliest frequency in commercial use in this country was fixed, to a certain extent, by constructional reasons, although the house-to-house transformer problem apparently indicated the need for a relatively high frequency. The Thomson-Houston company adopted a standard frequency of 15,000 alternations per minute. (125 cycles) instead of the Westinghouse 16.000, but the writer does not know why this difference was made. However, the two frequencies were so close together that practically they could be classified as one.

At this time, it should be borne in mind there were no real transmission problems, no alternating-current arc lighting, no induction motors, and the need for uniform rotation of the generators was not recognized. The induction motor, in its earliest stages, came in 1888 and considerable work was done on it in 1889 and 1890, but it required polyphase supply circuits and comparatively low frequency and, therefore, it had no connection whatever with the then standard single-phase, 133 1/3 and 125 cycle systems. The synchronous converter was also unheard of (one might say almost undreamed of) at that time.

60 Cycles

In 1889 or 1890 it was beginning to be recognized in this country that some lower frequency than 125 and 133 1/3 cycles would be desirable. Also about this time direct-coupled and engine-type alternators were being considered in Europe and it was felt that such construction would eventually come into use in America. It was appreciated that in such case, 133 1/3 cycles would present very considerable difficulties compared with some much lower frequency. For instance an alternator direct driven by an 80-rev. per min. engine would require 200 poles to give the required frequency and such construction was looked upon as being practically prohibitive. About this time L. B. Stillwell made a careful study of this matter of a new frequency, in connection with the possibilities of engine type generators, and after analyzing a number of cases, it appeared that 7200 alternations per minute (60 cycles per second), was about as high as would be desirable for the various engine speeds then in sight. Transformer construction and arc lighting were also considered in this analysis. While it was deemed that a somewhat higher frequency might be better for transformers, yet a lower frequency than 60 cycles was considered as possibly better for engine type generators. A compromise between all the various conditions eventually led to 60 cycles as the best frequency. However, while this frequency originated about 1890 it did not come into use suddenly, for it was impossible to introduce such a radical change in a brief time. Moreover, the direct-coupled or engine-type generator was slow in coming into general use and, therefore, there was not the necessity for the introduction of this low frequency in many of the equipments sold from 1890 to 1892. However, by 1893, 60 cycles became pretty firmly established and was sharing the business with the 133 1/3-cycle systems. It should be borne in mind that, at this time, the adoption of this frequency was not considered as a direct means for bringing forward the polyphase induction motor, for the earlier 60-cycle systems, like the 125- and 133 1/3-cycle, were all single-phase. Also, it was then thought that the polyphase motor would possibly require a still lower frequency and, moreover, the polyphase system was looked upon as in a class by itself, suitable only for induction motor work. At that time the introduction of polyphase generators for general service was not contemplated. This followed about two or three years later.

In 1890 the Westinghouse company, which had been developing the Tesla polyphase motor, laid aside the work, largely on account of there being no suitable general supply systems for this type of motor. The problem was again revived in 1892, in an experimental way, with a view to bringing out an induction motor which might be applied on standard frequencies such as could be used in commercial supply circuits for lighting and other purposes. It should be understood that at this time such circuits were not in existence but were being contemplated. In 1893, after the polyphase motor had been further developed up to the point where it showed great commercial possibilities, the best means for getting it on the market were carefully considered. It was decided that the best way to promote the induction motor business was to create a demand for it on commercial alternating-current systems. This meant that, in the first place, such systems must be created. Therefore, it was decided to undertake to fill the country with polyphase generating systems, which were primarily to be used for the usual lighting service. It was thought that, with such systems available, the time would soon come when there would be a call for induction motors. In this way experience would be obtained in the construction and operation of polyphase generators, and the operating public would not be unduly handicapped in the use of such generators, compared with the older single-phase types.

An early example of this new practice was in the 2000-kw. polyphase generating units used for lighting the Chicago World's Fair in 1893. Here the single-phase type still persisted, as each generator unit was made up of two similar frames placed side by side, but with their single phase armatures displaced one-half pole pitch from each other so that the combined machine delivered two single-phase currents displaced 90 degrees from each other. It was considered that each circuit could be regulated independently for lighting service, and polyphase motors could be operated from the two circuits. These generators (at that time the largest in this country) were designed in 1892 and were of 60 cycles. These, therefore, indicate the tendency at that time toward lower frequency and polyphase generation, although commercial polyphase motors were not yet on the market.

25 Cycles

At the same time that 60 cycles was selected as a new standard it was recognized that at some future time there would be a place for some much lower frequency, but it was not until two years later that this began to narrow down to any particular frequency. In 1892 the first Niagara electrification, after several years consideration by eminent authorities, had centered on polyphase alternating current as the most desirable system. The engineers of the promoting company had also worked out what they considered the most suitable construction of machine. This involved 5000-hp. units at 250 rev. per min. Prof. George Forbes, one of the engineers of the company, had furnished the electrical designs for a machine with an external rotating field and an internal stationary armature. His design used 8 poles, thus giving 2000 alternations per minute, or 16 2/3 cycles per second. Quite independently of this, the Westinghouse company, in 1892, had been working on the development of synchronous converters, using belted 550-volt d-c. generators with two-phase collector rings added. The tests on these machines had shown the practicability of such conversion and had even proved at this early date that the converter copper losses were much lower than in the corresponding d-c. generators. Thus it is an interesting fact that the first evidence of this important principle was obtained from a shop test rather than by calculation. The writer, from an analysis of the tests, which were made under his immediate direction, concluded that the armature copper losses must be considerably lower than in the same machine used as a d-c. generator. He also brought the matter to the attention of R. D. Mershon, and the problem was then worked out mathematically by him and the writer, in two quite different ways, but with similar results, showing that the converter did have actually very much reduced copper losses.

As a result of this work on the synchronous converter, it was decided that, to make such machines practicable, some suitable relatively low frequency was required. This appeared to be about 30 cycles. About this time the construction of the Niagara generators was taken up with the Westinghouse company to see whether it would construct these machines according to the designs submitted by the promoting company's engineers. These designs were gone over as carefully as the knowledge of such apparatus, at that time, permitted, and many apparent defects and difficulties were pointed out. The manufacturing company then proposed, as a substitute, a 16-pole, 250-rev. per min. machine (the speed being definitely fixed at 250 rev. per min.). This gave 33 1/3 cycles or as near to the proposed 30-cycle system as it was possible to get. Then many arguments were brought forward, pro and con, for the two machines and frequencies. Prof. Forbes' preference for 16 2/3 cycles was based partly on the possibilities it presented for the construction and operation of commutator type motors, just as with direct current circuits. The manufacturing company contended that this frequency was too low for any kind of service except possibly commutator type machines. Tests were made with incandescent lights and it was found that at 33 1/3 cycles there was little or no winking of light, while at 16 2/3 cycles, the winking was extremely bad. Tables were also made up showing the limited number of speed combinations at 16 2/3 cycles for induction motors, in case such should come into use. This showed how superior the 33 1/3 cycles would be as regards such apparatus. It was also brought out that synchronous converters, when such became commercial, would be much better adapted for the higher frequency, as the choice of speeds would be much greater.

As a consequence of all this discussion the suggestion was advanced by some one, that a 12-pole, 250-revolution machine, (that is, 3000 alternations, or 25 cycles), might meet sufficiently the good qualities of both of the proposed frequencies and would thus be a good compromise. In consequence a 12-pole, 25-cycle machine was worked up and eventually this frequency was adopted for the Niagara generators. Afterwards, while these generators were being constructed it was brought out pretty strongly that the great advantage of this frequency would be in connection with synchronous converter operation, but that it was also extremely well adapted for slow-speed engine type generators, which were then coming into use. In consequence of the prominence given this frequency it was soon adopted as a standard low frequency, especially in those plants where synchronous converters were experted to form a prominent part of the system.

However, while 60 and 25 cycles came into use, as described above, it must be recognized that they had competitors. For instance, 66 2/3 cycles (8000 alternations or one-half of 16,000) was used to a considerable extent by one of the manufacturing companies. Also 50 cycles came into use in certain plants and, to a certain extent, is still retained, but has become the standard high frequency of Europe. Instead of 25 cycles, 30 cycles were advocated for some of its plants, largely because with the 25 percent. higher speeds permissible with such frequencies, the capacities of induction motors could be correspondingly increased and also incandescent lighting was more satisfactory. However, it was soon recognized that the 66 2/3 and 30 cycle variations from the two leading frequencies of 60 and 25 cycles were hardly worth while, and they were gradually dropped, except in plants already installed. A brief attempt was made at a somewhat later period to place 40 cycles upon the market as a substitute for both 25 and 60 cycles. This was done under the impression that 40 cycles would give a universal system for arc and incandescent lighting, transmission, induction motors, synchronous converters, and about everything else. This frequency possessed many merits and it was thought, at one time, that it might win out, but apparently the other two frequencies were too well established, and the 40-cycle system eventually lost ground.

The problem of the frequencies finally narrowed down to the two standards, and these two were accepted because it was thought that they covered such entirely different fields of service that neither of them could ever expect to cover the whole. In other words, two standards were required to cover the whole range of service. It was recognized that 25 cycles would not take care of alternating-current arc lighting and that it was questionable for incandescent lighting in general. In other ways, such as suitability for engine-type construction, application to induction motors and synchronous converters and transmission of power to long distances, it met the needs of an ideal system, as then understood. Also, in parallel operation of engine-type alternators, which was one of the serious problems of those days, the 25-cycle machines were unquestionably superior to the 60-cycle ones, due to the lesser displacement of the e.m.f. waves with respect to each other with a given angular variation in the engine speeds. However, although the 25-cycle system presented so many advantages it could not take care of the lighting business, and, therefore, could not entirely dominate the situation.

As regards 60 cycles, it was felt that this could handle the direct lighting situation in a very satisfactory manner and was possibly better suited for transformers than 25 cycles although there were differences of opinion in this matter, especially when it came to the larger capacities. It was reasonably well adapted for induction motors in general, but not for very low speeds. In matters of transmission and in the operation of synchronous converters it was thought to be vitally defective.

From the above consideration it would appear that the 25-cycle systems presented the stronger showing as a whole and, therefore, there was a decided tendency toward this frequency, except in those cases where lighting directly from the alternating-current system was considered of prime importance. In those systems, such as many of the Edison companies, where low-voltage three-wire direct current was used from synchronous converters, the tendency was almost solidly toward the 25-cycle system. In those days the central station, which had gotten itself committeed to the 60-cycle system so deeply that it could not change, was looked upon with commiseration. Sixty-cycle plants were looked upon, to a certain extent, as a necessary evil. In fact, so strong was the tendency toward 25 cycles that in many cases 25-cycle plants were installed for industrial purposes, where 60 cycles would have been better. The 25-cycle synchronous converter development advanced by leaps and bounds and the machines were so good in their operation that it was believed that 60-cycle converters could never be really competitive with them.

On the other hand, in those large plants, which were so "unfortunate" as to have 60 cycles installed, many apparent makeshifts were adopted to meet the various service requirements. In arc lighting, incandescent lighting, transformers and motors there was no need for makeshifts. However, in conversion to direct current, one of the greatest difficulties appeared. There were many who advocated motor-generators for this purpose, largely because the 60-cycle converter was thought to be impracticable, in spite of the fact that the manufacturing companies were putting them on the market. The 60-cycle converter at that time bore a bad name. It is now recognized that many of the faults of the early 60-cycle synchronous converter operation were not in the converters themselves, but were, to a considerable extent, in the associated apparatus. Low-speed engine-type, 60-cycle generators were not always adapted for operation of synchronous converters. In fact, in numerous cases such generators would not operate in an entirely satisfactory manner in parallel with each other, and yet when it was attempted to operate synchronous converters from these same generators the unsatisfactory results were not blamed upon the generating system but upon defects of the converters themselves. Unfortunately, defects in the generating and transmission systems usually appeared in the converters as sparking and flashing, and such troubles naturally would be credited to defects in the construction of the converters themselves. In fact, in those days, 60-cycle converters were expected to do things which now are considered as absurd. For instance, in one case in the writer's knowledge a 60-cycle synchronous converter was criticized as being a very badly designed piece of apparatus, due to serious flashing at times. Investigation developed that this converter was expected to operate on either one of two independent 60-cycle systems with no rigid frequency relation to each other. The converter in service was thrown from one system to the other indiscriminately, and sometimes it flashed in the transfer and sometimes it did not. The machine was considered to be "no good" because it would not always stand such switching.

At one time the writer stood almost alone in his belief that the 60-cycle synchronous converter presented commercial possibilities sufficient to make it a strong future contender with the 25-cycle machine, provided proper supply conditions were furnished and certain difficulties in the proportions of the converter itself were overcome. One basis for his contention was that in some of the 60-cycle plants, where the generator rotation was quite uniform, the converters were evidently much superior in their operation to other plants, using slow-speed engine-type generators with considerable periodic variations. In such plants the hunting tendency of the converters was very greatly reduced, with consequent improvement in sparking and general operation. It was early recognized that hunting was a very harmful condition, both in 60- and 25-cycle synchronous converters, but whereas it was a relatively rare condition in 25-cycle plants it was much more common with 60 cycles. However, the operating public was not particularly concerned whether the trouble was in the generating plant or in the converters themselves, as long as such trouble existed and was not overcome. Very early in the synchronous converter development it was found that hunting would produce sparking or flashing at the commutators of the converters. However, even in those plants where there was no hunting apparent, there was difficulty at times due to flashing, especially with suddent change of load, which resulted in temporary increase in the d-c. voltage. This was a difficulty which was inherent in the converter itself and could not be blamed entirely upon the generating or transmitting conditions, for 25-cycle machines were practically free from this trouble under similar conditions of operation. Investigation developed the fact that this flashing trouble was due largely to unduly high value of the maximum volts between commutator bars. This difficulty was recognized long before it was overcome, simply because certain physical limitations in construction had to be removed. There were two ways in which the maximum volts per bar could be reduced, namely, by increasing the number of commutator bars per pole and by decreasing the ratio of the maximum volts to the average volts per bar, that is, by increasing the ratio of the pole width to the pole pitch, but both of these involved structural limitations in the allowable peripheral speeds of the commutator and the armature core. Here is where a little elementary mathematics comes in. The peripheral speed of the commutator is directly proportional to the distance between adjacent neutral points on the commutator, and the frequency. Therefore, with a given frequency the distance between the adjacent neutral points is directly proportional to the peripheral speed. Thus, a commutator speed of 4500 ft. per min. which was then considered an upper limit, the distance between adjacent neutral points on a 60-cycle converter is only 7½ in. This distance is thus fixed mathematically and is independent of the number of poles or revolutions per minute, or anything else, except the peripheral speed and the frequency. With this distance of 7½ in., about the only choice in commutator bars per pole was 36, giving an average of 16 2/3 volts per bar on a 600-volt machine, and nearly 20 volts per bar with momentary increase of voltage to 700, which is not uncommon in railway service.

(To be continued)

VIA THE SHEARS AND PASTE-POT ROUTE

Items of Interest Gleaned From Various Sources

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 Little Journal, a house organ issued by Arthur D. Little, Inc., of Cambridge, Mass., came into being last month. It gives promise of an interesting and useful future. The first five items printed below are clipped from it.

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The man with the chemical eye finds things of interest where the man who lacks it can't see anything.

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Do not mistake activity for progress. If Paul Revere had ridden a rocking horse he would not have arrived.

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Once upon a time there was a farmer whose wife daily pumped the household supply of water up to a tank on the roof. After 20 years he installed an electric motor to do this for her. Careful calculation brought out the fact that the wife had been working that pump handle 3,650 hours at a value of half a cent per hour. She had saved him $18.75 in 20 years. What was it The Preacher said about her worth being above rubies?

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The Audubon Society says that the value of gulls as scavengers is shown in the fact that thousands of them are reported to have worked all last winter for the health authorities of Green Bay, Wisconsin, disposing of the waste from fisheries at the rate of a wagonload in three minutes. Just a little industrial research would have shown the authorities of Green Bay, Wis., how to turn that fish waste into oil, glue, and fertilizer instead of into gulls.

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Nowadays the first step in making steel is, *to boil iron*. In the Bessemer converters hot air is blown through; in the open-hearth process the iron is boiled in big shallow pans by burning gas. In crucibles it is also boiled in smaller units. In most electric furnaces it is the heat of the electric arc that boils it. Electric furnaces are much greater in size than crucibles, those of twenty tons and more being in general use. It is, we might say, the wholesale way of making very high grade steel as against the retail way in the old crucible process. The production of electric steel is increasing by leaps and bounds. A leading English authority, J. O. Boring, says in *Iron and Coal Trades Review* that "There is no carbon steel or alloy steel and no kind of casting whether heavy or small, that cannot be made better and more profitably in an electric furnace than by older methods.

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The January issue of the *Public Service* magazine reports that in 1917, 462 applications for increased utility rates were made to various local and state commissions. Of these 401 applications were favorably acted upon, or more than 86 percent. This means that local and state commissions have become convinced that utilities in general are entitled to larger rates of return in order to afford adequate public service.

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According to *Central Station*, nearly 20 percent. of the accidents occurring to groundmen are due to being struck by falling bodies. This shows plainly greater care on the part of the linemen is necessary to prevent this class of accident. Tools should never be thrown up to linemen on poles nor should linemen drop tools when through with them. A canvass tool bag, securely fastened to the end of the hand-line, should in all cases be used in raising and lowering tools and materials. Never tie a tool to a handline. Care should also be taken by the groundmen to keep from under the lineman who is working on a pole.

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In an article proposing that public utilities be made preferred investment because a community necessity, ***Manufacturers' News*** says that the public utilities, such as gas, electric light, street railways and water systems, are the lifeblood of the nation. Without them business would be at a standstill in the larger cities. They are important in the conduct of the war, vitally important. The utility owners in many states have gone before their public service bodies and asked for increased rates. In few cases have the requests been declined.

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The high price of gasoline—it is now costing more than $1 an imperial gallon—and the multiplying of electrical supply stations are said to be creating a new demand for electric vehicles for both pleasure and commercial purposes in the United Kingdom. It is not supposed that such demand can be met by British manufacturers, so long as their energies are being devoted to supplying government needs, but after the close of the war there will in all probability be a marked development along this line, since to maintain and operate certain electric vehicles will be more economical. There is much less noise while running on the road and there will be standardization of construction. It is thought that through standardization it will be possible to construct a two-seated runabout complete for less than $500 and a half-ton trademan's van for about $750.—*Commerce Reports*.

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The sales force of a Seattle electric light company was recently sent out to interview power consumers using over 50 hp. and secure other co-operation in smoothing out a critical peak in the power load. This peak was a daily rise in the power load for about one month in the latter part of the year, recurring annually. It had become the governing factor in determining capacities of the company's power stations. This year the problem promised to be unusually acute by reason of new industries devoted to war purposes which had been added to the load. The critical interval was between 4.30 and 7 p. m. each day. Out of the first 266 consumers visited by the salesmen, says the *Electrical World*, only two were unable to co-operate by shifting their power requirements during those hours. Some of them did this by earlier closing, 24 concerns taking 2,600 kilowatts off the peak. Street-car requirements were reduced by arrangements with factories and stores whereby employees were dismissed in sections at intervals. In some cases, detailed study of a given concern's current consumption showed that it was more desirable to furnish energy for operation of plant during the peak period than to close down and release employees as energy requirements for street cars to carry the latter home added more to the peak than was saved by closing the factory. This campaign resulted in marked economies, but called for most intelligent interpretation of industrial current consumption and close teamwork by the sales force.

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Taking to task the methods employed in technical schools, the editor of the *Journal of Electricity* says: "Total neglect of public speaking for engineering students is a most serious handicap in after life. Witness for instance the awful stillness that follows some of our engineering speeches, and the unfavorable impression created, although the speaker may be a man of significant engineering attainment. Furthermore, written expression receives little attention in the engineering curricula and as for encouragement in technical writing, only a few students ever feel its invigorating influence".

We say amen to these comments, but are reminded that once upon a time we found a well-known engineer a veritable fountain of fluency and force when we broached to him the subject of a raise of salary.

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It was about 1908 that tungsten filament lamps were first used for street lighting says the General Electric *Review*, and the growth since that time has been rapid. In 1911, the tungsten filament or mazda lamps as they are now called were available in sizes up to 350 c.p., while in 1916 lamps of 1000 c.p. were in common use, and to-day 1500 c.p. lamps are being used in some places.

So long as incandescent lamps were not available in large candle-power sizes, the arc lamp had no series competitor for street lighting. With the advent of the large mazda series lamps, however, conditions were changed, and to-day units suitable for all classes of street lighting are available in both arc and incandescent lamps. The selection is usually governed by local conditions.

Probably the greatest advance in street lighting accessories was the development of the Holophane prismatic refractor which gives a control of light distribution hitherto unattainable. It can be used on either arc or mazda lamps, its use being made possible by the fact that with the magnetite arc lamp the arc does not travel down as it does on the open and enclosed carbon arcs, and with mazda lamps the filaments have been concentrated into a much smaller space than on the older incandescent lamps.

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Van H. Manning, Director of the Bureau of Mines, Department of the Interior says that the householder must realize that when he throws a shovelful of anthracite coal into his furnace its value is equivalent to half a pound of sugar, or half a loaf of bread, or a pint of milk. He must appreciate that it is worth while to examine his house and to overhaul his heating equipment. Weather strips, double windows, pipe covering, clean flues and chimneys, and tight fittings in ash-pit, doors, dampers and furnace parts will all pay. Damper control is one of the chief secrets of economical heating. Clean surfaces are most essential, *as soot is a poorer conductor of heat than asbestos*. Care, attention, and taking pains will be the greatest factors in saving domestic coal.

On the subject of the fireman he adds that the fireman is, however, the biggest single factor to be considered in a campaign to secure the largest saving of coal. Many manufacturers have made a serious mistake in failing to consider the fireman as a skilled worker. Too often he is treated as a roustabout. He is not well instructed, nor given proper labor-saving devices. As coal increases in price, or becomes difficult to get, the fireman handles more and more of his employer's money. His efficiency means more in dollars and cents. This is an encouraging feature in the situation. It means a better recognition of the importance of the fireman, more efficient work on his part, and a consequent increased saving of coal. The viewpoint is changing. It is no longer cheaper to pay for the coal than to educate the fireman.

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According to one of the statisticians in the Society for Electrical Development, 100 of the leading electrical manufacturers sold during the year just closed the following list of energy consuming electrical devices:

5 firms sold	782	dish washers
6 firms sold	122,499	grills
9 firms sold	69,320	heating pads
4 firms sold	6,478	tea pots
10 firms sold	82,127	heaters
5 firms sold	5,404	radiators
24 firms sold	3,202,339	irons
1 firm sold	28,000	ironing machines
40 firms sold	241,667	washing machines
31 firms sold	673,103	vacuum cleaners
12 firms sold	1,880,114	fans
7 firms sold	114,390	percolators
7 firms sold	30,280	chafing dishes
11 firms sold	239,668	disk stoves
11 firms sold	16,040	ranges
1 firm sold	22,000	vibrators
4 firms sold	27,676	water heaters
2 firms sold	1,300	griddles
2 firms sold	535	miscellaneous
100 firms sold	7,194,792	Total.

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According to the Stone & Webster *Journal*, the man who saves, instead of spending money on his own enjoyment, hands it over to some company or Government to be spent on some industrial or national purpose. When it is put into industry it builds a factory or ship or a railway or a canal, or clears a wilderness for cultivation, or does one of the innumerable other things which are necessary for the production and transport of the goods which mankind enjoys. And it is only by this process of handling over buying power, instead of using it for our own amusement and enjoyment, to others who will use it for furthering production that the tools and equipment of industry can be multiplied. Something can be done by banks and financiers in supplying credit in the form of advances and acceptances; but this method is only like oiling the wheels of industry, the real driving power of which has to be saved capital. Creating credits simply means that a certain amount of buying power is manufactured and handed over to those to whom the credit is given. It does not set free any labor or goods to be put into industry. That is only done by the man who abstains from consumption and saves money by restraining his desire to spend it on himself, and puts it at the disposal of industry. The man who saves money, who has always hitherto been rather despised by his companions and resented by a certain class of social reformer and many other uneducated people as a capitalist bloodsucker, is thus, in fact, the person who leaves the world richer than he found it, having put his money, the product of his own work, into increasing the world's output, instead of spending it on such forms of enjoyment as heavy lunches and cinema shows.

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The ordinary small lighting plant requires from 4 to 15 lb. of coal to produce one kilowatt-hour of electrical energy. Plants equipped with large turbine-generators sometimes show a consumption of as low as 1 lb. of coal per kilowatt-hour.

RECENT PROGRESS IN TELEPHONY

Not so long ago, well within the memory of the oldest inhabitant as the saying goes, those who felt they could not afford a one-party telephone line and therefore rented a two- three- or four-party line were often in doubt whether central was calling them or Jones or Smith or Brown. They had to count the number of rings. This feature of telephone service had its drawbacks, particularly after bedtime on cold winter nights. The insistent demand for a better method of calling subscribers on party lines set the telephone engineers to work to develop what is known as the "harmonic selective ringing system." They developed it, using up a lot of gray matter in bringing it to a satisfactory fruition. This system, now in general use, connotes their wonderful ingenuity. Ray H. Manson, chief engineer of the Stromberg-Carlson Telephone Mfg. Co., tells about it in this article. He also tells about other telephone service improvements, such as the automatic ringing circuit, the flashing recall circuit, the automatic listening circuit, the harmonic ringing converter and harmonic ringing dynamo, and improvements in speech transmission. The paper was presented at a recent meeting of the Rochester Section of American Institute of Electrical Engineers.

Telephony, like the other branches of the electrical art, has made notable progress during recent years. Improvements in the transmitting of articulate speech over greater distances and in the switching methods employed for interconnecting of telephone users' line circuits, are worthy of note.

In an attempt to improve the circuit switching equipment two distinct schools have been created, each backing a different system of operating. These systems can be designated as follows:

(a) The centrally-operated system.
(b) The subscriber-operated system.

The term, "centrally-operated," applies to a system in which all of the labor of interconnecting of the telephone users' lines is done by human agency in the form of telephone operators at the central office. Because the final connecting of the lines at the central office portion of this system is done by hand method, the complete plant is popularly known as the "manual telephone system."

On the other hand, the term "subscriber-operated" designates a system in which purely machine methods are used at the central office for the interconnecting of the telephone users' lines. The human intelligence in this case is supplied by the telephone user (subscriber) who manually operates a mechanically-governed circuit-interrupting device a number of times, so as to produce the circuit switching changes in the central office. Because the central office portion of this system is made up mainly of mechanical switching mechanism, the complete plant is known as the "automatic telephone system."

The mechanism of both the centrally-operated and the subscriber-operated systems have been reduced to a fairly high state of perfection. This paper, however, has to do only with the centrally-operated system and in particular with reference to a few examples which will indicate the trend of improvements now advocated and furnished in some modern telephone plants.

The centrally-operated system is built around one principle, that of removing from the telephone user all of the labor of making the electrical connections to the desired telephone line, and the labor of calling the desired subscriber to the distant telephone, leaving this work to a few skilled operators located in the central office.

It is obvious that any device or circuit arrangement which will cut down the amount of work required by the operator in the establishing of a circuit connection between two subscribers will serve to improve the service as well as to reduce the total number of operators required for a given number of telephone lines.

Special service features provided by the so-called automatic listening, automatic ringing and flashing recall, can be given as examples of such improvements in modern centrally-operated exchanges.

In the establishing of a connection between two subscribers' lines, a linking circuit is employed in which the operator's listening, ringing and disconnecting equipment is provided. The linking circuit is known in the telephone field as a subscriber's cord circuit. It terminates at both ends in plugs which are designed to make contact with the jacks that are used as terminals of the subscribers' lines.

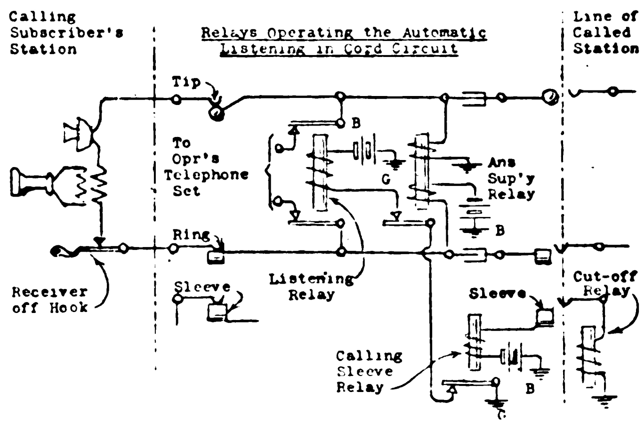


Fig. 1—Simplified automatic listening circuit.

Each plug and each jack has terminals for three conductors, so that when a plug is inserted in a jack a complete circuit connection is made through two wires for talking purposes as well as through a third wire for local switching purposes.

Automatic Listening Circuit

When an operator plugs into a line to answer a calling signal, it has been customary to connect her telephone set by means of a hand-operated key and manually to restore this key, so as to disconnect her telephone set, after the cord circuit is plugged into the desired subscriber's line.

In the automatic listening circuit shown in Fig. 1, this hand operation is done away with by providing a contact on the answering supervisory relay of each cord circuit, which will close when the answering plug of the particular cord is inserted in the jack of the line upon which a call is being made.

The closing of this contact establishes a circuit for battery current through the winding of the listening relay and the back contact of the calling sleeve relay, which latter at this stage of the connection is in its normal position as shown. The listening relay thus is operated and connects the operator's telephone set directly to the tip and ring side of the talking circuit.

Now when the operator inserts the calling plug of this particular cord circuit into the jack of the desired line the contacting of the sleeve of the plug with the sleeve spring of the line jack will establish a circuit for the central battery through the calling sleeve relay and the cut-off of the line. Both of these relays are energized and through the opening of the back contact of the calling sleeve relay the battery circuit for the listening relay is opened so that the latter restores to normal. Thus the operator's telephone set is automatically disconnected from the talking circuit of the connected lines.

In practice, an automatic listening circuit contains other elements for safeguarding its operation and for making it more flexible so as to meet all special telephone service requirements.

This automatic listening circuit, as shown in Fig 1, will give "secret service" so far as the operator is concerned, as no means is provided for the operator to cut-in on an established connection between two subscribers. This secret service may be considered a desirable feature on small exchanges, but reduces the flexibility of the switchboard operation to such an extent that on large systems emergency listening keys usually are provided.

These keys are employed only in the handling of such calls as would otherwise interfere with the regular operation of the switchboard. In this case the secrecy of the service is guarded by the use of large pilot signals. These light when an emergency ringing key is operated and call the attention of supervising operators or others to this fact.

Automatic Ringing Circuit

The so-called automatic ringing of subscribers' telephones is a serviceable feature which benefits both the subscriber and the operator. In the case of a subscriber making a call, the continuous intermittent ringing of the bell of the desired subscriber by machine methods calls for an immediate response. With the old hand method of ringing, the desired subscriber often failed to heed or to hear the one or two rings first made by the operator, requiring that the calling subscriber request the operator to ring again.

In the case of the operator, the automatic ringing avoids the necessity of so closely monitoring each connection, as once the ringing key is set to call the desired subscriber, the operator's work in the establishing of a connection is complete.

The fundamental elements employed in one form of automatic ringing are shown in Fig. 2. This sketch illustrates the condition of the circuit when the operator has plugged into the jack of the desired subscribers' line. Now the pressing of the ringing key establishes a circuit from the main exchange battery through a resistance coil, H, and the energizing winding of the ringing relay, through the key to the ground side of battery.

This operates all three contact springs in the ringing relay, one of these springs closing a contact at K so as to retain the battery circuit through the winding of the ringing relay when the pressure on the ringing key is removed and the contact of the latter is opened. In other words, the ringing relay then is locked in its ringing position.

This allows ringing current to be intermittently connected to the cord circuit through an interrupter, the ringing current first passing through a non-inductive resistance, M, and winding of the tripping relay in multiple, thence through the telephone ringer and condenser and back through the tip side of line to the main exchange battery or to the ground of the ringing generator.

The tripping relay is provided with a copper sheath over the core, so as to act as a low-resistance short-circuit turn of wire and thereby reduce the impedance of this winding to such a point that considerable ringing current can go through the tripping relay winding without completely pulling up the relay armature.

The battery connection to the tip side of line is interrupted in the called subscriber's station by the presence of the condenser which is in series with the ringer. However, when the called subscriber removes the receiver from the hook, a path for this direct battery current is provided through the talking circuit of the telephone, the hook switch contact, the ring of the line, the tripping relay winding and the resistance, M, in parallel to the ground on the interrupter or to the ground on the ringing generator.

Under this condition, the battery current positively operates the tripping relay. This actuation of the tripping relay shunts the battery current to ground and away from the winding of the ringing relay so that the latter is restored, stopping the ringing.

A special feature of this circuit is the absence of marginal adjustments in the tripping relay. Any tendency of this relay to vibrate in unison with the frequency of the ringing current does not shunt the ringing relay battery current, as the release-time-element of the ringing relay is longer than the longest frequency period of the low frequency ringing current.

When, however, battery current flows through the line circuit, due to the removing of the receiver from the hook switch, then the direct current alone, or the superimposed direct current alone, or the superimposed direct current on the alternating ringing current, causes the tripping relay armature to be retained in its operated position, so as to give positive action.

This feature allows the tripping relay to have a sensitive adjustment so as to act positively when the receiver is removed from the hook of a telephone located on the end of a long high resistance line. This relay, with the same adjustment, will not operate with the heavy ringing current which is used to ring a full equipment of bridged party line bells on a short low resistance telephone line, to operatively release the ringing relay.

This automatic ringing circuit, Fig. 2, when in its complete form, includes safeguards which will terminate the ringing if

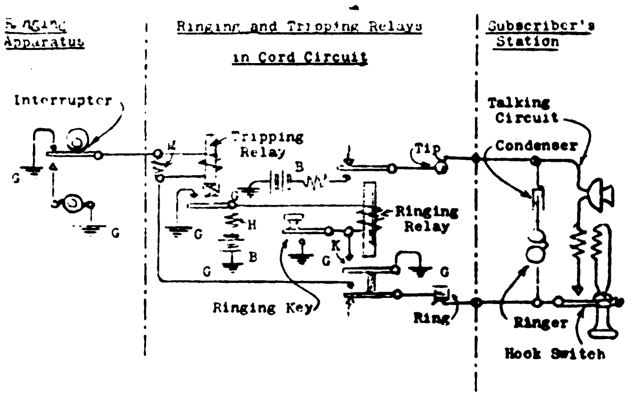


Fig. 2—Simplified automatic ringing circuit.

the calling party abandons the connection before the called party responds, so that when the called party has responded and is on the line, it is impossible for the operator to actuate the ringing relay and ring the subscriber in the ear.

Flashing Recall Circuit

Many schemes have been devised for insuring prompt attention from the operator when a subscriber desires to make a call to a second party, immediately after finishing a conversation with a first party. Under ordinary conditions the hanging-up of a telephone receiver after finishing a conversation, causes a supervisory lamp in the connecting cord circuit to become steadily lighted and serves as a signal to the operator that the conversation has been completed and that the cord circuit can be used for other service.

This working of the hook switch up and down by hand so as to flash this supervisory lamp, has been the customary means employed for obtaining the operator's attention for another call.

This hand flashing of the signal does not prove completely satisfactory, for the subscriber usually fails to realize that the lamp does not flash distinctively unless the hook is worked slowly; also that the flashing has to be continued for an appreciable length of time to secure the operator's attention, which attention may be directed to other work during a brief flashing period. Then when the operator is free to direct her attention to the signal, this lamp will be lighted steadily, which is not a signal for a recall but for an ordinary disconnect.

To overcome this difficulty, an automatic flashing recall has been provided as shown in the circuit, Fig. 3. Under normal conditions the hanging of the receiver on the hook switch lever after conversation has been completed allows the answering supervisory relay to be deenergized and to close a

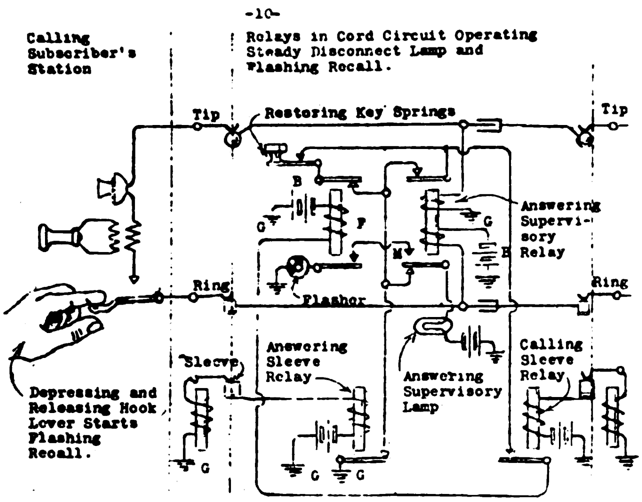


Fig. 3—Simplified flashing recall system.

circuit from the central office battery through the answering supervisory lamp, back to the ground side of battery through a contact on the answering sleeve relay. This latter relay is in its energized position, due to the answering plug still being inserted in the jack of the calling line, as shown in the diagram.

A steady light from the answering supervisory lamp and another steady light from the calling supervisory lamp (not shown in the diagram) indicates to the operator that the cord circuit is no longer required in this particular connection and is available for other service.

However, if the calling party desires to immediately get the attention of the operator for the establishment of a connection to another telephone line, then depressing the hook lever once is sufficient to substitute for the steady battery supply for the answering supervisory lamp, an interrupted battery supply, giving a flashing signal until the operator responds.

This is brought about by the energizing of the flashing relay, F, through a circuit from the central office battery through the winding of this relay, F, a closed contact of the calling sleeve relay, the upper closed contact of the answering supervisory relay and the upper closed contact of the flashing relay F in multiple, thence through the closed contact of the answering sleeve relay to the ground side of battery.

The reason for providing a second circuit through the upper contact of flashing relay F in multiple with the contact on the answering supervisory relay, is that when the latter is again energized (due to raising of the hook switch), a locking circuit will exist for maintaining the flashing relay F in its operated condition.

If pressure is removed from the hook switch at the calling telephone, its contact is again made and the answering supervisory relay again energized. This reestablishes battery circuit for the answering supervisory lamp through a new path which includes the contact, M, and the lower closed contact of the relay, F, through the flashing interrupter and thence to the ground side of battery. Thus the answering supervisory lamp is caused to flash continuously until the operator responds and restores the circuit to normal by means of the restoring key springs which form a part of the operator's emergency listening key.

Selective Party Line Ringing

The ideal telephone system is one having only one subscriber's telephone on each of the line circuits extending to the central office switchboard, so as to reserve the one circuit for the exclusive use of the one subscriber without the possibility of interference. There are several reasons, however, why it is not desirable to give each subscriber in the exchange such exclusive service. Some of these reasons are:

(a) The providing of a less expensive service for such telephone subscribers as cannot afford the individual line service.

(b) The serving of a greater number of subscribers on a given size of line and switchboard equipment.

(c) The cutting down of the number of line terminals appearing before each operator so as to facilitate the handling of the switchboard equipment.

(d) The providing of emergency capacity for the serving of additional telephone subscribers when the ultimate capacity of the line and switchboard equipment has been used and when additional line circuit material or central office apparatus is not immediately available.

It has been found from experience that a maximum of four subscribers can be served to advantage on one line circuit, when a non-interfering method of selectively ringing the subscribers' bells is provided. Of course, some of the lines can be limited to only two subscribers so as to reduce the chance for interference between the telephone users on each of such lines and thereby provide a service of a higher class than the four-party line. In this case the equipment would be the same, the only difference being that the telephone company limits the number of instruments on a line to a total of two for two-party line service.

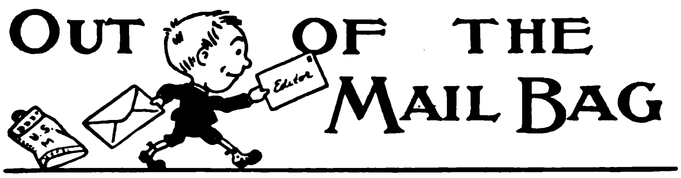
There are other limitations in the providing of a successful selective ringing system, such as the avoiding of ground returns for the ringing current and the avoiding of complicated mechanism in the substation instrument, which would increase the first cost as well as the maintenance cost of the telephone.

Harmonic Selective Ringing System

A selective party line system which meets all of these demands is known as the harmonic and now is extensively used throughout this country.

This system depends for its operation upon alternating currents of different frequencies. The ringers in the telephone are bridged directly across the line wires with the customary condenser in series to prevent the flow of central office battery when these instruments are used on the modern central energy systems. The armatures of these ringers are weighed or controlled in such a manner as to respond only to alternating currents of certain frequencies, this being accomplished as follows:

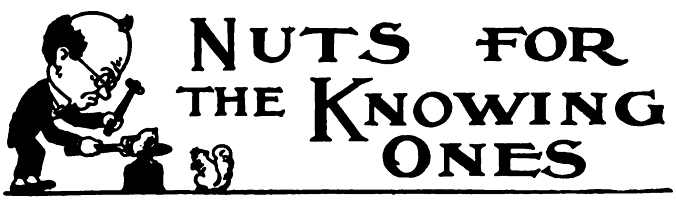
(To be continued)



OUT OF THE MAIL BAG

FROM OUR CONTRIBUTING EDITORS

A letter received from the United States Fuel Administration says in part: "An investigation convinces us that electric railways offer a chance for large savings, particularly through reductions in schedules. We are not suggesting changes in railway schedules which will seriously inconvenience the public, but it is well known that the pressure of private interests has in many instances led the electric railways to provide service which represents a wastage. In addition, our attention has been called to a number of other opportunities for economy of electric railway companies. One has to do with heating of cars. It has been stated that heating represents nearly 30 percent. of the electricity used. May it not be possible to make a substantial saving?"



NUTS FOR THE KNOWING ONES

QUERIES AND ANSWERS IN TECHNICS

We have one light upstairs and one light downstairs to be controlled by one switch upstairs and one switch downstairs. We want the switches to control the lights, upstair light on by itself, then off, and downstair light on, then off, and both on, then both off, the lights to be controlled the same way from both switches.

Can it be done, and if so, what kind of switches can be used? And of course the lights are to be turned by the upstair's switch, and turned off from the downstair's switch, or vise versa. W. J. Cameron, Daytona, Fla.

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What is tungsten? When was it discovered, and what are its characteristics? F. W. Cleary, Covington, Ky.

Tungsten is a metal, discovered in 1781, and is one of the natural elements. It is one of the heaviest metals known (specific gravity 19.12), being heavier than lead or about the same as gold. In fact, the word "tungsten" is derived from the Swedish "tung" (heavy) and "sten" (stone). The chemical symbol for tungsten is "W," (wolfram). Tungsten has certain properties that make it an ideal lamp filament. It has a high fusing point, 300 deg. C., and it has a low vapor tension (tendency to vaporize). This allows the operation of tungsten filaments at about 2150 deg. C., for say a 25-watt mazda B lamp, and about 2400 deg. C., for say a 400-watt mazda C lamp.

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I am told that the Bureau of Mines at Washington has approved several makes of portable electric mine lamps. Can you tell me what lamps have been approved, and when?

S. M. Romer, Albany, N. Y.

When small electric bulbs, with their clear, white light, and small electric storage batteries became available, the advantage of combining these elements for a miner's lamp seemed manifest. The combination looked simple and safe, but was soon found to have elements of danger and weakness peculiar to itself. The Bureau of Mines then undertook the task of finding out what lamps were serviceable for this exacting service. Seven portable electric mine lamps had been approved prior to August, 1916, as follows: Edison lamp, approved February 24, 1915; Manlite lamp, approved July 16, 1915; Concordia hand lamp, approved July 26, 1915; Wico lamp, approved June 10, 1916; Concordia cap lamp, approved June 17, 1916; General Electric lamp, approved July 11, 1916; Pioneer lamp, approved July 21, 1916. Each of these lamps is identified by a plate that bears the seal of the Bureau of Mines, the approved statement, and the number of the approval. No lamp is considered as approved unless it bears this plate.

The bureau grants its approval as an indication of its confidence in the excellence of the lamp as a safe and practical device for lighting mines, especially those mines in which there may be inflammable or explosive mixtures of gas and air. The approval is conferred only after thorough examination and tests have shown that the lamp reaches the standard established by the bureau.

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What are the relative proportions of energy in the United States derived from coal and water power? How much water power is going to waste? R. A. Taylor, Lansing, Mich.

In the United States to-day we are developing about 40,000,000 horsepower from steam and about 6,000,000 from running water. We are mining more than 400,000,000 tons of soft coal annually, to make steam, while the unharnessed water, merely running down hill, represents a possible horsepower of 30,000,000. That is to say, every twenty-four hours the potential but wasted waterpower in America is equivalent to 1,000,000 tons of coal daily going to waste!

Electrical ODDS AND ENDS

BRIEF TIDINGS FOR THE BUSY MAN

About 67 percent. of the total fuel mined each year is consumed by 250,000 steam-producing plants, while only 15 percent. is consumed by 20,000,000 domestic users.

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There has been such substantial industrial development in Salina, Kan., recently, that the demand for power has increased to an extent which will result in the doubling of the capacity of the present plant. It is expected that the needed changes can be made within the next few months.

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Vocational training, says Charles P. Steinmetz, chief electrician of the General Electric Co., is the most important industrial problem in this country. The superiority of America in the electrical industry over all other countries is due largely to educational development and co-operation between the manufacturing companies and educational institutions.

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An alternating current transformer consists essentially of three parts—a laminated iron core, a primary winding and a secondary winding. The alternating magnetic flux set up by the primary current induces an alternating current in the secondary winding, the ratio between the primary and secondary voltages being the same as that of the number of turns on the primary and secondary windings. The principal types of transformers are: shell type, with rectangular coils; circular shell type, and core type. In shell type transformers, the iron is built up outside the coils, forming a shell around them. In the core type transformer, the iron is built up into a suitable number of links, over which the coils are slipped, the links being connected at the ends by yolks. The type of transformer, whilst having little effect on the efficiency, is often important in view of other considerations.

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A motorman operating an electric street car is held negligent in the Main case of Foster v. Cumberland County Power & Light Co. L.R.A.1917E, 1044, in failing to reduce his speed to the lowest possible rate or stop when he is blinded by the light of an approaching automobile so that he can see nothing ahead of him.

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Theoretically, the best transformer efficiency occurs when the iron losses are equal to the copper losses. With a lighting load, in use for but a few hours per day, the iron losses are, however, of greater importance, while with a power load the iron losses may be small compared with the copper losses. The nature of the load will accordingly govern the relation of the iron to the copper losses.

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The Coal Economy Commission of Great Britain has in mind the complete electrification of England. It is proposed to consolidate all the electrical establishments of the United Kingdom and create six large central power stations. If carried through, this plan would save the United Kingdom half a billion dollars in coal annually and put an end to London smoke-fogs.

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Some of the Boston hotels have purchased the telephone booths installed by the New England Tel. & Tel. Co., and are charging 10 cents a call where the published rate of the telephone company is but 5 cents. The hotels contend they are not in the telephone business and are not subject to the jurisdiction of the Massachusetts commission. This is a case that will be watched with interest by the telephone companies of every state.

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Engineers who incline to be literary will please observe that in the English language, the language we are supposed to speak and write, there is no such word as "insofar." If there were such a word we should be puzzled how to define it, and then how to pronounce it. As things are now we don't have to do either, for fortunately all engineer-author attempts to force this hybrid into the language have failed. It persists in manuscripts though, and occasionally finds its way into print, where it means nothing for the simple reason that it has no meaning.

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The secretary of the Electrical League of Cleveland, Ohio, has received the following letter from a League member now training with the 114th Engineers at Camp Beauregard, La.:

"I am located here on temporary duty, and expect to be assigned elsewhere soon.

"The enlisted man's idea or opinion of the officers is given here as follows:

"The first sergeant knows everything and does everything.

"The lieutenants know nothing, but have to do everything.

"The captain knows everything and does nothing.

"The major knows nothing, and does nothing."

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The largest electric postal fleet in this country is probably that of the New York Postal Service, which operates 47 electrics. These trucks have been in service for 3 years, and are on duty for two 10-hour periods each day. The dependable, simply operated electric truck has been found almost indispensable in this service, which requires the speedy and safe negotiation of congested traffic. The postal service in Boston uses 15 electric trucks, which are operated on the "battery-service" plan. These electrics make runs of 25 miles each day, and have made substantial savings as well as greater efficiency in handling the mail.

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ELECTRIC STEEL FURNACES

Outside of the steel trade, said Norman T. Wilcox, sales manager of the Mississippi River Power Co., at a meeting of the Western Society of Engineers, few people appreciate the rapid growth in the use of electric furnaces for the production of the highest grades of steel and steel castings.

This growth has resulted from the efficiency of electric power and has for the most part occurred within the last five years, the greater portion of the increase occurring in the last year or two.

Up to March 1, 1917, at least 158 steel making electric furnaces had been contracted for or were at that time in actual commercial service in the United States. These furnaces if operated twenty-four hours a day, six days in a week, would have a total capacity of 1,000,000 tons of steel per annum.

Ten years ago, or less, there were but a few tons of electric steel produced in this country. The production of a million tons of steel made from cold scrap would represent at least 600,000,000 kilowatt hours per annum. A large portion of this energy should be supplied from public utilities, and should contribute its part in widening the use of public service investments, with consequent benefits to the communities served.

Because of its uniformity greater freedom from segregation and its greater homegeneity, *electric* steel is somewhat higher in tensile strength and elastic limit than steel made by other processes. Owing to its greater density the electric steel shows a marked resistance to fatigue.

No doubt the discovery that the best quality crucible steel can be made in the electric furnace, and the further fact that crucibles have become almost prohibitive in price, has contributed greatly to a rapid realization of the great practical value of the electric furnace.

Small furnaces have been developed even in the multi-phase type down to capacities as low as one-half ton of metal per heat. A furnace of this size will require from 100 to 125 kilowatts of capacity and when operated multi-phase will run on a power factor of approximately 90 percent. The larger furnaces as now installed, for most efficient operation require approximately 250 kilowatts of capacity per ton of metal per heat.

In order to obtain the desirable rapid melting down, the transformer connections are now arranged for more than one voltage and furnaces so arranged that after extra heat is absorbed by the cold metal the voltage may be reduced and the furnace refractories saved from undue wear. This is important.

As many, if not most, of the small steel furnaces, as well as some of the larger ones, can be so operated as to keep off the peak, the furnace load is an attractive one.

Electric furnaces cannot be expected to take the place of the ordinary cupola, such as is used for the making of common grades of cast iron. However, we should not lose sight of the fact that the electric furnace is the only apparatus which will successfully produce all grades of material from and in the same furnace. These products range from superior quality cast and malleable iron to the finest grades of crucible and tool steels.

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The conditions under which the periodical and newspaper postage increase was jammed into the War Revenue Act when the Senate after full investigation and discussion had rejected it, and the House forced through passage after refusing hearings and discussion, mark it as a deplorable abuse of legislative power.

THE TRADE IN PRINT

What The Industry is Doing in a Literary Way

George Cutter Company, South Bend, Ind., is distributing copies of its new bulletin No. 3337 on Sol-Lux industrial lighting reflectors and fixtures.

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Stow Mfg. Co., of Binghamton, N. Y., is distributing a 20-page illustrated booklet covering portable tools. Prompt shipment of these tools is assured prospective buyers.

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Robbins & Myers Electric Fans are pictured and described in a small pocket catalogue of 35 pages just issued by The Robbins & Myers Co., offices at Springfield, Ohio. It is dated January 1, 1918, and is known as Catalogue No. 1117.

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Electric Welding is the title given to Catalogue No. 2 just issued by The Wilson Welder & Metals Co., Inc., New York. It contains pictures of the different types of welding apparatus made by this concern, wiring diagrams showing how welding apparatus is connected up, directions for operating welding apparatus, data on welding different kinds of metals, also tables of weights and measures, and wiring calculations. It is bound in stiff board covers.

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To Stimulate Dealer Interest and Co-operation, the Westinghouse Electric & Mfg. Co. is issuing a new monthly publication to be known as "Contact." It is the same size as the *Saturday Evening Post,* to permit effective display of its contents and full scale reproduction of advertisements in national mediums. The new magazine will replace the Westinghouse company's monthly "Merchandising Calendar" and also the special publications distributed on merchandising campaigns, which are issued from time to time through the year. The intention is to make "Contact" a clearing house of ideas for Westinghouse distributors.

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NEW BOOKS

The Lighting Art,

This book is written by M. Luckiesh, physicist of the Nela Research Laboratory. Published by McGraw-Hill Book Co., Inc., New York, 6 x 9 in. 230 pages, price $2.50. In addition to a number of chapters on the practical aspects of lighting, such as the principles of light control, the author tells interestingly of the psycho-physiology of color and the language of color. Here we learn that red is exciting, green is soothing, blue is cold and serene, violet is depressing, and purple pompous. "There is no doubt," says the author, "as to the growth of our like or dislike for certain colors."

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Central Stations

Like all the other useful books compiled by Terrell Croft, this addition to the already overcrowded library of electrical literature is justified by its substance and form. Here will be found in readable style the elements of electrical generation, transmission, and distribution. The pictures are illuminating and the text convincing. Sections 3 to 6 contain the only extended and really lucid exposition that we have been able to find on the puzzling "factors" that beset central station operators, the public utility commissions, and the dear but thickwitted public. Lawyer-politicians who sit on public utility boards would profit somewhat by absorbing the subject matter of pages 15-100, for these pages concern themselves seriously and temperately with maximum demand and demand factors; diversity and diversity factors; load factor; plant factor, and connected load factor. This book measures 6 x 8 in. has 332 pages, and sells for $2.50. It is published by the McGraw-Hill Book Co., Inc., New York.

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Radio Communication

This book is written by John Mills of the Research Department of the Western Electric Co. In substance it comprises a course of lectures given by the author during the summer of 1917 to a company of the United States Signal Corps composed of Western Electric employees. The individuals to whom the lectures were addressed differed widely in their training as electrical engineers. For this reason the author assumes that his readers are equipped mentally with but a limited knowledge of elementary algebra and physics. The aim throughout the book is to present fundamental principles and methods rather than detailed instruction as to apparatus and methods. Trained in the fundamentals, says the author, a student will find but little difficulty in dealing with the apparatus of that new stage of the art into which radio communication seems to be entering. This book is bound in red limp leather, measures 5 x 7 in., contains 205 pages, and sells for $1.75. It is published by the McGraw-Hill Book Co., Inc., New York.

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Finding and Stopping Waste in Modern Boiler Rooms

The saving of coal is the purpose of this practical handbook, which is addressed to power plant owners, managers, engineers, and firemen. The preface states that such statements, tables, charts, etc., have been selected as are supported by experiments and tests, references being given wherever possible to the original authorities. The latter include many well-known engineers and writers in technical periodicals, also authors of papers before engineering societies, while the excellent bulletins on the utilization of fuel issued during recent years by the United States Bureau of Mines have been freely drawn upon. Pains have been taken to compare statements and to check each source of information against others.

The work is divided into five sections. The first section is about "Fuels." The second section is on "Combustion." The third section treats of "Heat Absorption," including heat transmission by conduction, convection, and radiation, heat transfer from a fluid in a channel, heat transfer in economizers, air heaters and superheaters, improving heat absorption, relation between heating surface and boiler capacity, boiler setting, refactories and fire brick, soot, scale, softening feed water, and feed water heating. The fourth section treats of "Boiler Efficiency and Boiler Testing," and the fifth section of "Boiler Plant Proportioning and Management."

The book has been compiled for the Harrison Safety Boiler Works by George H. Gibson, assisted by Percy S. Lyon, now Captain of Coast Artillery. It is bound in cloth covers, measures 7 x 9 in., has 276 pages, and 213 illustrations, and costs $1.00.

DID YOU KNOW THAT-

BITS OF GOSSIP FROM THE TRADE

Friction Tape prices are going up. On January 14, increases of about 25 percent. went into effect.

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Menominee Electric Mfg. Co., manufacturer of motors, telephone and electrical goods, is removii.g from Menominee, to Cairo, Ill.

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"Union" Renewable Enclosed Fuses and renewals are listed in a folder issued last month by the Chicago Fuse Mfg. Co., 1014 West Congress Street, Chicago, Ill.

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Wagner Electric Mfg. Co., of St. Louis, announces the removal of its Seattle office to 535 First Avenue, South, to continue in charge of C. Kirk Hillman.

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Central Electric Company, Chicago, Ill., announces that on January 1 the name of Fifth Avenue was changed to Wells Street. Its address is now 316-216 South Wells Street.

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Crescent Electric & Mfg. Co., Pittsburgh, Pa., is reported to have bought the entire stock of the Pittsburgh Armature Works. The Crescent company with this added equipment is in position to take care of any kind of armature work.

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Commonwealth Edison Company, original electric shop, Jackson and Michigan Boulevards, Chicago, which was operated for nine years from January, 1909, was discontinued on Jan. 1, 1918.

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Shapiro & Aronson, Inc., 20 Warren Street, New York, have elected the following officers for the ensuing year: D. Shapiro, president; N. W. Belmuth, treasurer; M. Rosenberg, secretary; H. A. Leibler, assistant secretary.

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Youngstown Sheet & Tube Company has established a branch office at Cleveland, O., with G. G. Stewart in charge. The St. Louis office of the company has been moved from Third National Bank Building to 706-707 Post Dispatch Building.

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Bell Telephone System report for eleven months ending November 30, 1917, was issued last month. It shows total operating revenues of $269,855,019. Due to increases in operating expenses the surplus earnings fell about $3,000,000 below those of 1916. The system has 10,438,253 owned and connected stations in the United States. It owns 22,195,963 miles of wire.

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Vulcan Steel Products Company representative in Paris, George S. Thompson, was recently appointed to the Purchasing Board of the American Expenditionary Forces in France. He has been assigned particularly to the handling of steel matters. This board is composed of American civilians living in France, headed by Major Drake. Their duties consist of passing upon all purchases made in Europe by the American army. Among the other members on the committee are representatives of Armour & Company, Baldwin Locomotive Works, Standard Steel Car Company, American International Corporation, Vacuum Oil Company, United States Steel Products Company, Borgfelt & Company, Allied Machinery Company, and the United States Rubber Company.

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Crocker-Wheeler Company, Ampere, N. J., has announced a bonus to its employees to meet unusual conditions incident to the war. Under this bonus employees will receive not less than 10 percent. of their wages since October 1, 1917, and during 1918. All employees receiving less than $2,500 yearly will benefit and those who have been in the employ of the company for more than a year will receive 12 percent. of their earnings.

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Edison Electric Appliance Co., Inc., has been incorporated under the laws of the State of New York. On January 1, this corporation took over the entire business of the Hotpoint Electric Heating Co., the Hughes Electric Heating Co. and the household heating device business of the General Electric Co. The general offices of the Edison Electric Appliance Co., Inc., will be located at 5660 West Taylor Street, Chicago, Ill.

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Goulds Manufacturing Co., Seneca Falls, N. Y., has put into effect, beginning Jan. 1, 1918, a bonus system whereby all hourly, piecework and salaried employees rated at $40 a week or under, will receive quarterly a bonus of 10 percent. on their total salary for the previous three months. This bonus is contigent upon a stipulated amount of time being put in at actual work during the year, and is aimed to encourage full-time work.

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Chicago Fuse Mfg. Co., Chicago, Ill., manufacturer of the "Union" line of electrical protecting materials and conduit fittings, has secured the exclusive right to manufacture the multi-refillable fuse, under patents owned and controlled by the Multi Refillable Fuse Company, Chicago. The transaction also includes the good will and trademarks, as well as the merchandise and machinery required in the production of this fuse, which will hereafter be known as the "Union" renewable fuse.

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General Electric Company completed 5 years ago the largest single building in the world devoted exclusively to the manufacture of electric motors. The original structure was 809 ft. long and 82 ft. wide with a floor space of nearly 5 acres which was expected to suffice for years to come. The demand for motors has increased so that an addition became necessary. The new wing covers the entire length of the original building and is 56 ft. wide. With this increase the total floor space in this building devoted to the manufacture of motors from 1 to 50 hp. is nearly 6 1/3 acres..

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New York Edison Company, through the Automobile Bureau, is distributing the 1918 edition of the charging station booklet. It shows several new charging stations in the suburbs. In addition it describes the electric vehicle route to Atlantic City, and the new charging station at Lakewood. Since the Lakewood station was opened, it has been used by several companies, including ice cream manufacturers who have run trucks between Newark and Atlantic City. Other new stations include one at Tuxedo, N. Y., maintained by the Garage Company; one at Bayside, L. I., maintained by the New York & Queens Electric Light and Power Company; and one at Tompkinsville, Staten Island, opened by the Richmond Light & Railway Company. At Southampton, L. I., an additional charging point has been established by Adolph Guidi, located on Main Street, and the Essex and Sussex Garage has opened a new garade at Spring Lake.

PURELY PERSONAL

William Marconi, the inventor of the Marconi wireless system, has been appointed Italian high commissioner to the United States.

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John Hays Smith, consulting engineer, Milwaukee, Wis., has closed his office to accept a position as assistant engineer to the Public Service Commission of Pennsylvania.

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F. Emerson Hoar, for five years head of the gas and electric department of the Railroad Commission of California, is leaving for Petersburg, Va., for three months' training as a captain in the Engineers' Corps.

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R. S. Dunning has resigned as secretary of the Cleveland Electric Club, Jovian Chapter, and is engaged in sales promotion work with the Forest City Rubber Company of Akron, Ohio.

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B. W. Cowperthwait, manager of the Faribault (Minn.) division of Northern States Power Company, has been appointed a member of the Rice County War Savings Committee.

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R. E. Brown, manager of the Mankato (Minn.) division of the Northern States Power Company, has been appointed chairman of the War Savings Committee for Blue Earth County.

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Lieut. Edward B. Strong, Jr., of Company F, 159th Infantry, and W. A. Strong, electrician in the U. S. Naval Radio Service, are members of the editorial staff of the *Journal of Electricity.* Lieut. Strong is treasurer of the Technical Publishing Company, publisher of the Journal.

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B. J. Arnold, president of the Arnold Co., Chicago, consulting engineers, has been commissioned a lieutenant-colonel in the Signal Corps of the U. S. Army, and is slated for active service in France at an early date. For the last 25 years he has been actively interested in flying machines.

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Charles R. Underhill, chief electrical engineer of the Acme Wire Company, New Haven, Conn., has just been appointed captain in the Aviation Section of the Signal Reserve Corps. He is the inventor of a number of signal and wireless-telegraph devices.

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Frank G. Baum, consulting engineer of San Francisco, has charge of the engineering and construction of a hydroelectric plant for the Cerro de Pasco Mining Company in Peru, and another for the Homestake Minning Company at Spearfish, South Dakota, and has under way a 1000 hp. hydroelectric plant for the San Luis Mining Co., of Mexico.

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Nelson P. Hall has taken up the duties of district sales manager for the Chicago territory of the Van Dorn & Dutton Company, gear specialists, of Cleveland, Ohio. He will look after the gear and pinion requirements of electric railways and mines in the Chicago field. His office will be located at 14 East Jackson Blvd., Chicago.

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Guy E. Tripp, of New York, heretofore chairman of the Board of Directors of the Westinghouse Electric & Mfg. Co., has been appointed by the War Department as Chief of the Production Division of the Ordnance Department, intrusted with the task of supervising and stimulating the production of all ordnance supplies. Mr. Tripp was selected because of his experience in the manufacture of munitions of all kinds, the Westinghouse company having obtained large contracts from the British and Russian Governments immediately on the outbreak of the European war. The Board of Directors of the Westinghouse Company has given him a leave of absence for the duration of the war. He has been commissioned as colonel.

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W. R. Thompson, formerly captain of the 109th Regiment of Engineers, stationed at Camp Cody, Deming, New Mexico, has been made a major in the same regiment. In civil life Major Thompson was manager of engineering and construction for H. M. Byllesby & Company, and won recognition for valuable work in construction and engineering performed at and near Camp Cody.

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Frank J. Foley, formerly manager of the Mining Department of the Westinghouse Electric & Mfg. Co. has gone to the Edison Storage Battery Co., Orange, N. J., as manager of the Mining and Traction Department, with headquarters at the main office in Orange.

During the time Mr. Foley was associated with the Westinghouse company, he helped install the original multiple-unit control on the Brooklyn Rapid Transit system, helped install the switchboards and turbines in the Kent Avenue power station of the Brooklyn Rapid Transit, and the turbo-generator unit at the Waterside Station of the Consolidated Gas Co., New York.

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H. A. Hornor has recently resigned his position as electrical engineer of the New York Shipbuilding Corporation, Camden, New Jersey. Mr. Hornor has been connected with this company for the last 17 years, during which time he has greatly advanced the applications of electricity in the marine field. He is chairman of the Marine Committee of the American Institute of Electrical Engineers and has been active in various engineering societies. He is popular as a lecturer on his own and allied subjects, and has appeared before large audiences in the prominent cities of the East and Middle West. He has been a frequent contributor to the journals of the electrical technical societies and is author of the articles on marine applications in the Standard Handbook for Electrical Engineers. He is now writing a series of articles appearing in Electrical Engineering, which deal with the practical engineering features connected with the applications of electricity to the building and navigating of ships. Mr. Hornor severed his connection with the New York Shipbuilding Corporation on the first of February.

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American Red Cross urges all draftsmen having odds and ends of tracing cloth to send them to the local Laundry-owners Association for washing and sterilizing preparatory to shipment for surgical purposes to France. Old tracing cloth containing drawings will also serve this purpose as both the gelatine dressing and the ink can readily be removed by treating the cloth with malt extract or disastase.

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OBITUARY

Robb Mackie, assistant to manager of the supply department, Westinghouse Electric & Mfg. Co., East Pittsburgh, died at his residence, 117 North Linden Ave., Pittsburgh, on January 5.

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James Edward Latta, general agent of the Underwriters' Laboratories, died after a short illness at Washington, D. C., January 17. He was a graduate of the University of North Carolina and of the Graduate School of Harvard University. His engineering training was obtained at the Polytechnic Institute of Brooklyn, at Stevens Institute of Technology, and at the shops of the Westinghouse Electric & Manufacturing Company, and those of the Hooven, Owens, Rentschler Company. In the summer of 1911 he became technical editor of *Electrocraft;* when that publication was consolidated with *Electrical Review and Western Electrician* six months later, Mr. Latta became associate editor of the *Electrical Review*. In December, 1913, he was appointed special agent of the Underwriters' Laboratories, Inc., and about a year ago was advanced to the position of general agent.

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Charles J. Klein, inventor, connected with the push-button specialties department of the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., died on December 16, aged 50 years. Mr. Klein was born in New York City and was associated with Edison in the installation of the first electric station in New York City.

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Henry L. Herrick, consulting engineer of the Montana Power Company, died recently in Butte, Montana. He was one of the most widely known hydraulic engineers in the country, and was a member of the firm of Charles T. Main & Co., Boston. He lived at Great Falls, Montana, for a number ot years and was consulting engineer on construction of the Thompson Falls dam at Thompson Falls, the Holter dam at Wolf Creek, Hebgen dam at Madison, the lower Madison dam, and all of the engineering design work of the Montana Power Company. He was 61 years old.

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William Henry Baker, formerly vice-president of the Postal Telegraph and Cable Company and one of the best known men in the entire telegraph world died suddenly in New York on January 17. He started his business career as an office boy for a lawyer. Then the commission business attracted him, but he quickly switched his ambition and became a messenger in the office of Gen. Eckert, general superintendent of the Western Union Telegraph Company. He was promoted to an office position that carried with it the handling of the lines in eastern New York and Vermont, and when Jay Gould got hold of the old Atlantic and Pacific Telegraph Company he was made cashier and secretary for that corporation. He acted as private secretary for Theodore N. Vail when the latter was president of the Metropolitan Company. Mr. Baker took a step up when he became in 1899 vice-president and general manager for the Postal Telegraph and Cable Company. He held this post until 1907, when he became secretary of the Western Union Telegraph Company, where he remained until the close of 1916. Since that time he had been supervising a number of private ventures.

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ASSOCIATION NEWS

New York Electrical Society campaign to increase its membership is getting good results. About 200 new members have already been obtained.

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New York Chapter of the American Association of Engineers was established Wednesday evening, January 16, for the purpose of aiding the Government in conducting the war.

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Proceedings of the American Institute of Electrical Engineers for December contains a list of members of the Institute who are now in the service of the United States. There are lieutenants and captains galore, a plentiful supply of majors, and a few colonels.

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The National Association of Electrical Contractors and Dealers was formally organized at St. Louis, Mo., on January 22. This association is successor to the old Electrical Contractors' Association of the United States. It includes not only electrical contractors but also electrical jobbers and dealers. The following officers were elected to serve for the rest of the calendar year: National Chairman, C. W. Peet, of New York; National Secretary, Harry C. Brown, of Utica, N. Y.; National Treasurer, Ernest McCleary, of Detroit, Mich. The office of the association, located heretofore at Utica, N. Y., will be removed to New York for the present. Eventually, this office will be in Chicago.

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American Association of Engineers held section meetings at Pittsburgh, Cleveland, New York(Chicago, Philadelphia, Washington, D. C., Richmond, Savannah, Birmingham, Atlanta and Cincinnati last month.

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"The Telephone and the World War" was the title of an address made before the members of the New York Electrical Society on January 24, by H. J. Carroll of the New York Telephone Company. He told stories of the quick wit and heroism displayed by the men who are serving the trench line telephone systems.

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Robt. G. Ball, of the Sheldon School of Business Science, gave a lecture on self-development at a recent meeting of the New York Companies' Section of the N. E. L. A. He talked at some length on what we give to the world and what we receive from it. "Imagine," he said, "100 men, all 25 years old and fully equipped mentally and physically. Tell them to seek their fortune in the world and report back to you at the age of 65. In 40 years' time 34 of these men will be dead; 56 will be dependent upon relatives or charitable organizations; 5 will still be earning their daily bread; 4 will be wealthy, and 1 will be rich. These are facts; statistics compiled by the insurance companies!"

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C. H. B. Chapin, secretary of the Empire State Gas & Electric Association, has written Chairman Van Santvoord of the New York Public Service, Second District, in reply to a letter urging that the public service companies in New York State cooperate with the Federal and State fuel administrators in conserving the fuel supply. Mr. Chapin's letter says, in part:

"This committee believes that the gas and electric companies of the State are alive to the situation and are ready and willing to do their share. If curtailment of service either for purposes of economy or for other reasons will help in winning the war, the service should be curtailed and we are confident that each company will cheerfully co-operate.

On account of the important relation which the fuel item bears to their total operating costs, gas and electric companies are normally operated at as high an efficiency as possible in respect of fuel consumption and therefore the substitution for many purposes of gas and electric service for coal is in itself a measure of fuel conservation.

In the thrift campaign it is being urged that the utilization of men, money and materials for purposes not essential to the conduct of the war is in effect competing with the government. We venture therefore respectfully to suggest that in addition to the subject of "fuel economies" the commission might well give some consideration to other questions, such, for example, as discouraging at this time extensions and improvements to plants and systems not immediately necessary for purposes of fuel conservation or for the promotion of the interests of the country. Similar questions into which these factors enter will occur to you."

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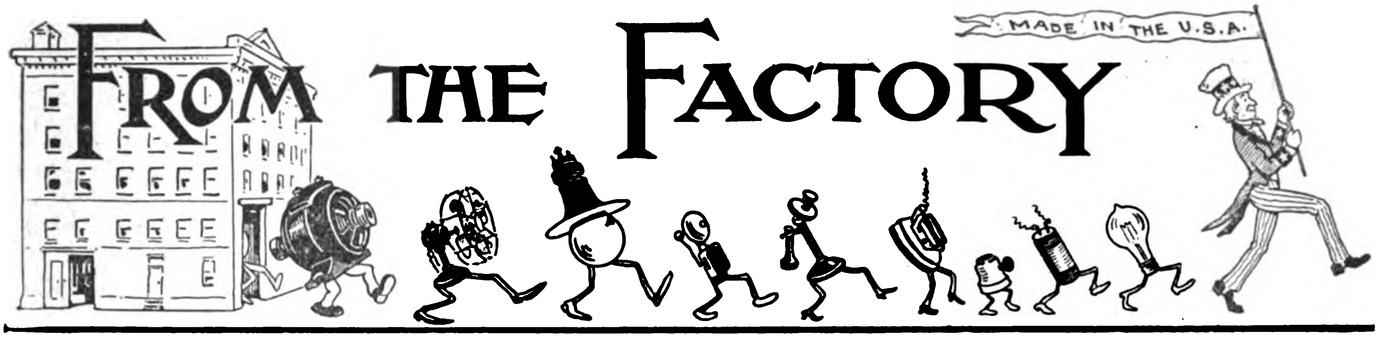
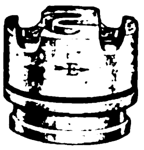
Sixth Annual Midwinter Convention of the American Institute of Electrical Engineers will be held February 15 and 16 in the Engineering Societies Building, New York. On account of war conditions the Meetings and Papers Committee, with the approval of the Board of Directors, has decided to make this convention purely a business meeting and therefore no entertainment features or excursions have been included in the program. The convention will include four technical sessions which will take place on Friady morning, Friday afternoon, Friday evening, and Saturday morning. A strictly informal dinner will be held between the afternoon and evening sessions on Friday.



Short Stories About Electrical Goods Offered By Manufacturers

OUTLET BOX RECEPTACLE

The Arrow Electric Company, of Hartford, Conn., has just placed on the market an outlet box receptacle with a removable porcelain ring grooved for shadeholder. This shadeholder groove is the new feature of the device, as the receptacle base



Outlet box receptacle. Arrow Electric Co., Hartford, Conn.

is nothing more than the standard short type of sign and outlet box receptacle which has been on the market for a number of years.

The ring is threaded sufficiently to support a considerable weight, and it can be fitted to bases, for ordinary cleat wiring, for weatherproof work, and for concealed terminals.

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FLASHLIGHT OPERATES FIRE ALARM

An automatic electric controller can be used for other purposes than that of operating flashlight signs. For example, a controller recently built by the Reynolds Electric Co., of Chicago, is designed to operate a fire alarm siren.

By an ingenious arrangement of contacts, the sounds from the siren are graduated in tones ranging from low to shrill. By means of suitable contacts the blowing, after continuing for a period of two minutes, is automatically cut off. Pressing of a push button switch closes the circuit and starts the motor driving the controller.

The motor is direct geared to the controller to insure positive drive. The fingers are reinforced at the contact end and are of the "quick break" type and a holder provides for one inch take-up in case of wear. The contacts are removable and adjustable.

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NORTHRUP MILLIVOLTER

This instrument is designed for:

1—The accurate measurement of pressures up to one volt without the abstraction of *any* current from the source of the e.m.f. being measured.

a—For the taking of voltage drops in motors, etc., where uncertainty of contact resistance at potential point connection exists.

b—For measurement of low voltages over electrolytic baths in which a carefully measured current is flowing.

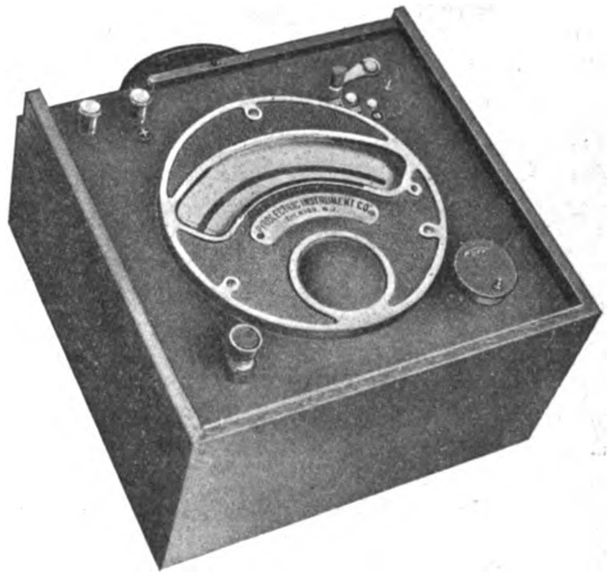
c—For use in thermocouple pyrometry.

d—For general use in place of a millivoltmeter, where accuracy is of importance.

e—For measuring internal resistance of dry cells, accomplished by opposing two cells, and then following the usual practice.

f—For the accurate measurement of large currents by reading the voltage drop over a low known resistance.

The Northrup millivolter operates on the pyrovolter principle. This, in effect, is the potentiometer principle applied to a deflection instrument. The result has been accomplished by using the meter as a balancing galvanometer to balance a battery e.m.f. against the unknown e.m.f., then suddenly changing connections to permit direct reading of drop of potential across a fixed resistance.



Northrup millivolter. Pyrolectric Instrument Co., 148 East State St., Trenton, N. J.

The meter supplied is of low resistance, double pivot type, with jewel bearings. A metal case shields it from stray magnetic fields. The pointer is of flat design, viewed on edge, with a mirror placed beneath to avoid errors due to parallax. It is designed for portable use and will stand up under all ordinary conditions of shop and laboratory service. It has three ranges: 0-10 millivolts, 0-100 millivolts, 0-1000 millivolts. It is made by the Pyrolectic Instrument Co., 148 East State Street, Trenton, N. J.

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SIGN AND OUTLET RECEPTACLE

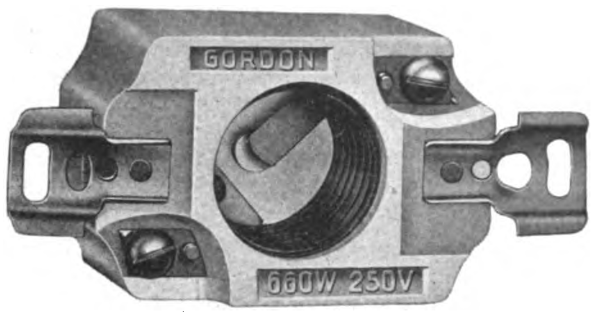
Pass & Seymour, Inc., Solvay, N. Y., are about to place on the market a receptacle that will be known to the trade as their number 437. This device is of the well known screw ring type which fits the common 1½ in. hole. The principle advantage of this device is that the body of the receptacle proper is but 13/16 in. in depth. This allows the wires to be carried the proper distance from the surface wired over and effects a material economy of space because it does not extend back far from the face of the sign or, when used in outlet boxes, it does not extend from the outlet box as far in the box as the common receptacle. The trade would classify this receptacle as a "short backed receptacle."

Provision is made in the back for pouring weather-proofing compound; thereby, entirely covering the metal parts.

A ball-tiped spring center contact of phospher bronze guarantees continuous contact with the base of the lamp.

GORDON FLUSH RECEPTACLE

A new form of Edison screw plug type flush receptacle is announced by the Gordon Electric & Mfg. Co., 430 South Green Street, Chicago, Ill. All the current-carrying parts of this device are made of solid brass, in accordance with the requirements of the Underwriters' Laboratories. Here will be found,



Flush receptacle. Gordon Electric & Mfg. Co., 430 S. Green street, Chicago, Ill.

too, brass terminals and contact pieces. A pleasing effect is produced by the brass-plated brackets on each end.

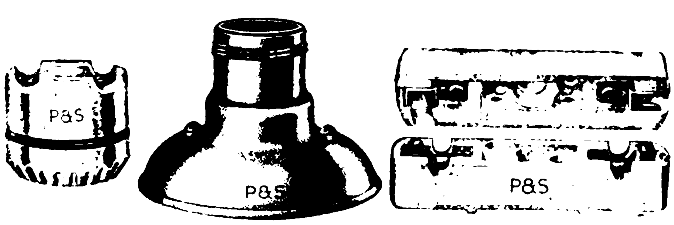
A box designed especially for this receptacle has a color scheme of blue and black, the same colors that are used on the other "Gordon Quality Products" made by this company. The annexed illustration shows this receptacle ready to be installed.

PASS & SEYMOUR FITTINGS

To satisfy the demand for a medium base brass covered receptacle, Pass & Seymour, Inc., Solvay, N. Y., are releasing P&S 60020. The shell or cover of this receptacle is in one piece and is made especially rigid by an additional bead which is spun on the skirt of the cover.

The shell proper of this device is threaded to receive the standard types of the "Uno" shadeholder.

The brass shell or cover is anchored to the porcelain interior by means of twin screws, and these in turn are held in place by means of special washers.



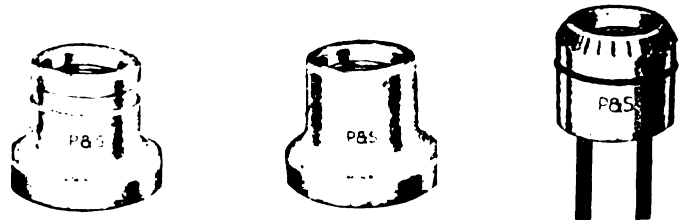
Sign and outlet receptacle.
Medium base, brass covered receptacle.
Cleat rosette.

The porcelain foundation for the interior is cast in one piece and on this the keyless interior is mounted—providing a freedom of accessibility and wiring room, so much desired by the practical wireman.

The supporting screw-holes for this device are spaced 1⅝ in. and 2 in. on center.

The holes for introducing the wires from the back of this receptacle are of ample size to accommodate heavy wires, and the terminal screws will be found of sufficient size and strength to grip and hold the wires. The lamp-screw shell is of special copper alloy and is secured to the porcelain base by a heavy horseshoe reinforcement.

Other fittings recently marketed by this concern include P&S 565, a cleat rosette designed to carry the wires a full half-inch from the surface wired over. The terminals are arranged to separate the wires by a space of 2½ in., and the binding screws which secure the cap to the base are so arranged that the cap may be pivoted on one end while the other end of the cap.

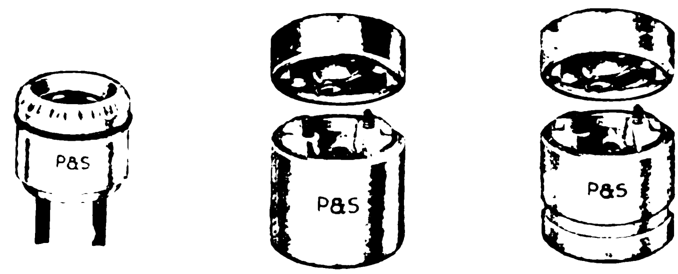


Porcelain concealed receptacles.
Short backed receptacle.

when the binding screws are released, swings in or out of position and is thereby made easy to wire on a step-ladder or at the bench.

Ample wiring room will be found in the base and provision is made in the cap for a practical knot in the drop-cord to relieve the strain on the terminals.

P&S 4000 and 4001 are new P&S porcelain concealed receptacles. The wires are introduced from the back of these receptacles. The outer porcelain shell entirely conceals the supporting screws as well as the binding screws and terminals.



Screw ring sign and outlet box receptacle.
Two-piece porcelain socket with and without shade holder. All made by Pass & Seymour, Inc., Solvay, N. Y.

P&S 4000 is shown without the shadeholder groove and P&S 4001 with the shadeholder groove. The outside diameter of the base of these receptacles is 2 5/16 in.

P&S 4003, a companion piece to P&S 437, is a short backed receptacle furnished with 6-in. leading-in wires.

P&S 4035 is a screw ring sign and outlet box receptacle of the same family as P&S 437 and P&S 4003. It differs from P&S 4003 only in that it has a 1-in. back.

P&S 1233, a two-piece porcelain socket without shadeholder groove, and its companion piece P&S 1234 with shadeholder groove are placed on the market by this concern to meet the requirements for heavy-duty sockets for medium or normal-base type C lamp fixtures.

These receptacles have ample wiring room or clearance for a single or double pair of wires in the terminal hood which may be supported by substantial machine screws, spaced 1 3/16 in. on centers.

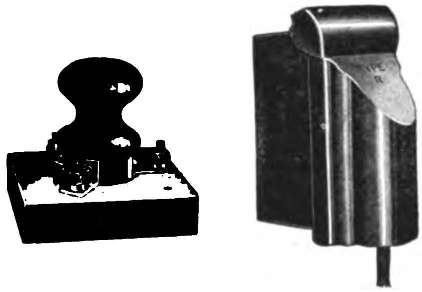
These receptacles are entirely front-connected and the socket-body is easily positioned by the aid of heavy porcelain tenons.

All live parts, where necessary, are sealed in with a special compound which will successfully resist the extreme temperature to which the devices may be subjected in use.

V. V. FITTINGS, TYPE R

Type R receptacles, plugs, and boxes are made with two, three, and four poles, and with capacities of 30 and 60 amperes. The finish is black enamel. Designed for outdoor work, the box can be used in connection with portable motors and machinery like coal hoists, boat loaders, and electric tractors.

The box is of heavy cast iron with a gravity closing weath-



Type R box. V. V. Fittings Co., 1910 *No. Sixth street, Philadelphia, Pa.*

erproof lid and designed so as to remain closed with the plug in or out. The receptacle is made of heavy slate thoroughly insulated. When placed in the box it sets at an angle which permits easy connection and disconnection of plug. The receptacle is made of wood to stand rough handling. Polarity of the plug and receptacle cannot be reversed.

The manufacturer is the V. V. Fittings Co., 1910 North 6th Street, Philadelphia, Pa.

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SHAVELIGHT

An electric light attachment for use with a safety razor is announced by the Shavelight Corporation of 30 Church St., New York. The outfit is complete with razor, trench mirror, strop handle and extra blades. The "Shavelight" attachment can also be used to advantage with a pencil or a fountain pen. The battery is of standare size and will last for more than 100 shaves. The outfit is contained in a khaki case.

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"AMCO" INDUSTRIAL LIGHTING UNIT

In this unit, recently brought out by The Art Metal Mfg. Co., of Cleveland, Ohio, the large reflector is made in two pieces and spun together forming a hollow body, and provided with a 2¼ in. fitter. The lower part of the fixture is made in one piece, open top and bottom, and so formed that the lamp filament is focused at the intersection of the upper and lower parts, causing the light to be projected down-

Amco industrial lighting unit. Arc Metal Manufacturing Co., Cleveland, Ohio.

ward at a 45-degree angle through a concentrating reflector, and also to pass upward, to be projected outwardly from the large diffusing reflector, over a wider field, and producing a uniform illumination without glare. The entire fixture is finished in white porcelain enamel. The lower part of the fixture is attached to the upper reflector by three small brass rods, that are provided with screw adjustments. It is made in two sizes; No. 300 for 200-watt, and No. 301 for 100-and 150-watt mazda C lamps.

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MIR-O-LITE

This is a small portable lamp designed for home, office, hospital, and travel use. It folds in such a way as to protect the bulb, a feature not often found in this sort of article. Folded, with bulb screwed into the socket, it takes up about as little room as a collar box. It can be carried about in a grip or small trunk. By means of this lamp, shaving is made possible in any inside or otherwise poorly lighted bathroom as it can be adjusted so as to throw the light just where it is wanted. By means of friction adjustment the lamp is retained in position at any predetermined angle. The Mir-O-Lite is made by the Wizard Electric Lamp Co., 147 New Montgomery Street, San Francisco, Cal.

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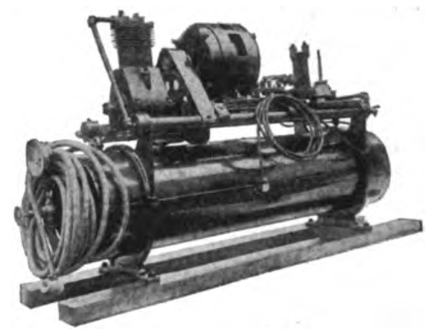
AUTOMATIC AIR PRESSURE OUTFIT

A new outfit has been developed by the M. L. Bastian Auto Engineering Works, Olney, Philadelphia, Pa., for service in garages and other places where compressed air is required. The outfit contains a pump, motor, storage tank, pressure gauge and the necessary air and electrical connectors. The steel tank is 12 in. in diameter by 48 in. long and is tested to a pressure of



Automatic air pressure outfit. L. M. Bastian, Auto Engineering Works, Olney, Philadelphia, Pa.

300 lb. per square inch. The pump is a two-cylinder, air cooled design with a 1¾ in. bore and 3 in. stroke.

The outfit is equipped with a one-way valve between the tank and pump, and when the pump is stopped the air is not held by check in pump and the pump does not start against pressure.

The pump is gear connected to a ½ hp. Robbins & Myers motor which is equipped with cord and plug for connection to a lamp socket. A rawhide pinion is provided on the motor shaft to eliminate u necessary gear noise.

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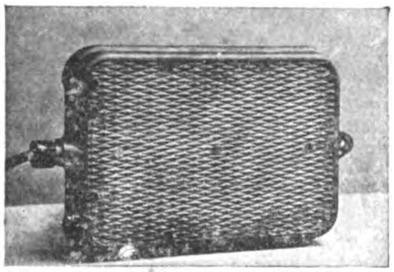
FOOT-WARMER FOR OUTDOOR SERVICE

To minimize the discomfort of long standing outdoors in severe weather, an electrically heated foot-warmer has just been placed upon the market by the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa. While designed primarily for lookouts stationed in the bow and crow's nest of vessels, the device is applicable to the use of watchmen, sentries, doormen, traffic policemen, and others whose work requires them to be out of doors continously with little chance for exercise. It has been found that if the rest of the body is adequately clothed, a foot-warmer will ensure comfort at any temperature.

As will be seen from the illustration, the device consists of a casting 14 in. by 20 in. by 25 in. with diamond-tread top. This is of castiron, or of aluminum where non-magnetic qualities are desired, as in ship service. Against the under surface of this the heater element is clamped. The heater is a slotted ribbon clamped between two plates of built-up mica, so arranged as to give uniform distribution of heat. A sheet-steel plate fastened by screws and sealed with high-melting gum renders the entire unit waterproof. The resistance is divided into two parts, which may be connected to draw 200, 100 or 50 watts at 125 volts. A 3-conductor cable 7 ft. long is provided. By using the lower heats in mild weather, there is no danger of causing chilblains.



Foot warmer for outdoor service. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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ETCHOGRAPH

The Etchograph, as its name implies, is an electrically operated device for marking machine shop or other tools to put a damper on stealing. It is made of high speed, carbon, or machine steel hardened or soft. No acids or waxes are used with it, all it requires is connection to a lighting socket giving current at 110 or 220 volts, 60-cycle, single-phase. Alternating current is required: it will not operate on direct current. It is flexible, will write or print any width of line and any style or size of letter, figure, or design. Ability to letter or write legibly is the only requisite on the part of the operator. It is offered by Wm. Brewster Co., Inc., 30 Church Street, New York.

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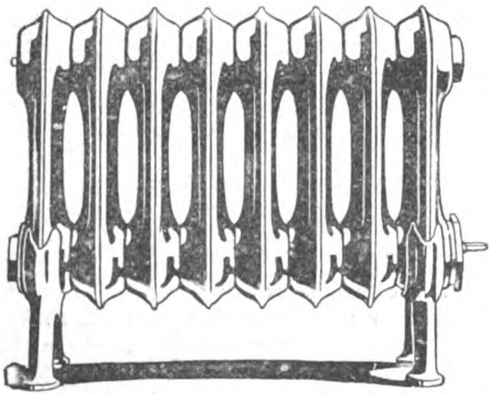
ELECTRIC NITROGEN RADIATOR

An electrically operated radiator of a novel sort is announced by the Willis Mfg. Co., 6613 Hough avenue, N. E. Cleveland, Ohio. In addition to the usual heating unit, this radiator is said to be filled with nitrogen gas. The nitrogen gas serves to carry the heat from the heating element to the radiating surfaces at temperature higher than that of a steam radiator. After the gas has given up its excessive heat to these radiating surfaces it returns to the element to be re-heated, and in that way—by means of the circulating system within the columns of the radiator—the heat is readily carried to the walls and the gas is able to be maintained at a much higher temperature than if the element were called upon to heat new cold air continuously. This gas is carried under slight pressure, but at no time, even under continuous operation, will it reach one-quarter the tested pressure of the radiator.



Nitrogen radiator. Willis Manufacturing Co., 6613 Hough avenue, Cleveland, Ohio.

This radiator comes in four different sizes; the smallest size has 4 sections, the largest, 10 sections. The smallest section consumes 400 watts, the largest 850 watts.

The heating capacity of this radiator is said to be much more than either a steam or hot water radiator of the same size, as the surface temperature here is about 100° hotter than a steam radiator and between 125 and 200° hotter than the usual hot water radiator. The average surface temperature of this radiator is 341° fahr.

It operates on 110-volt circuits, either direct or alternating.

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COMPENSARC FOR MOTION PICTURE PROJECTION

The General Electric Company, Schenectady, N. Y., has recently developed an a-c to d-c compensarc equipment which permits series operation of two arc type projection lamps while projection is being changed from one lamp to the other.

The compensarc is known as the series type for obvious reasons. It is made in capacities of 3, 50 and 70 amperes, for all standard a-c. circuits and can be used in most installations.

Series operation was desirable to simplify wiring and to save current by eliminating the steadying resistance in series with each arc lamp, found necessary with previous methods where lamps were connected in parallel across the generator armature.

Complete equipment includes the compensarc, a steel cabinet control panel, and a short circuiting switch for each projection lamp. The 50- and 70-ampere outfits have in addition a starting compensator. The control panel has an ammeter and a generator field rheostat, which are enclosed in the cabinet. The handle of the field rheostat comes through the panel just beneath the ammeter where it is convenient to regulate the arc lamp current.

The ammeter, the field rheostat, and all the wiring are mounted on the front wall of the cabinet which is removable for mounting and for attention. Wiring may be either at the top or the bottom as knockouts are provided.

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TRI-POLAR OSCILLATOR

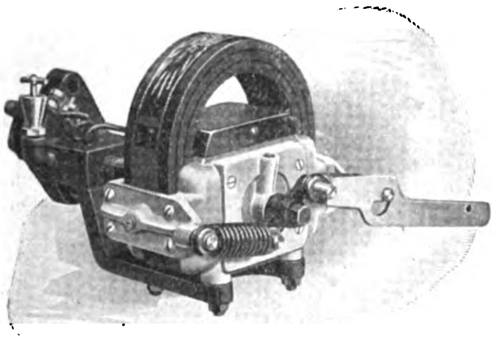
The high tension Webster tri-polar oscillator is of the inductor type. Its armature and field are stationary while a moving inductor shifts the path of the magnetic flux. Even this inductor, however, does not rotate, but merely moves through an angle sufficient to generate one wave of an alternating current. Inasmuch as this wave is required only at the time when a spark is needed by the engine, it is necessary to move the inductor only once for every other revolution of the crankshaft in a four-cycle engine. The angle through which the inductor moves is about 30°, and the necessary speed of motion is produced by a pair of coiled tension springs.

In action, some portion of the engine, by means of the tripping mechanism, cocks the inductor through a 30° angle, and then releases it. The springs return the inductor to its original position with sufficient speed to generate a heavy current wave in the primary windings of the armature. The action of these springs is without shock or jar, for there is no positive stop employed. In their "at rest" position, the springs are in a straight line and balance each other.

It is apparent that because the spark is produced by the recoil of the inductor springs, the speed of the engine has no effect upon the size of the spark. No matter how slowly the engine may be turned by hand when starting, at the ignition point a spark of maximum intensity is produced.

Since the inductor moves back and forth through an angle of 30° for each explosion stroke of the engine it operates, the average travel for each explosion stroke of the engine would be 60°, whereas the average gear driven rotary magneto, operating at engine speed on a four-cycle engine, makes two complete revolutions or 720°.

Because of the tri-polar construction of the pole pieces, the



Majestic oscillator for attachment to gas engines. Webster Electric Co., Racine, Wis.

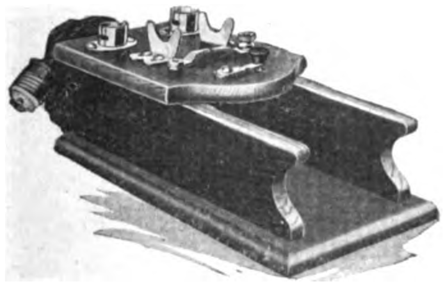
amount of motion required by the inductor is said to be much less than on any other type of magneto.

For starting on compression or from standstill a lever is furnished with each magneto and is permanently attached to it. This enables the user to operate the magneto entirely by hand in any position of the engine crank. After once having the priming charge and the proper compression in the cylinder, the engine can readily be started without cranking, by backing the fly wheels up against compression and snapping off the magneto with this lever.

No battery is needed with this device. It is made in six different sizes by the Webster Electric Co., of Racine, Wis. The different sizes take care of engines ranging from ½ hp. to 35 hp. capacity.

AUTOMOBILE TESTING DEVICE

To make easy the testing and adjusting of the Ford coil unit and for testing automobile lamps of any candlepower or voltage, electric horns, spark plugs, for finding short circuits, grounds, etc., and for starting Ford engines in cold weather, the Jefferson Electric Mfg. Co., 426 South Green Street, Chicago, Ill., has brought out the device shown in the accompanying cut. It



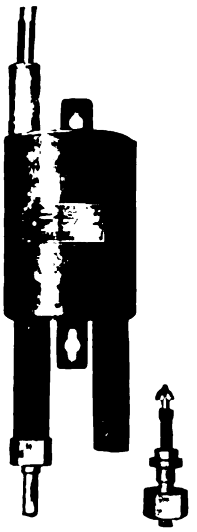
Ford combination tester. Jefferson Electric Manufacturing Co., 426 So. Green St., Chicago, Ill.

tests the Ford coil unit under alternating current. The Ford coil is wound for and operates in actual service under alternating current.

The No. 28 tester is designed for use with an alternating-current lighting circuit, while the No. 30 tester is identical in every respect with the No. 28, with the exception that it is designed for use where alternating current is not available and receives its energy from a 6-volt storage battery or four dry cells. The No. 28 is equipped with an extension cord and plug so as to attach it conveniently to any alternating-current lighting circuit.

NEW G. E. DEVICES

In towns where construction men are not familiar with "wiped" joints on ornamental lighting circuits the new General Electric current transformer, for series circuits, with a union joint is a great convenience. With the new transformer it is not necessary to "wipe" the joints enclosing the gap



Convenient current transformer. General Electric Co., Schenectady, N. Y.

Ornamental lighting unit. General Electric Co., Schenectady, N. Y.

between the lead sheath of the underground cable and the sleeves surrounding the cable going from the transformer. This device is provided with a strong union joint which, when screwed up tight, is entirely waterproof.

Another device is a new ornamental lighting unit which diffuses the light with very little absorption. It is of great value where low candle power lamps can be used. The stippled globe is in three sections, making renewal costs

New ornamental lighting unit. General Electric Co., Schenectady, N. Y.

much lower than where a complete globe is used. This fixture can be furnished with, or without, dome refractor and, in both cases, there is enough light in an upward direction to illuminate the globe for its entire length. It is said to be the only globe of a diffusing nature in which the refractor can be used to good advantage, especially with low candlepower lamps, because it does not rob the light source of very much of its initial candlepower. When the refractor is used the lamp is of exceptionally high value for residential street lighting because it collects all of the upward light and redirects it to the street surface away from the trees. The stippled glass globe is of irregular on the inside so as to split up the light rays and eliminate glare.

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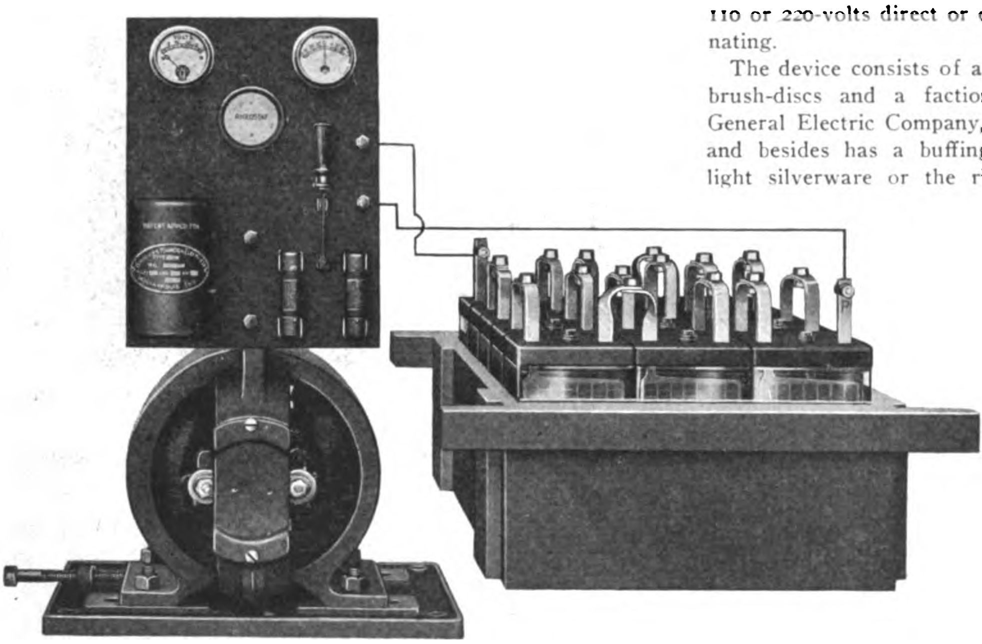
HENRICKS FARM LIGHTING PLANT

In the farm lighting plant, manufactured by the Henricks Magneto & Electric Company, of Indianapolis, the switchboard is mounted on the generator, therefore requiring only a small space in which to set the plant. On the switchboard are mounted voltmeter and ammeter, and back mounted rheostat, automatic cutout, two fuses, a line switch, and starting switch. The self-starting switch, by throwing in a downward position, converts the generator into a motor and can be used to crank the engine.



Farm lighting plant. Henricks Magneto & Electric Co., 1237 St. Paul street, Indianapolis, Ind.

Any engine can be used in connection with this plant; at the same time the engine can be used for other work, which makes the operating expense a small item.

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SMALLEST MOTOR IN THE WORLD

The *Scientific American* says that a jeweler of Hillsboro, North Dakota, has recently constructed a motor, said to be the smallest in the world. The motor, just a fraction over a quarter of an inch long, is perfect in every way, and contains everything found in larger motors. The commutator has four segments made of gold, each segment being insulated from the other with mica. Fiber is used as insulation between commutator and shaft; also between the end pieces and commutator. The commutator is built up in the same way as the ones on the large machines, no glue or cement being used in its construction. The commutator is 0.015 in. in diameter, and is mounted on pivot steel shaft 0.009 in. in diameter. The armature has four poles and is wound with No. 40 silk covered wire. Its diameter is 0.09 in. The brushes are made of silver and are 0.12 in. in diameter. The springs for the brushes are 0.004 in. in diameter. The motor has two field coils between the armature and yoke. The length of the entire motor is 19-64 in. and its height 11-64. It weighs 5½ grains. A small flashlight battery is used to supply energy.

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MOTOR OPERATED MACHINES

The American Machinery Company, of Philadelphia, Pa., has developed motor operating machines for simultaneously paring and washing all hard root vegetables. They remove the outer skin of the vegetables and turn them out ready for cooking.

This company has also designed a number of motor operated machines for other purposes. Power for the various types of machines is obtained from fractional horsepower motors manufactured by the General Electric Company.

Another concern engaged in turning out motor operated machines is Ernest Koppen, of New York City. He has developed a motor operated knife cleaning and silver buffing machine. According to the motor supplied, it can be used on circuits of 110 or 220-volts direct or on 60 cycles, of 110 or 220-volts, alternating.

The device consists of a pair of patented cleaning or polishing brush-discs and a factional horsepower motor made by the General Electric Company, which drives the discs through gears and besides has a buffing-shaft extension for the buffing of light silverware or the rinsing of coffee or tea-pots, etc. A small General Electric motor is also used to operate the "Lectroflater," a hand portable air compressor and tire pump made by the Black & Decker Mfg. Co., of Baltimore, Md. It is intended for private use, and also for the use of garages, public accessory stores, and tire shops. The Lectroflater is of unit construction, that is the gear box and high pressure air compressor are encased in one housing.

The motors are designed for use on 32, 110, or 220-volts, and can be used on either alternating or direct current circuits, connection being made by cord and plug to convenient incandescent lamp socket. The motor, geared to the pump, which is of the piston type, with a 2-in. stroke and capable of developing a pressure of 150 lb. The compressor is automatically cooled and lubricated and the air passes through an expansion chamber which removes moisture. The operating cost based on an 8 cent per kilowatt-hour rate is 2¾ cents per hour for uninterrupted service.

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SERIES TRANSFORMERS FOR STREET LIGHTING CIRCUITS

According to E. D. Treanor in the General Electric *Review*, the rapid growth of street lighting with high candle-power incandescent lamps has greatly increased the use of small series transformers which are connected in existing high-voltage constant-current circuits to facilitate the operation of street lighting units. These transformers are used primarily to utilize existing circuits and to retain the advantages of the series system while limiting the voltage on the circuits actually connected to the lamps. Therefore, they are largely employed in areas where the maximum voltage is fixed by considerations of safety. It frequently happens that the voltage which may be used in streets or parks is fixed by ordinance.

The system as usually operated consists of one or more series transformers connected in a constant-current series circuit, which is supplied by a constant-current transformer or constant-current regulator. The transformer may be in series with high candle-power lamps, or the entire load on the constant-current transformer may be made up of small circuits each isolated by a series transformer. These series transformers may each feed the lighting circuit for a park area, one or more city blocks, a bridge, a "safety isle," etc. As the usual consideration is to limit the voltage on the lamps and their fixtures, the size of the series transformer is fixed by the voltage which is considered safe. As the current is known, the working voltage may be obtained by dividing the load in watts, plus the line loss in watts, by the current.

The transformers are built in capacities ranging from 40 watts to 10 kilowatts, and in all standard series currents from 4 amperes to 7½ amperes. They may be mounted either on the poles, in manholes, or, in case of the smaller sizes, in the base of ornamental poles, or buried at the foot of the poles. When mounted on poles they are provided with suitable porcelain outlet bushings and weather-proof cable for connection in the primary and secondary circuits. When they are to be used in manholes or at the base of poles, a water-tight construction is used with wiping sleeves for connection to the lead cable of the circuit.

The smaller transformers, namely, the 2-kw. sizes and less, are of the air-cooled type with a shell-type core and circular steel casings. The larger transformers are oil-cooled and use standard lighting transformer parts with special porcelains or subway bushings. The insulation throughout is so proportioned as to be adequate for the strains to which the transformers may be subjected on series system of approximately 10,000 volts, and for the internal strain due to open-circuit voltage.

The protective devices are usually mounted across the secondary terminals of the transformer. They are contained in small steel cases similar to the transformer cases. The films consist of disks of easily fusible metal, cemented to the two sides of insulating washers. Under the open-circuit voltage of the transformer, the gap between the two disks breaks down and the soft metal melts and bridges the gap, thus short circuiting the transformer.

* * *

EMERSON 150-WATT CHARGING SET

Emerson charging set mentioned last month is identical with the motor-generator set offered without switchboard. The motor is of the split-phase induction type, operating at 1750 rev. per min., direct connected to a two-pole direct current generator

The shunt windings of these generators are especially proportioned to produce what is known as a "boosting" or "taper-er" charge. Such a charge starts at a high rate (above normal) and finishes at a low rate (below normal). A charge of this character is recognized as being the most efficient for re-charging a battery in the shortest possible time and is especially well adapted for bringing up a run-down battery over night.

This 150-watt generator has an output of 10 amperes at 15 volts, operating at 1750 rev. per min. on 110 volts 60 cycles. It may be satisfactorily used for charging one 12-volt or two 6-volt 100-ampere-hour batteries. When used for charging a single 6-volt battery the regulator should be adjusted to a point where the initial charge is reduced to approximately 15 amperes. The charge will then be found automatically to taper as specific gravity of the battery rises.

This company is also marketing three new direct current motor frames 1/3 to 2 hp in size. Suitable starting rheostats are provided with each motor. All are made by the Emerson Electric Mfg. Co., St. Louis, Mo.

THE CLEARING HOUSE

Advertisements on this page 5 cents a word. No advertisement accepted for less than $1.00. Electrical Engineering reserves the right to open all letters addressed in its care and agrees to forward only answers that are germane to the product or subject advertised.

FOR SALE

FOR SALE—Motors for sale. Twelve 1 to 35 h.p., 500 volts D.C. Address I. K. care ELECTRICAL ENGINEERING, 1642 Woolworth Bldg., New York.

FOR SALE—75 kw. Generator. G. E. form D, class 8-75-900 2300 volts three phase 900 r.p.m. serial number 62249, direct connected exciter burned out and equipped with belted exciter size 3 kw. 60 volts 50 amp. 1500 r.p.m. Price $550. Address Lexington Mill & Elevator Co., Lexington, Neb.

HELP WANTED

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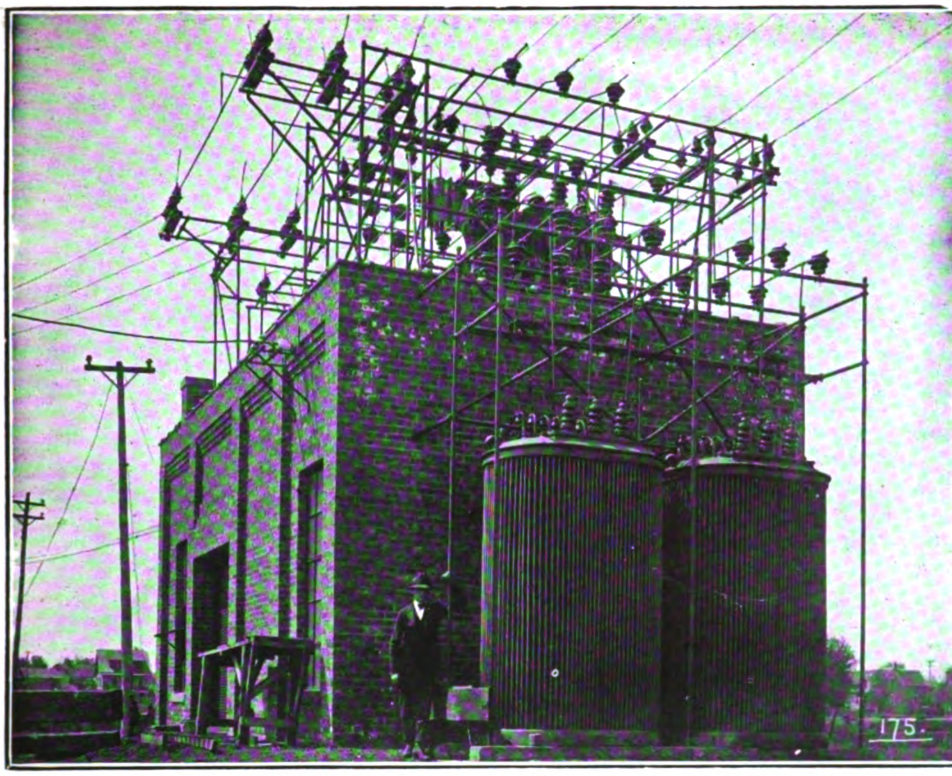

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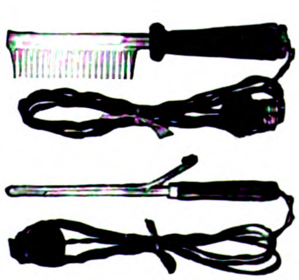

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ELECTRIFY THE RAILWAYS TO CONSERVE COAL — An Address Delivered by E. W. Rice, Jr., at the Midwinter Convention of the American Institute of Electrical Engineers.

CONTEST OF THE FREQUENCIES—Conclusion of the Story on How the Various Commercial Frequencies Came Into Use. Why 25 Cycles and 60 Cycles Survived and the Others Dropped Out.

SINGLE-PHASE INDUCTION AND REPULSION MOTORS—Elements of Alternating Current Machine Design For Embryo Electrical Engineers. Second Article of This Series.

DRYING OUT ELECTRICAL APPARATUS — Tells of Various Methods of Driving the Moisture From the Coils of Alternating and Direct Current Generators and Motors, Also Transformers.

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Chicago Office, 814 Westminster Building

CHAS. B. THOMPSON, President

GEO. A. WARDLAW, Editor

Volume 51 — MARCH 1918 — Number 3

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Other Items of Interest:

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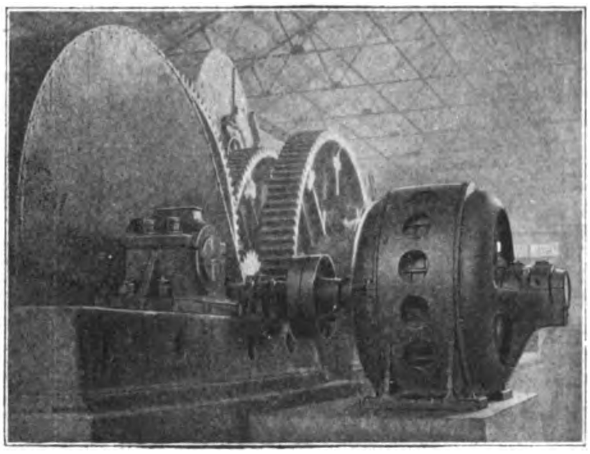

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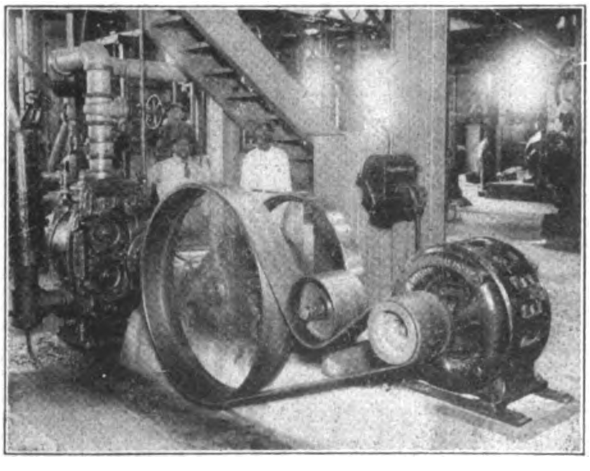

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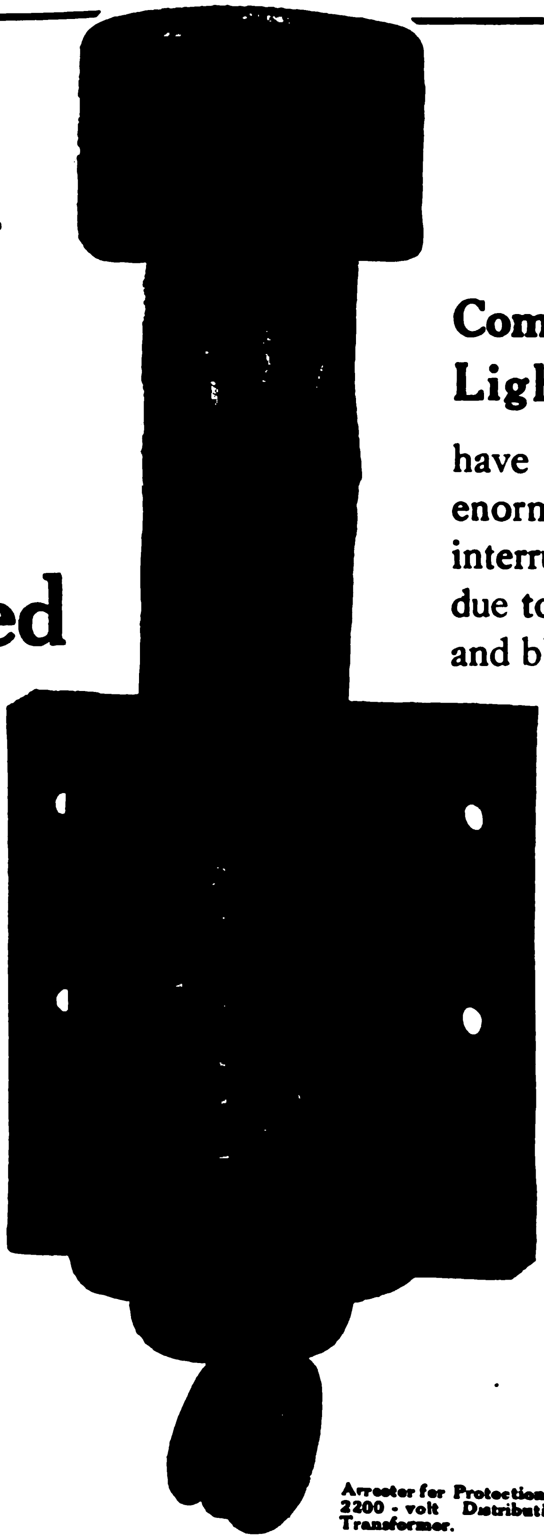

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*Southwest General Electric Company

For Canadian Business refer to Canadian General Electric Company, Ltd., Toronto, Ont.
General Foreign Sales Offices, Schenectady, N. Y.; 120 Broadway, New York City; 83 Cannon St., London, E. C., England.

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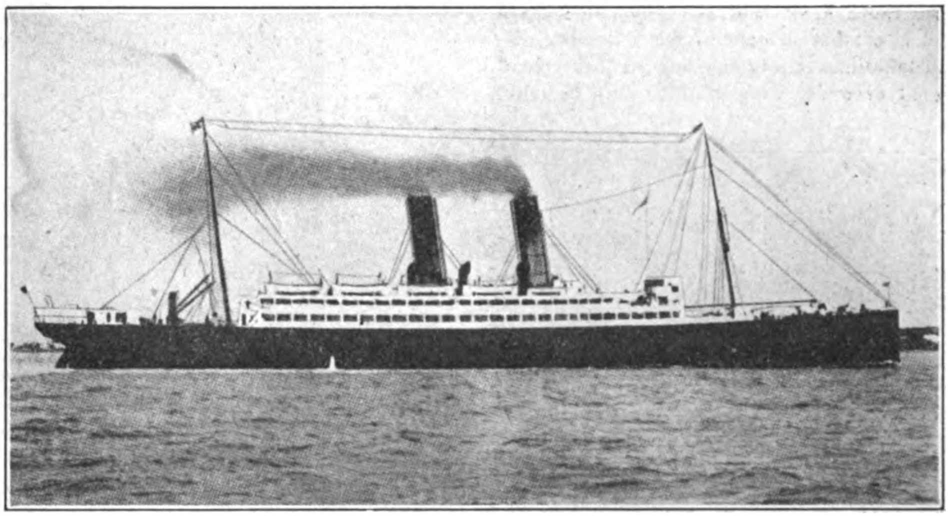
ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

By H. A. Hornor

(*Continued from page 30, February issue*)

These rules and requirements would seem to be entirely sufficient for all purposes, if it were not fully understood that they are general in character and ships as a rule are particular. There is a class of vessels called "tramp steamers" which the owners build with the intention of using in any trade the world over; but one tramp steamer differs from another as much here, but that they are necessary and not arbitrary must be fully borne in mind when considering the applications of electricity. It is because of this differentiation in type that the Classification Societies and governments make general rules and that the owner's naval architect prepares a specification in detail. It is to the owner's specification that all the engineers must go to settle the various details of machinery and installa-



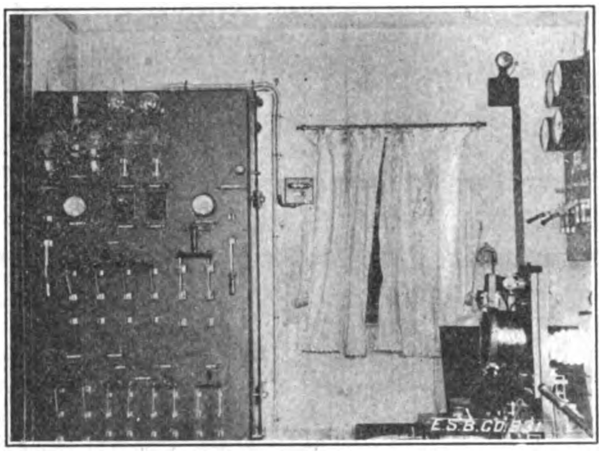
Steamship "Bermudian" of the Quebec Steamship Co., equipped with Exide battery for wireless service.

as one owner differs from another. In contra distinction to the tramp steamers are those vessels which are designed and built with special reference to a definite trade. This trade may be along the coast of their own country. If the country, like the United States, has two remote coasts undoubtedly the type of vessel suitable for one coast will not quite satisfy the economic or commercial conditions of the other. In like manner vessels plying the lakes, gulfs, and rivers will differ in general design and construction from each other and from ocean going vessels.

The reasons for this difference in type cannot be discussed

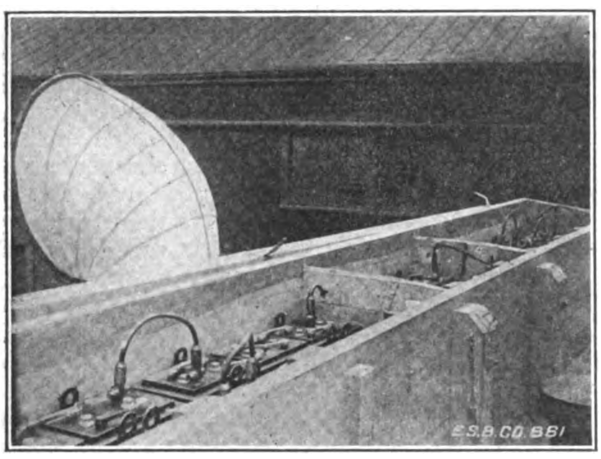
tion. Here are decided all the whims that infect the choice of engineers in the selection of many designs of apparatus, materials, and methods. The owner's specifications do not supercede or infringe the rules of the insurance company or the laws of government, but bear weight in the legal sense of guarantee to themselves of the fulfillment of their contract with the shipbuilder and serve the purpose of estimating and establishing a price for the ship. They are usually compiled under the direction of men in the owner's company who have had years of experience in the actual running of ships, and therefore they are instrumental in providing the shipbuilder with a knowledge otherwise difficult for him to acquire.

The comprehensiveness of the statement that any material that floats on water may be fashioned into a ship cannot be denied. The ship is hollow. Of the many materials that man has at his disposition, he first selected wood which was in turn sheathed with metal, this makeshift was rejected for iron which again was surpassed by steel. Though the wooden sailing ship has lived to some extent in our day, many have in recent years



Wireless operator's room on steamship "Panama."

been built of steel. The limitations of the wooden vessel it is understood rest upon the weakness of the structure if the length is greatly increased. This restricts carrying capacity, which is still more affected if powerful propelling machinery is added to the dead weight in order to gain speed. The part electricity might play in furnishing very light weight machinery for propulsive purposes is to-day speculative. For the installation of electric auxiliaries and the type of installation, these details would not greatly differ from established practice on steel vessels. Where changes could be made in the construction work on wooden ships, these items will be commented upon when taken up in detail later; but in general the following discussions appertain to installations on ocean going steel merchant vessels. For some urgent necessity wooden ships may be built,

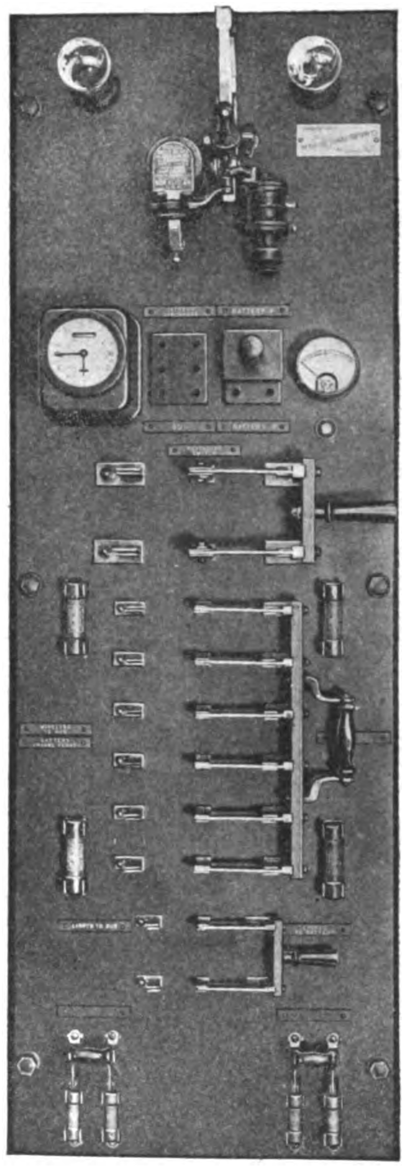


Exide battery on steamship "Panama" of the Panama Railroad Co.

but under any and all conditions they will be inferior to the steel vessel.

Electrical Drawings

Though a foreknowledge of electrical construction details are essential to the designer of the ship installation, yet a logical consideration of this subject requires that these plans be first prepared before the actual work on board the vessel is commenced. The electrical marine draftsman has before him in addition to the above mentioned rules and specifications, a set of drawings made by the hull drafting department. These drawings, called general arrangement plans, give in outline the various decks as they are divided and sub-divided by transverse and longitudinal partitions called bulkheads. Although these plans do not cover fine details, they serve to determine sufficiently well the general run of the electric leads, location of distribution panels, and approximate location and number of the lights and portable outlets. A blueprint of the hull general



E.S.B.CO.1078

Standard type of switchboard panel for marine wireless service. Electric Storage Battery Co., Philadelphia, Pa.

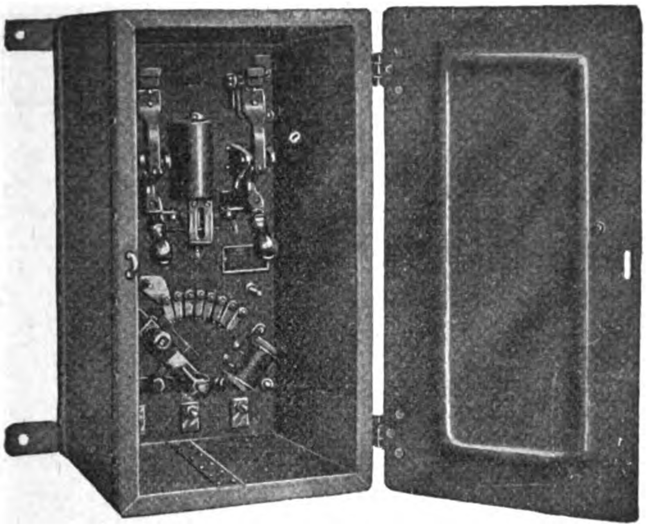
arrangement plan is then marked by those in charge of the electrical equipment, showing where the various items of the equipment may be suitably located. With this rough layout the electrical draftsman starts to work.

For a very simple general freight vessel of about 4000 tons carrying capacity, the draftsman would have an owner's specification something on this order:

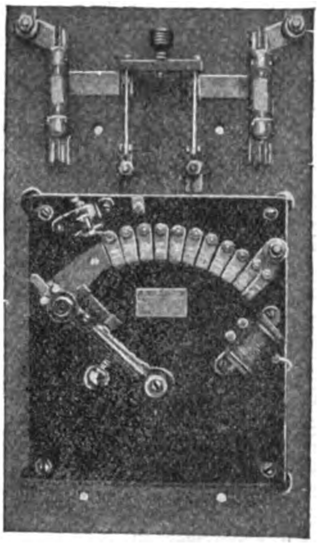
Electrical Specifications

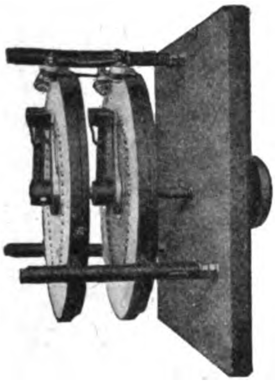
The electrical plant will consist of two vertical marine generating sets of 10-kw. capacity. The generating set will consist of one compound-wound, direct current generator, rated at 110 volts, direct-connected to a single cylinder vertical engine arranged to give its full rated output at 110 lb. steam pressure.

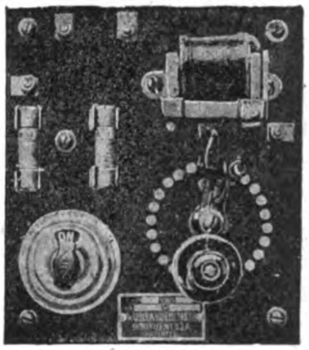
There will be provided a main switchboard with the proper



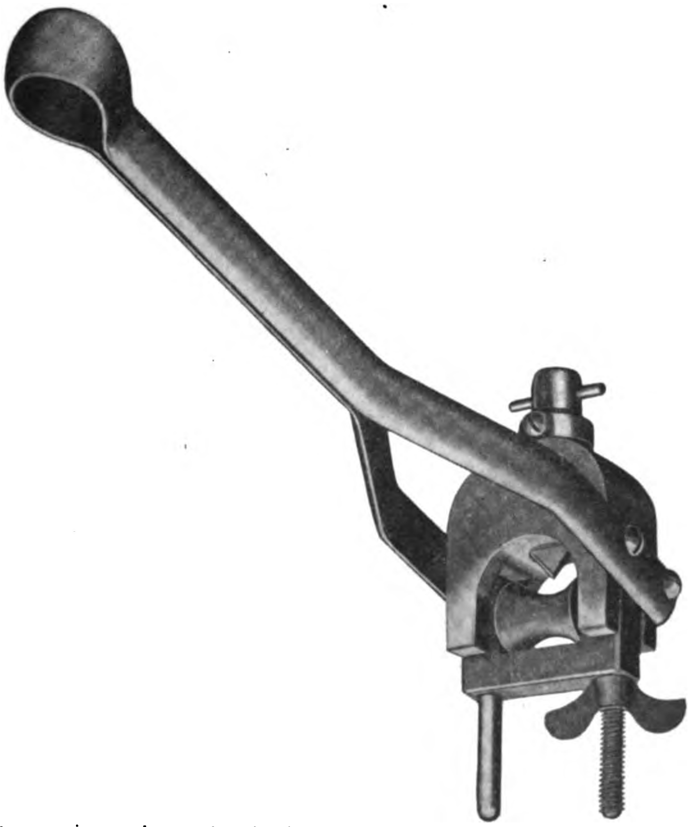
Showing Panel Mounted in Sheet Iron Enclosing Case.



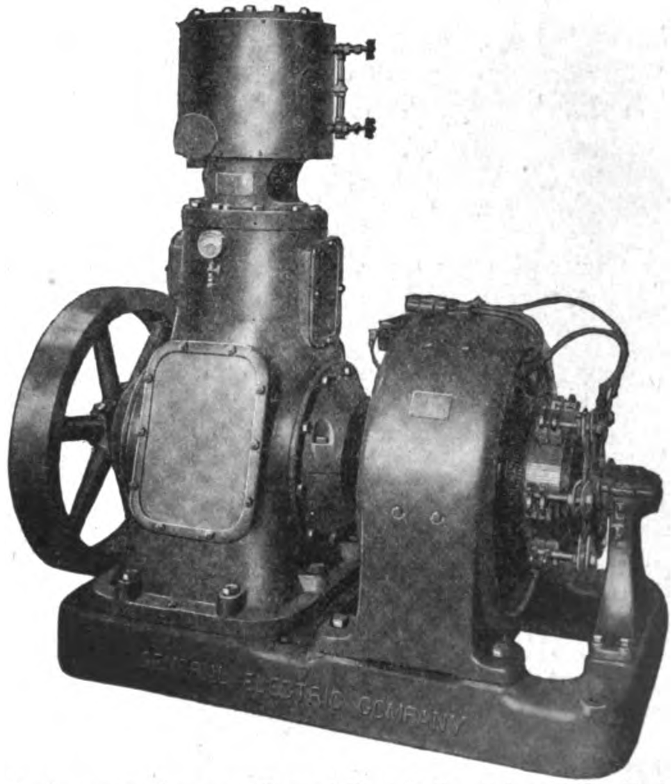




Various types of field rheostats and motor starting devices for use in controlling electrical machinery on board ship. Made by the Ward Leonard Electric Co., Mount Vernon, N. Y.

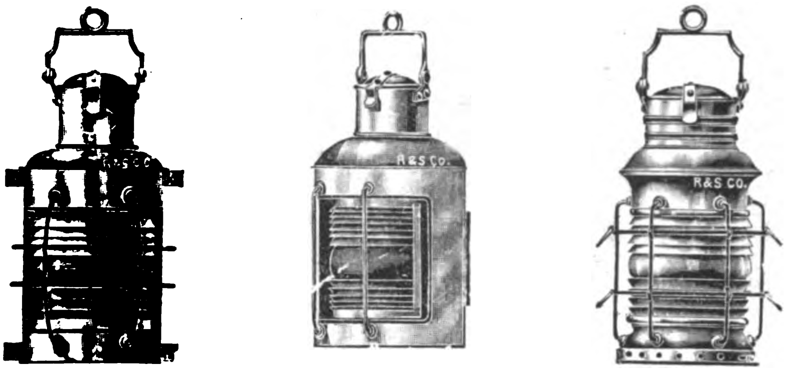


Argo wire stripper for lead-covered, steel-armored conductors. Novelty Electric Co., Philadelphia, Pa.



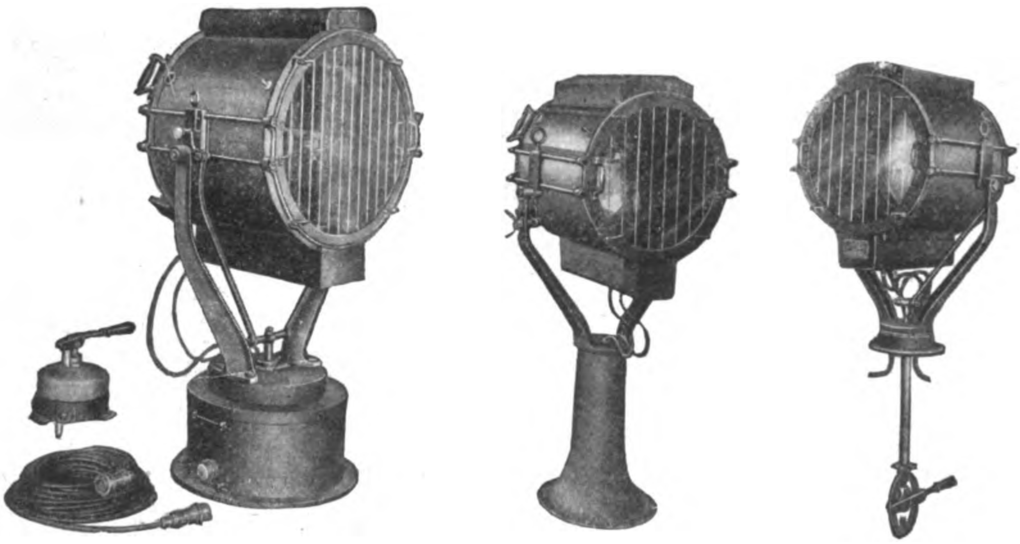
Marine generating set. General Electric Co., Schenectady, N. Y.

PART OF THE ELECTRICAL EQUIPMENT OF A MODERN SHIP

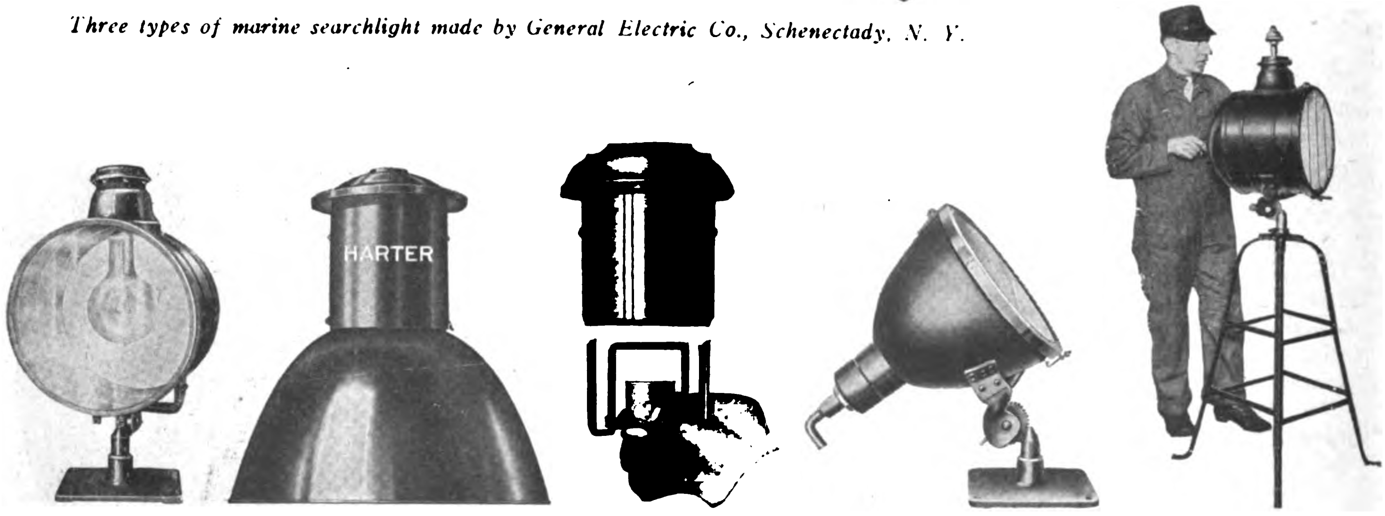


Signal lights for use on shipboard, made by Russell & Stoll Co., 17-27 Vandewater St., New York.


Projector for use on shipboard from 200 to 1000 kilowatts capacity. Luminous Unit Co., St. Louis, Mo.


Three types of marine searchlight made by General Electric Co., Schenectady, N. Y.


Diagonal 16-inch abolite. Adams-Bagnell Electric Co., Cleveland, Ohio.



Various types of lighting fixtures designed for marine uses and made by the Harter Manufacturing Co., 522 So. Clinton St., Chicago, Ill.

instruments for observing and controlling the voltage, and the necessary switches for the proper distribution of the current. Distribution panels to be provided for controlling lights in the quarters.

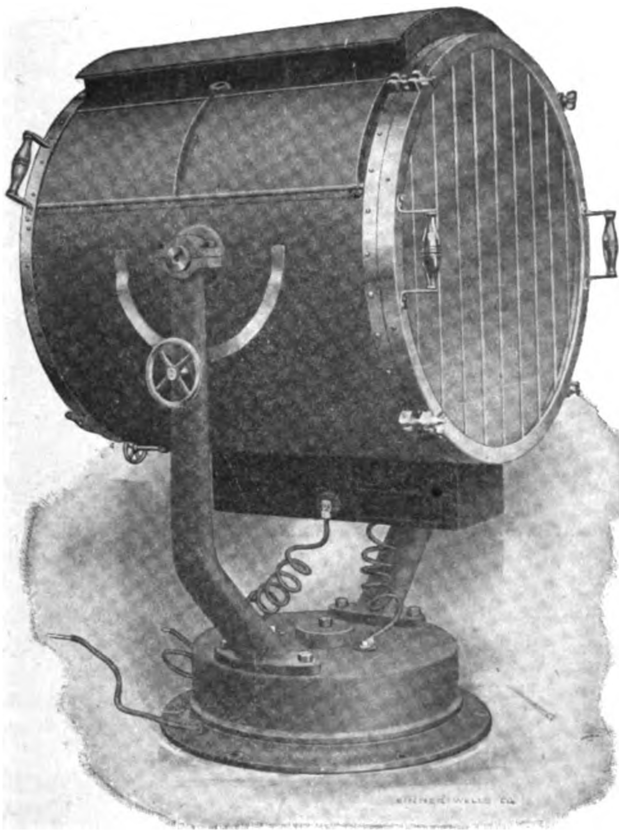
Approximately one hundred 110-volt, 25-watt mazda lamps will be furnished for the installation, hand portables to be supplied where necessary. Four 4-light cargo clusters to be furnished.

The two-wire system of distribution to be used. Lead armored cable to be used throughout, and all work to be done in accordance with Lloyd's requirements.

In the engine room, fire room, on open decks and any place liable to a mechanical injury, steam-tight guarded fixtures are to be used. The switches, junction boxes, etc., in these places must be watertight. In the quarters non-watertight fixtures of a standard design, as well as non-watertight fittings will be acceptable. The fixtures must be adapted to the location.

One 18 in. searchlight complete must be provided.

One set of galvanized iron steaming lights to be equipped



32-inch and 38-inch marine projector. Carlisle & Finch Co., Cincinnati, Ohio.

for oil and elelectric lamps, except where noted, will be furnished.

One port light.
One starboard light.
Two masthead lights (electric only).
Two riding lights.
One overtaking light.

In order to assure that these steaming lights are functioning at all times, there will be provided one 5-circuit tell-tale panel located in the pilot house.

Spare brushes for the generators, spare assorted fuses, and 25 extra 25-watt mazda incandescent lamps will be furnished.

The communicating system will consist of mechanical repeating telegraphs with large brass dials for the engine room, and white enamel with glass front in the pilot house.

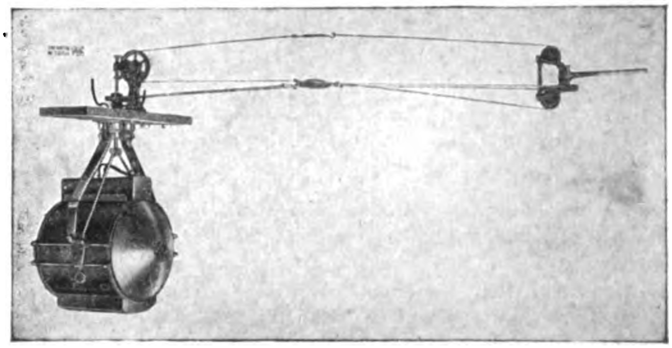
A speaking tube will be provided between the bridge and pilot house and between the pilot house and captain's cabin. Speaking tube will be also provided also between pilot house and engine room.

Mechanical whistle pulls will be provided in pilot house.

Alarm bells will be provided in accordance with standard requirements.

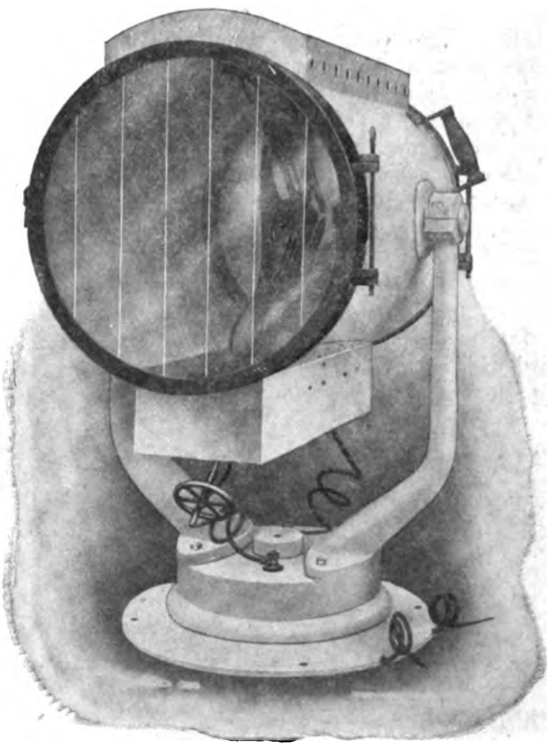
Draftsman and Drawings

With these data in hand the draftsman borrows the original tracing of the hull arrangement deck plans and makes a new tracing on the reverse, or glazed, side of the tracing cloth. He



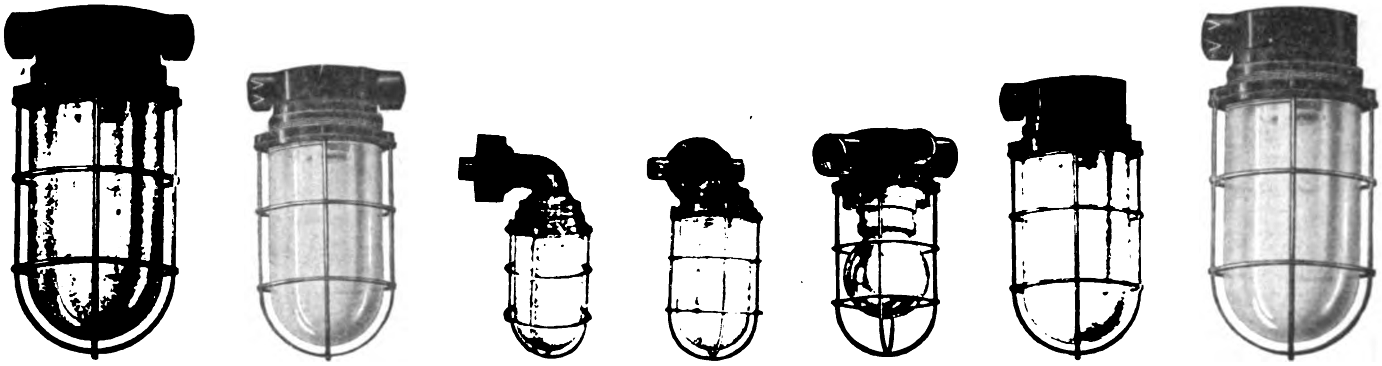
Another type of marine searchlight made by General Electric Co., Schenectady, N. Y.

incorporates all that these hull drawings contain and makes no change except the location of the lettering designating the various compartments where such lettering might interfere with the clear indications of the electrical equipment. When this tracing is finished he turns it over and for the sake of



Alternating current searchlight for 60-cycles at 110 volts. Carlisle & Finch Co., Cincinnati, Ohio.

precautions lays down in pencil the locations of the various apparatus, fixtures, appliances, etc. The number of feeder circuits having been determined for him he lays these in, making the connections from the main switchboard to each distribution panel or terminal apparatus. From the distribution panels the mains feeding groups of lights are each laid out in accordance with the approximate "spotting" of lights, as previously mentioned. In a conservative layout not more than eight or nine lights are made dependent upon one fuse. This number permits of additional lights, added either before the completion



Various types of V. V. marine fittings. V. V. Fittings Co., 1910 No. Sixth street, Philadelphia, Pa.

of the installation or sometime afterwards by the owner. This practice is based on the old carbon filament incandescent lamp consuming about 60 watts and follows the rules of the Fire Underwriters that no circuit depending upon one fuse may carry more than 660 watts. The introduction of the tungsten incandescent lamp has caused a modification of this ruling and more latitude is permitted in the number of lamps on one circuit. However, when the vessel is in commission the tendency is to use lamps of higher wattage, as they may replace the low-wattage lamps without any change in the lamp receptacle, so that caution must be exercised in designing the wire size of mains if conditions require a large number of lamps on a single branch. A safe rule, if no fixture wiring is used, is to base the permissible watts on the voltage of the system times the safe carrying capacity of the wire. For example, No. 14 B & S is allowed to carry 12 amperes; this amount multiplied by 110 (volts) would equal 1320 permissible watts.

At this point in the layout the draftsman should stop and check up by calculation what he has done. Knowing the loads on each main and, by addition, the total load on each feeder, he takes, with proper allowance for bends, etc., the length of each lead and computes the wire size based upon a 3% drop in voltage to the farthest light from the main switchboard. If there are any long feeders supplying motors, he would calculate these on a basis of 5 to 8 volts' drop. On an ordinary freight vessel the length of lead is usually so short that the conductivity required for the operation is the motor plus that called for by the Underwriters to cover starting current and overload will more than cover the drop in voltage. He is now able to list these data in the form of a tabulation which he includes on the drawing. This tabulation gives the feeder and main number, size of wire, kind of material, length, location, number of lights, motor sizes, and the load in amperes.

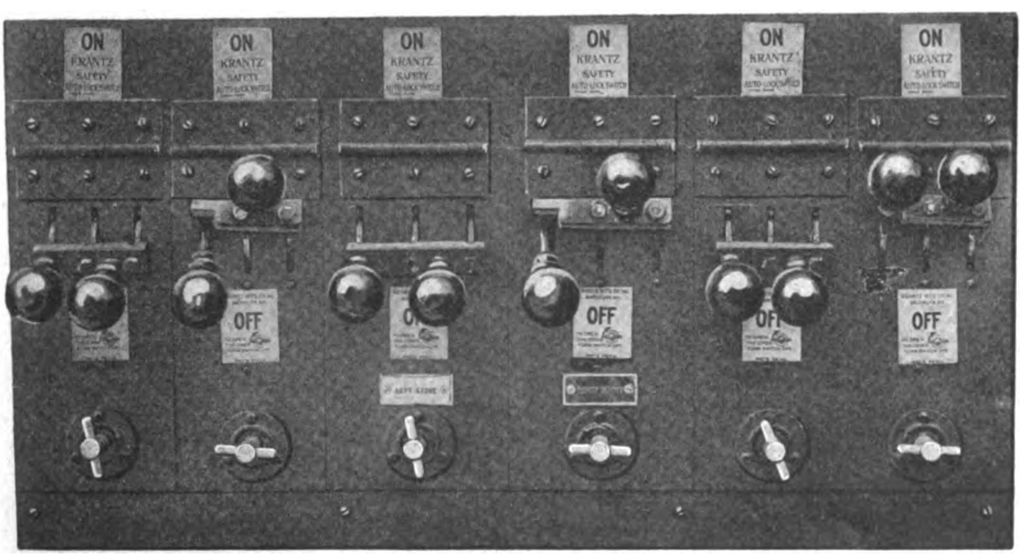
As such drawings are on a small scale, usually 1/8 in. to the foot, it is customary to designate the whole circuit by one solid black line. If, for example as in this case, the wiring is a 2-wire, direct current system, the two wires constituting both sides of the circuit would be indicated by one solid line. The draftsman would then draw an arrow-headed line with the lettered description of what the particular circuit required. This is clearly shown in the accompanying sketch.

Accompanying the table of data is another giving the symbols and their meaning. These symbols permit of quick detection in a rapid check for omissions and are necessary for the workmen when preparing for the actual installation. They also allow the installation to be laid out on a small but convenient scale.

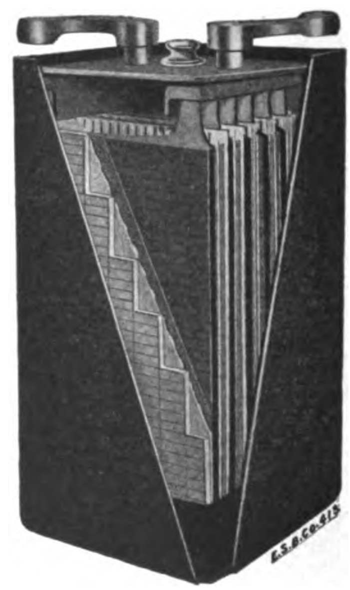
Final Touches

The checking and collection of data finished, the draftsman now starts to ink in. This is the final stage of his work. In order to bring the electrical work into clear relief on the blueprint, heavy solid lines are used for the whole network of circuits, apparatus, fixtures, and appliances. Thin black lines are used only for arrow-headed indicating lines; dashed lines only for center-lines.

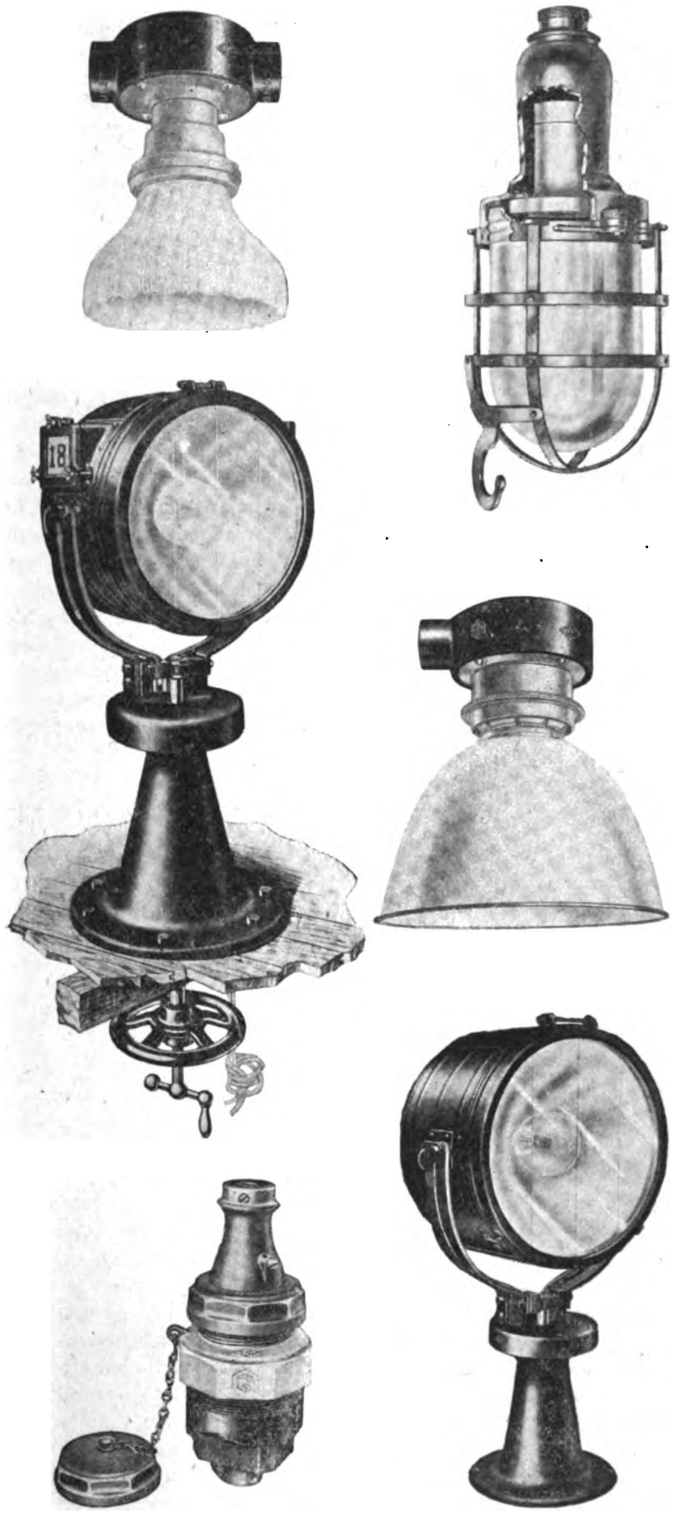
It is customary to combine on one drawing the electrical equipment with the signaling system. The aggregate of signaling systems is usually called interior communication. These systems are usually mechanical, but custom in the established shipyards has always consigned them to the electrical depart-



Distributing panel for use on shipboard. Krantz Manufacturing Co., Brooklyn, N. Y.



Exide cell, type MV-13, cut away to show construction.



Plug receptacle, two types of reflectors, hand lamp, and two types of shades—all designed for use on shipboard. Made by Crouse-Hinds Co., Syracuse, N. Y.

ment. Doubtless by this action it has been hoped that electrical signals would supersede the mechanical. Indubitably on a very small installation these interior communicating systems are better included on the same drawings as the electric lighting system, yet on a very large installation confusion might ensue, especially as this class of work is often performed by a different set of mechanics. The drawings are not extensive and can be made quickly and inexpensively.

When the draftsman has finished the drawings they are turned over to the chief draftsman who in turn carefully checks them with the specifications. The drawings are then approved by the head of the electrical department, issued to the blueprint department for prints and the filing of the original tracing. Copies of these drawings are then forwarded to the owner's representative for final comment and approval. After the owner's approval has been obtained the chief draftsman makes a complete count of all the material required and issues bills of material to the purchasing department.

When the material has arrived and the vessel is far enough advanced in construction for the electrical installation work to be safely started, the drawings are sent to the ship electrical foreman. He, or one of his competent leaders, takes the drawings and marks with chalk the location of the appliances on the steel hull and lays out the run of leads actually on the ship. At this point the closest co-ordination is necessary between the drawing room and ship foreman. As indicated above, the electrical drawings are at the best a guide. They cannot be drawn in great detail without expending more money than would be consistent with the value of the work done. Besides such work is very flexible and the most elaborate drawings would not prevent those in authority from changing the installation on board ship if it interfered with some other system. These other systems, such as steam, fresh water, sanitary, fire mains, and ventilation, are very extensive and are more costly to install than electric wiring. It becomes necessary when the foreman lays out the leads on the ship that these be carefully checked for all interferences with other installations and especially must care be exercised when passing through watertight bulkheads. To accomplish these avoidances the chief draftsman and foreman consult and investigate together the different system that may clash with the electrical work, and in concert with those in charge of other installations agree upon a clear route.

What the Draftsman Must Know

From this explanation it can be seen that the draftsman must know:

1—The current required for the operation of the searchlights, motors, incandescent lamps, etc.—all of this information is available to him through the manufacturers of the apparatus.

2—The kilowatt capacity of the generating sets in order that he may calculate the wire sizes for the leads between the generators and switchboards.

3—He must at the start have at least a general conception of the other installations that may produce interferences with the electrical equipment, and,

As the general detail plans of the vessel are developed in the engine and hull departments, he must fully acquaint himself with these details so as to advise intelligently with the ship foreman when the latter meets obstructions to the run of electric leads on the ship.

It should be understood that if, instead of the simple equipment here considered, the ship is a large passenger and freight vessel and the electrical installation expands to corresponding dimensions it will be requisite to increase the scale of the drawings and make them in sections (Fig. ?) of each deck. In such cases if a congestion of leads occurs, as it frequently does in some particular compartment, a detail plan of that space is made in addition to the general layout.

As the sample specifications of this small electrical equipment for a merchant vessel is of the order of the standard cargo vessels now to be built in large quantities, it may be well to follow the electrical construction on such a vessel until final completion and acceptance. This will give a clear indication of the difficulties of installation and serve as a type of present marine electrical practice. Then consideration will be given to a discussion of the various types of construction, the apparatus usually installed, and the tendency of development in the applications of electricity on board ship.

Installation of a Small Equipment

Although the installation of the main propelling machinery and boilers is a large and serious undertaking, there are besides numerous auxiliaries both for the main engines as well as for the deck department. The details connected with this important work have made it necessary for the shipbuilder to organize a separate department for such purposes. This department is called the ship installation department. As the electric generators are steam driven they are always located in the machinery space and are looked upon as engine room auxiliaries. They are not so specifically, as they are not essential to the operation of the main engine. They are directly under the care and supervision of the chief engineer and he is dependent upon them for furnishing light at all times in those spaces with which he is most concerned. This ship installation department installs the two 10 kw. generating sets. The switchboard, searchlight, and remaining electrical apparatus are installed by the electrical department.

The foreman electrician, having laid out and checked his leads, proceeds to distribute the various jobs to groups of mechanics. As far as the completion of the steel structure will permit, an orderly procedure is adopted, but in the nature of things ideal conditions are most rare. If piece work, or a premium system, is the policy the foreman works out the various jobs on a premium basis and thus starts the men to work. He sees to it that the materials are secured from the general store department and delivered to the ship.

Drilling Lead Holes

The run of leads and location of apparatus having been definitely fixed, the first work is drilling either the holes through which the leads are to pass or those which being tapped are used for securing the wires or appliances. As this is a lead-covered, steel-armored installation to be acceptable to Lloyd's inspection, the drilled holes through steel must be bushed with lead. This is accomplished with an ingenious tool resembling a countersink drill. At watertight decks and bulkheads the holes are drilled larger in diameter to permit of the insertion of stuffing tubes. These stuffing tubes are intended to preserve the integrity of the watertight compartments. The tube is so constructed that a tight joint is made with the steel and a packing of flax, and red lead surrounds the outside of the conductor upon which the cap of the brass stuffing tube is screwed down. This completely prevents water from leaking through at the point where the conductor pierces the bulkhead. Along the run of the leads, every 14 inches, are drilled and tapped small holes for the strap hangers which secure the steel-armored conductors to the deck or bulkhead. These strap hangers are made to suit the number and arrangement of leads. They are made from narrow strips of steel about 3/32 in. thick and about ¾ in. wide. A forming machine is used to expedite their making, as they vary greatly in number and combination of sizes. As a preparatory measure for the laying-in of the steel-armored conductors the strap hangers are temporarily held in place by a single screw slightly started on the thread.

(To be continued)

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ELECTRIFY THE RAILWAYS AND CONSERVE THE COAL AND OIL

An address delivered by E. W. Rice, Jr., president of the General Electric Company and of the American Institute of Electrical Engineers at the midwinter convention of the Institute, New York, Febrvary 15, 1918.

The Coal Famine

We are in the midst of an extraordinary coal famine, due to causes which it is perhaps undesirable for us to attempt to outline. However, I would like to point out how much worse the situation might have been were it not for the contributions of the electrical engineer; and also how much better our condition might have been if our contributions had been more extensively utilized.

Suppose we assume that the present serious situation is due to a lack of production of coal. It is comforting to consider to what extent conditions surrounding such production have been improved and how the output of our coal mines has been already increased by the use of electrical devices in connection with coal mining—such for example as the electric light, electric coal cutters, electric drills, and electric mining and hauling locomotives. I have no figures before me but I think it is a fair assumption that the output of coal mines would have been increased at least 25 percent. on the average by the employment of such electrical devices. If this estimate were cut down to 10 percent. it would still leave a possible increase in the tonnage of coal produced of something like 50,000,000 tons during the past year.

If on the other hand, our situation is not due to a shortage in the production of coal, but rather to the failure of the distributive agencies of the country, which is more probable, it is interesting to see how this difficulty would have been largely removed if the railroads of the country were operated by electricity instead of by steam.

Electric vs. Steam Locomotives

Where electricity has been substituted for steam in the operation of railroads, fully 50 percent. increase in available capacity of existing tracks and other facilities has been demonstrated. This increased capacity is due to a variety of causes, but largely to the increased reliability and capacity, under all conditions of service of electric locomotives, thus permitting a speeding up of train schedules by some 25 percent. under average conditions. Of course, under the paralyzing conditions which prevail in extremely cold weather, when the steam locomotives practically go out of business, the electric locomotives make an even better showing. It is well known that extreme cold (aside from the physical condition of the traffic rail) does not hinder the operation of the electric locomotive but actually increases its hauling capacity. At a time when the steam locomotive is using up all its energy by radiation from its boiler and engine into the atmosphere, with the result that practically no useful power is available to move the train, the electric locomotive is operating under its most efficient conditions and may even work at a greater load than in warm weather. It may therefore be said that cold weather offers no terrors to an electrified road, but on the contrary it is a stimulant to better performance instead of a cause of prostration and paralysis.

But this is not all. It is estimated that something like 150,000,000 tons of coal were consumed by the railroads in the year 1917. Now we know from the results obtained from such electrical operation of railroads as we already have in this country that it would be possible to save at least two-thirds of this coal if electric locomotives were substituted for the present steam locomotives. On this basis there would be a saving of over 100,000,000 tons of coal in one year. This is an amount three times as large as the total coal exported from the United States during 1917.

The carrying capacity of our steam roads is also seriously restricted by the movement of coal required for haulage of the trains themselves. It is estimated that fully 10 percent. of the total ton-mileage movement behind the engine drawbar is made up of company coal and coal cars, including in this connection the steam engine tender and its contents. In other words, the useful or revenue carrying capacity of our steam roads could be increased about 10 percent. with existing track facilities by eliminating the entire company coal movement.

I have not mentioned the consumption of fuel oil by the railroads which we are told amounted in 1915 to something like 40,000,000 barrels, nearly 15 percent. of the total oil produced. This fuel is entirely too valuable to be used in a wasteful manner. It is important for many reasons that such a wonderful fuel as oil should be most economically used, if for no other reason than that it will be needed for the ships of our forthcoming merchant marine, for the tractors that till our fields, and the motor trucks that serve as feeders to our railways.

Develop Our Water Powers

The possible use of water power should also be considered in this connection. It is estimated that there is not less than 25,000,000 hp. of water power available in the United States, and if this were developed and could be used in driving our railroads, each horsepower so used would save at least 6 lb. of coal per horsepower-hour now burned under the boilers of our steam locomotives. It is true that this water power is not uniformly distributed in the districts where the railroad requirements are greatest but the possibilities indicated by the figures are so impressive as to justify careful examination as to the extent to which water power could be so employed and the amount of coal which could be saved by its use. There is no doubt that a very considerable portion of the coal now wastefully used by the railroads could be released to the great and lasting advantage of the country.

The terrors of these "heatless days" will not have been without benefit if they direct the attention of the people and of our law makers to the frightful waste of two of our country's most valuable assets—our potential water power and our wonderful coal reserves. The first, potentional water power, is being largely lost because most of it is allowed to run to waste, undeveloped, unused. The second asset, coal, is wasted for exactly the opposite reason. It is being used but in an extravagant and inefficient manner.

Our waterfalls constitute potential wealth which can only be truly conserved by development and use—millions of horsepower are running to waste every day, which once harnessed for the benefit of mankind become a perpetual source of wealth and prosperity.

While the amount of coal in our country is enormous, it is definitely limited. While Providence has blessed us with a princely amount of potential riches in our coal beds, it is known that there is a definite limit to the amount of coal so stored and when this coal is once exhausted, it is gone forever. It is really terrifying to realize that 25 percent. of the total amount of coal which we are digging from the earth each year is burned to operate our railroads under such inefficient conditions that an average of at least 6 lb. of coal is required per horsepower-hour of work performed.

The same amount of coal burned in a modern central power station would produce an equivalent of three times that amount of power in the motors of an electric locomotive, even including all the losses of generation and transmission from the source of power to the locomotive. Where water power may be utilized, as in our mountainous districts in the West, all of the coal used for steam locomotives can be saved. In the Middle and Eastern States, however, water powers are not sufficient and it will be necessary in a universal scheme of electrification that the locomotives be operated from steam turbine stations, but as I have already stated, the operation of the electrified railroads from steam turbine stations will result in the saving of two-thirds of the coal now employed for equivalent tonnage movement by steam locomotives.

It is therefore not too much to say that if the roads of the country were now electrified that no breakdown of our coal supply, due to failure of distribution, would exist. What this would mean for the comfort of the people and the vigorous prosecution of the war, I will leave for you to imagine.

Electrify the Railways

Of course this picture which I have briefly and inadequately sketched of the great benefits which our country would have received if the roads had been electrified does not improve our present situation, and it may be claimed that any discussion of such a subject at this time is of an academic nature. This point of view is in a sense true, but I think that we can properly take time to consider it because of the effect which it may have upon our future efforts. This picture is not merely an inventor's dream, but is based upon the solid foundation of actual achievement. We have had enough experience upon which to base a fairly accurate determination of the stupendous advantages and savings which will surely follow the general electrification of the railroads; in fact, I think we can demonstrate that there is no other way known to us by which the railroad problem facing the country can be as quickly and as cheaply solved as by electrification.

The solution of the railroad problem would also "kill two birds with one stone" by solving the fuel problem at the same time.

If it is a fact, as has been stated, that the steam railroads of the country have failed to keep pace with the country's productive capacity—the increased output of manufacturing industries, the extension of agriculture and other demands for transportation—it is obvious that if the country is to go ahead, the railroad transportation problem must be solved and it must be solved at the earliest possible date. It becomes a matter of national importance that the best solution should be reached in the shortest possible time. That solution is best which will give the greatest amount of transportation over existing tracks, in the most reliable manner, and if possible, at the lowest operating cost. We electrical engineers are confident that we can make good our claim that the best solution is to be found in a general electrification of the railroads. That such a solution would be of great advantage to our profession and to our industry is important, although not as important as the great advantage which it would be to our country, freeing it as it would from the present threatened paralysis of business, possibility of untold human suffering, and incalculable financial loss. It should give us courage and optimism for the future of our profession to contemplate the service which we may render in this direction, and which it seems to me as immediately at hand. It should arouse in all of us, and particularly in the younger engineers, an enthusiastic confidence in the present and future stability and value of our profession and of the electrical industry. It should satisfy the young engineer that the opportunity for him to render important service is as real and great to-day as it has been in the past for those of us who have seen and participated in the marvelous growth of the industry up to the present time.

We would not be justified in being so confident of the benefits of electrification of railroads if every element in the problem had not been solved in a thoroughly practical manner. The electric generating power stations, operated either by water or by steam turbines, have reached the highest degree of perfection, efficiency, and reliability, while the transmission of electricity over long distances, with reliability, has become a commonplace. Electric locomotives capable of hauling the heaviest trains at the highest speeds, up and down the heaviest grades, have been built and found in practical operation to meet every requirement of an exacting service. There is, therefore, no element of uncertainty, nothing experimental or problematical, which should cause us to hesitate in pressing our claims upon the attention of the country. Electrification of railroads has progressed with relative slowness during these many years, waiting upon the development and perfection of all of the processes of generation and transmission and of the perfection of the electric locomotive itself. When all these elements had been perfected, as they now have been for several years, the railroads found themselves without the necessary capital to make the investment.

I realize that the task of electrifying all of the steam railroads of the country is one of tremendous proportions. It would require under the best of conditions many years to complete and demand the expenditure of billions of dollars.

The country, however, has clearly outgrown its railway facilities and it would require, in any event, the expenditure of billions of dollars and many years' of time to bring the transportation facilities up to the country's requirements.

It is not necessary that electrification should be universal in order to obtain much of its benefits. It is probable that the most serious limitations of our transportation system, at least in so far as the supply of coal is concerned, is to be found in the mountainous districts and it is precisely in such situations that electrification has demonstrated its greatest value. Electrification of a railroad in a mountainous district will in the worst cases enable double the amount of traffic to be moved over existing tracks and grades.

If a general scheme of electrification were decided upon, the natural procedure would, therefore, be to electrify those portions of the steam railroads which would yield the greatest results and give the greatest relief from existing congestion. Electrification of such sections of the steam railroads would have an immediate and beneficial effect upon the entire transportation system of the country, and it is our belief that electrification offers the quickest, best, and most efficient solution that is to be obtained.

It may be said that the present is not a propitious time in which to deflect any of the country's money into railroad electrification. I think that in spite of the enormous advantages of which I have spoken, we would be inclined to agree with such a point of view if it were not for the recent unpleasant demonstration of the failure of our railroad transportation systems to meet the demands which have been placed upon them by the industries, aggravated it is true by the war conditions and also by the unkindness of the weather.

After all, the question for the country to decide is whether we dare to limp along with the present conditions of restricted production, due to limited transportation, at a time when the world demands and expects from us the greatest possible increase in our efficiency and total production.

What assurance have we that the present conditions are temporary, and even if they improve, as they surely shall with the coming of warm whether, what are we going to do next winter? Of course, even if we should start electrification at once, we could not have all our railroads electrified by next winter, but we could have a good start, and as Sherman said about the resumption of specie payments—"The way to resume is to resume" so "The way to electrify is to electrify."

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CHEMICAL RECTIFIERS

By M. A. Walker

Instances sometimes arise where it is desired to obtain direct current with little loss of time where alternating current only is available. The need for direct current is only temporary and amount of energy small—but a few amperes, hence the cost of installing converting apparatus or storage batteries would not be justified, based upon the size of the load and the frequency with which it would be needed, and dry cells would be too cumber some because of the large number required for voltages usually used. In such cases the chemical rectifier can be used to advantage as regards low first cost and absence of working parts which get out of working order or need frequent attention.

The theory of the chemical rectifier, electrolytic valve or electrolytic rectifier as it is sometimes called, is complicated and really requires a knowledge of chemistry and the ionization theory, and, even so, more than one theory exists as to the actual phenomena exhibited by the electrolytic cell. Fortunately it is possible to use the rectifier without more than a superficial knowledge of its operation, because it is simple as regards construction, performance and installation. It is cheap in the extreme, requires practically no attention once the plates are formed other than an occasionaly replenishment of the electrolyte or plates, is safe and always on the job. With these characteristics it is obvious that such a piece of apparatus is emminetly well suited to places where small direct currents are required occasionally and for short duration, because of its low initial and maintenance costs. The rectifier is not of high efficiency, but since energy is taken from it sporadically this is of minor importance.

The chemical rectifier or electrolytic valve consists of an arrangement of plates, which possesses the characteristics of permitting the flow of alternating current through it in the one direction, but prevents the flow in the opposite direction. The anode or positive plate is always made of aluminum while, theoretically, it is immaterial of what the cathode or negative plates are composed. In practice, however, the choice rests between a few materials, because of secondary chemical action such as corrosion, etc., the actual choice finally depending upon the electrolyte to be used or the materials at hand at the time. Aluminum or tungsten must always be used for the anode, the more common materials for the cathods being steel, lead and

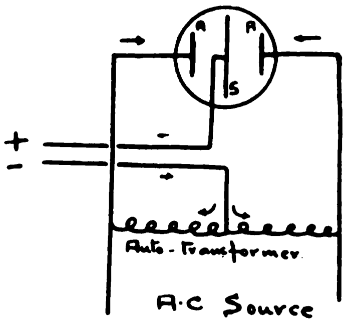

Fig 1

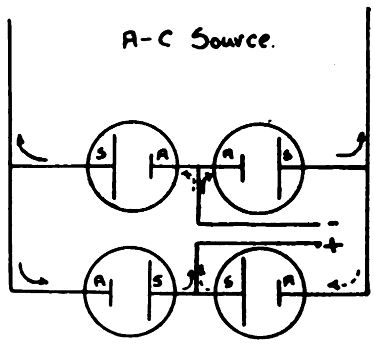

Fig 2

iron. Iron should be used only when the other metals are not available because it is not very well suited on account of its becoming coated with iron phosphate and alumina, the adherance of which increases the internal resistance of the cell. Lead is often used, and with satisfaction, for after a short time in service the lead becomes covered with a coating of lead peroxide, and this serves to protect the metal. The most satisfactory metal of all is steel, which should perferably be polished, with it is attacked but slightly. The cathode should have greater surface than the anode.

The rectifier is equally convenient as to electrolyte, in that the electrolyte used is composed of materials easily obtained. Theoretically water would suffice as the electrolyte, but in practice it is never used, because of the corrosion of the electrodes, high internal resistance and similar secondary effects. The most satisfactory electrolyte is a neutral solution of ammonium phosphate although the oxalate and carbonate can be used if necessary. It may easily happen that it is necessary to build and use one of these electrolytic rectifiers far from the city where all chemicals are available and substitutes must be found. Perhaps the most satisfactory under these circumstances are Rochelle salts, better known perhaps as potassium and sodium tartrate (obtainable at any drug store), and bicarbonate of soda. The former is probably the better, and should be admixed with distilled water in the proportion of ¼ pound of salts to five gallons or chemically pure water.

The containers for holding the electrodes and electrolyte may be of porcelain or of glass, their size depending upon the capacity of the rectifier. It is best to have ample electrolyte as this permits circulation and the dissipation of heat. The losses in the cell result in the generation of heat, and means must be found for dissipating this. On small cells natural cooling by radiation suffices, but if the cell is to be worked for any length of time forced cooling by the circulation of air round the cell by means of a fan, or by circulating water round the cell externally or through cooling coils internally, is necessary. If air is used it is advisable not to allow it to play on the electrolyte directly as if it does so the electrolyte will evaporate rather rapidly and affect the efficiency and performance of the cell. If water is used care should be exercised so that it cannot leak into the cell, or that current can leak through the electrolyte from the plates to the piping system, as this likewise reduces the efficiency of the rectifier by increasing the total current and therewith the heating to no useful purpose. The rectifier should not be air-tight, of course, as the gases evolved while the cell is in operation must be able to escape. The efficiency of the cell depends very largely upon its temperature, which must be below 40 degrees C for best results. At about 65 degrees C the film which forms on the aluminum will break down and the cell then short circuits.

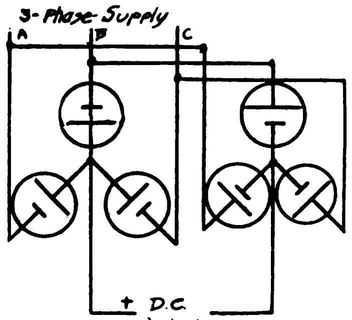

Fig. 3

The electrolytic valve or rectifier uses the asymmetrical resistance characteristic of aluminum to rectify alternating current by permitting the flow of current in one direction but by preventing its flow in the opposite direction. If one cell is conneced across the alternating current circuits the rectifier is able to utilize only one half of the alternating current wave and the wave-form of the rectified current will be pulsating in the extreme. By using one cell having two aluminum electrodes as in Fig. 1, connected to the alternating current circuit and one side of the rectified circuit taken off from the middle point of an auto-transformer, both half-waves of alternating current may be used, resulting much smoother rectified wave-form.

By using four cells both halves of the a. c. wave may be utilized, the rectified wave being far smoother yet. With the cells connected in this way (see Fig. 2), which is the way the cells are generally used upon a single phase circuit, each half-wave of current traverses two cells connected in series, and two successive half-waves are rectified in one direction and add their effects upon the external or rectified circuit. A reactance coil is usually inserted in the a. c. circuit by which to regulate the applied voltage, while it also assists in stabilizing the rectified current.

While electrolytic rectifiers are generally used only on single phase circuits there is no reason why they should not be equally applicable on three phase and two phase circuits.

For three-phase operation six rectifiers may be used as shown in Fig. 3, or three only may be used, in which case reactance coils are substituted for one group. The exact scheme of connections to be used with two-phase circuits depends on the type of distribution—whether three or four wire, but the general idea is to connect the + leads from each phase together, and also the — leads. Thus each phase helps to fill the depressions in the voltage curve of the other.

Before a cell is ready for use the film must be formed upon the anode or aluminum electrode. Until this film exists the current rush on connecting the rectifier and its load to the alternating current will be quite heavy. To place the rectifier in service it is customary first to connect the cell across the alternating current supply mains through a 100-watt lamp. This prevents excessive current flowing and permits the film to form. The process usually requires on small cells about 15 to 30 minutes. At first the lamp burns brightly and then slowly gets dimmer and dimmer until no light is visible, as the resistance film form upon the aluminum plate. The rectifier is then ready for use.

In making a rectifier for performing a definite purpose it is, of course, desirable to be able to predetermine its performance with reasonable accuracy. This can be done with the majority of electrical apparatus but the large number of factors and variables intimately related with each other in the electrolytic rectifier makes its operation rather an uncertain matter until actually tried. Two cells may be built of the same material and arranged in the same way, and yet they will not operate similarly. Nevertheless it is possible to tell before hand with sufficient precision what the voltage, efficiency, etc., is going to be, for definite electrolyte and electrodes. Experience has shown that lead or steel cathodes and ammonium phosphate for the electrolyte are the most satisfactory, and remarks will therefore be based upon this combination.

Rectifiers with the above working elements have a commercial efficiency of between 25 and 50 per cent., although claims have been made that efficiencies as high as 75% can be obtained.

The voltage of the rectified circuit bears a definite relation to that of the alternating current circuit, theoretically. While this ratio holds more or less, it is often found that surprising results are obtained by a voltmeter connected to the rectified circuit, and these results will vary with the type of instrument used. Theoretically a single cell when measured with a direct current instrument, which measures average values, will give a reading which is equal to the alternating current voltmeter reading divided by 2.22, since alternating current instruments indicate the square root of the mean square values. Using an alternating current instrument for making the measurements in both circuits it will be found that the rectified voltage is about half that of the alternating current circuit, with the cell carrying load. The condition of the electrodes, of the electrolyte and the spacing, leakage current, capacity effects are some of the factors tending to cause erratic results. One rather interesting phenomena of the electrolytic cell is that sometimes the open circuit voltage of the rectified circuit is found to be higher than that of the alternating current supply by about 30 per cent. at room temperature and about 15 per cent. when the electrolyte is hot. Directly the load is applied to the rectified circuit, however, the voltage drops to what it is expected to be, namely between 80 and 85 volts. The phenomena is due to the difference between effective values and root mean square values of a sine wave and to the influence of leakage and capacity effects.

Normally with about 115 volts to the cell, the electrolyte cool and the load on, the voltage of a new cell will be about 90 volts. It will soon drop however to between 80 and 82 where it remains. As the electrolyte heats up—about half the input is consumed in heat, usually more—the efficiency of the rectifier drops, average efficiencies on load being 35 to 45 per cent. when cool and 20 to 28 per cent. when hot, which emphasizes the importance of keeping the cells cool.

The greatest recommendations of the electrolytic rectifier are that it is obtainable so easily from material which is available almost anywhere at low cost, its simplicity and the small amount of attention required. Of course where large amounts of direct current for long periods of time are needed other apparatus would be preferable. The chemical rectifier will be found useful however, for demonstrating purposes and experimental work, for energizing electro-magnets, charging small storage batteries and similar applications requiring an unidirectional although somewhate pulsating current. In many places only alternating current is supplied, and in these instances surgeons and doctors will find the chemical rectifier convenient and economical. The so-called dry storage battery is now finding increasing favor where dry cells are not applicable.

POWER PLANT, LINE AND DISTRIBUTION PROBLEMS

A Record of Successful Practice and Actual Experiences of Practical Men

SINGLE-PHASE INDUCTION AND REPULSION MOTORS—OPERATING CONDITIONS

By T. Shutter

As stated in the article appearing on pages 31-32 of the February issue, single-phase induction motors are not self-starting unless some special means are employed.

The two methods which are used in most of the modern types of induction motors are known as split-phase and repulsion methods. The split-phase method is produced by having two windings on the stator, both being supplied from the same source, but one of the windings having a greater inductance than the other. The repulsion phase method is produced by having both the stator and the rotor wound. The rotor winding is similar to the winding of a direct-current armature, being connected to the commutator; the brushes, however, have no connection with the supply circuit, and are short circuited on each other, and the stator winding is supplied with a single-phase current.

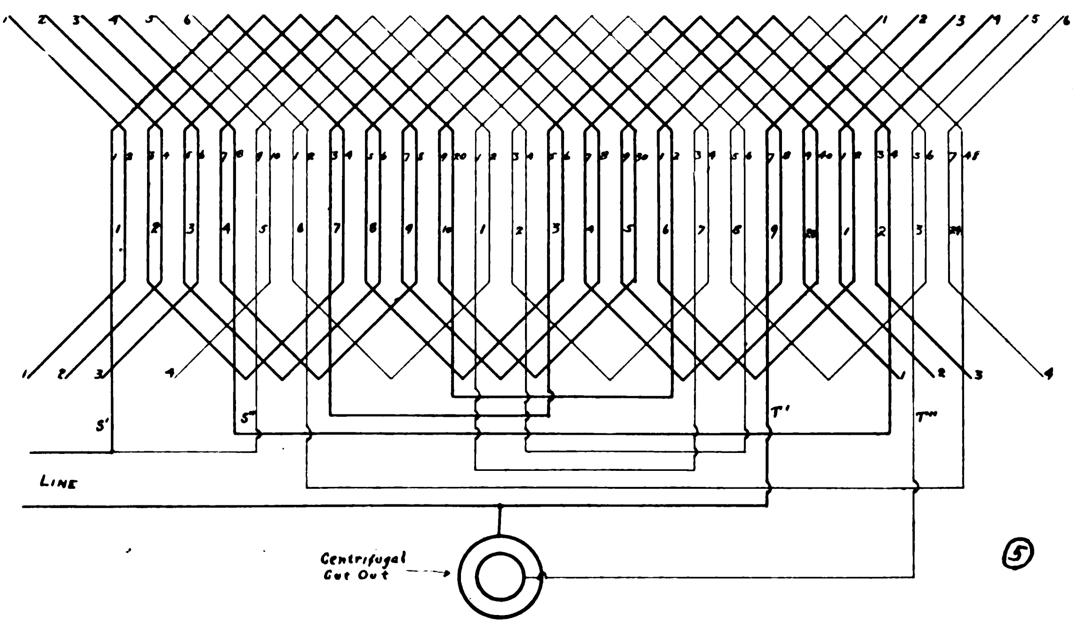

Fig. 5—Development of winding, polyphase induction motor.

Fig. 5 represents a 4-pole, 2-layer, 24-coil split-phase stator winding. The 16 coils shown in heavy lines are the running winding, and 8 coils shown in fine lines are the starting winding. This winding is divided into as many groups as there are poles. In practice this is called a whole coiled winding because the number of groups of coils and the number of poles are equal. The winding or coil pitch is expressed in the number of winding spaces that the opposite sides of a coil are apart. The number of winding spaces per slot depends on the number of coils per slot. In the above winding there are two layers or two coils per slot, so there will be two winding spaces per slot also.

The winding or coil pitch is found by the following formula:

$$Y = \frac{C \times 2}{P}, \text{ where}$$

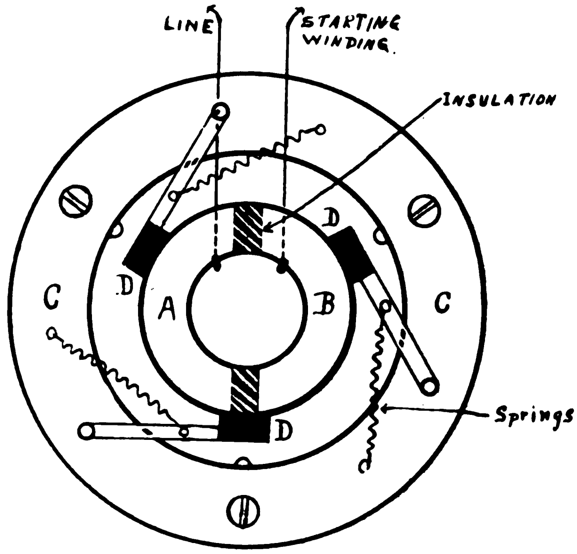

Fig. 6—C. C fastened to rotor A, B, stationary D, D, D, contacts fastened to C, C.

Y = winding or coil pitch. If the result is an even number it must be made odd by + or — 1.
C = whole number of coils to be placed.
P = number of poles.

$$\text{then } Y = \frac{C \times 2}{P} = \frac{24 \times 2}{4} = \frac{48}{4} = 12 \pm 1 = 13 \text{ or } 11.$$

The following table shows the manner in which the coils have been placed in the slots:

Coil No.	In winding spaces	In slots
R 1	1 and 14	1 and 7
R 2	3 and 16	2 and 8
R 3	5 and 18	3 and 9
R 4	7 and 20	4 and 10
S 5	9 and 22	5 and 11
S 6	11 and 24	6 and 12
R 7	13 and 26	7 and 13
R 8	15 and 28	8 and 14
R 9	17 and 30	9 and 15
R10	19 and 32	10 and 16
S11	21 and 34	11 and 17
S12	23 and 36	12 and 18
R13	25 and 38	13 and 19
R14	27 and 40	14 and 20
R15	29 and 42	15 and 21
R16	31 and 44	16 and 22
S17	33 and 46	17 and 23
S18	35 and 48	18 and 24
R19	37 and 2	19 and 1
R20	39 and 4	20 and 2
R21	41 and 6	21 and 3
R22	43 and 8	22 and 4
S23	45 and 10	23 and 5
S24	47 and 12	24 and 6

The letters R and S in front of the coil numbers represent running or starting coil.

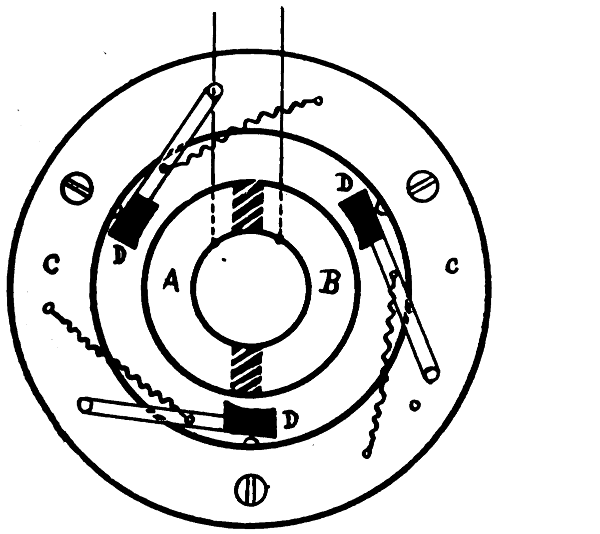

Fig. 6a.

After all 24 coils have been placed in the slots they are paired into groups, by using the following formula:

$$\frac{C \times 2}{P \times Ph \times 2}; \text{ where}$$

C = No. of coils placed
P = No. of poles
Ph = No. of phases

$$\text{then, } \frac{C \times 2}{P \times Ph \times 2} = \frac{24 \times 2}{4 \times 1 \times 2} = \frac{48}{8} = 6 \text{ coils}$$

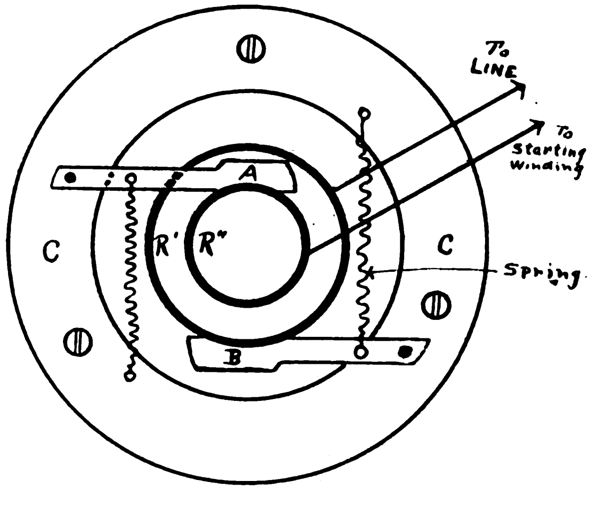

Fig. 7—C, C fastened to rotor. R R are stationary. AB complete circuit for starting winding.

per group; of these six coils per group there will be four running and two starting coils, which will be connected independent of one another; that is, the four running coils in each group will be connected in series with one another, and the same with the two starting coils of each group. When all coils have been connected into groups, the groups are then also connected in series with one another; that is, each winding for itself.

The connections for the running winding are as follows: The beginning of group No. 1 is one of the line terminals; the end of group No. 1 is connected to the end of group No. 2, the

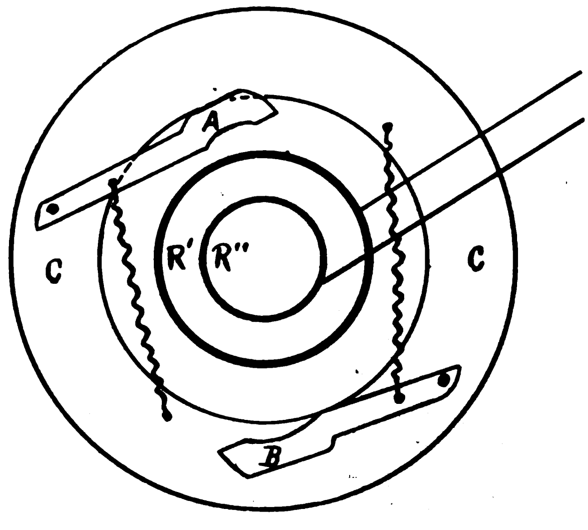

Fig. 7a.

beginning of group No. 2 connects to the beginning of group No. 3, the end of group No. 3 connects to the end of group No. 4, and the beginning of group No. 4 is the other line terminal. The starting winding is connected in exactly the same manner as the running winding, but its connection to the line is made somewhat different. In the running winding the beginnings of group Nos. 1 and 4 are connected directly to the source of supply, while only one end of the starting winding is connected directly to the line, and its other end is connected to the centrifugal switch or cutout.

This centrifugal switch or cutout is made in different ways, the details of which are shown in Figs. 6, 6a, 7, and 7a. When the rotor is at rest the contact clips or fingers are in the position as shown in Figs. 6 and 7, while Figs. 6a and 7a show their position when the rotor is in motion. It will be seen in these figures that as long as the contact clips or fingers are resting on the segments in Fig. 6 or on the rings in Fig. 7 the starting winding circuit is closed, and the current will flow through both windings; but as the starting winding is wound with a smaller size of wire than the running winding, it will be of a greater inductance and cause the current to lag. This

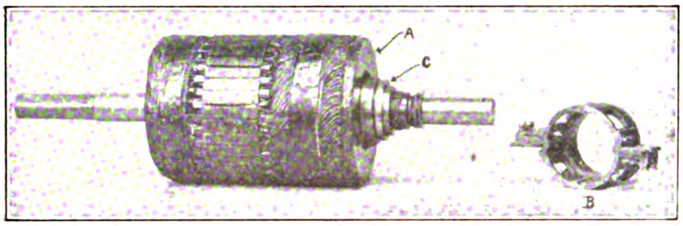

Fig. 8—Rotor of induction motor.

will result in a rotating field, on the same principle as explained in the previous installment of this series.

The repulsion motor has a winding on both the rotor and the stator. The rotor winding is the same as that on an armature wound for a direct current machine, only the brushes on the commutator of this armature have no connection with the external circuit. Fig. 8 shows a completed armature. This armature has a radical commutator as shown at A; the brush rig is shown at B. The brushes make contact on the commutator until the armature attains synchronous speed, then they are automatically pushed back off the surface by the centrifugal governor which is installed on the inside of the core.

When this governor acts it performs two function: first, it removes the brushes from the commutator; second, it short circuits the commutator, which then causes the armature to act in the same way as a squirrel cage induction rotor. The brushes are pushed back when collar *C* is thrown by the centrifugal governor. As above explained the armature is wound just as if it were to operate on a direct-current circuit.

Fig. 9 shows the field or stator; *A* is the laminated stator, which is similar in appearance to an armature, only that the

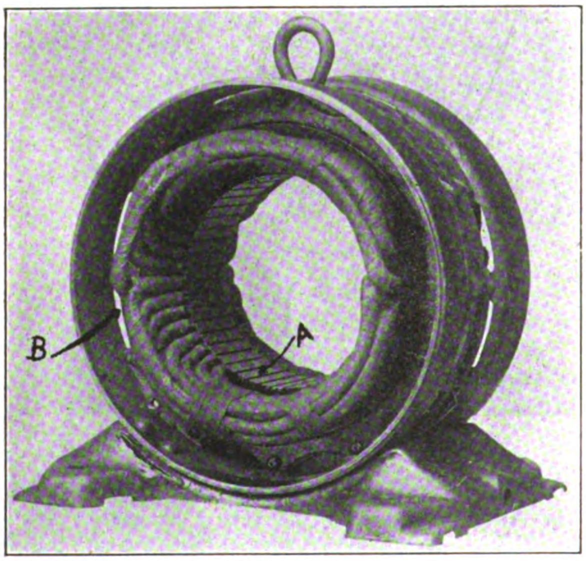

Fig. 9—Stator of induction motor.

slots are on the inner surface instead of on the outer. *B* are the windings which produce a rotating field.

Fig. 10 shows the front and back end plates or heads; 1 is the back end head and 2 is the front end head; at *B* is shown the brush rigging and holders.

The winding for the stator or field for a repulsion motor is similar to that of a split-phase winding (see Fig. 5), only all coils are wound with the same size wire.

Fig. 11 will be the winding of a stator for a 2-in. pole single-phase repulsion motor having 24 coils. The spread of the coils will be found by the formula:

$$\frac{\text{coils} \times 2}{\text{No. of poles}} = \frac{24 \times 2}{2} = \frac{48}{2} = 24;$$

this being an even number must be made odd by + or — 1; then the spread will be $24 \pm 1 = 25$ or 23. There will be two coil sides per slot, so there will be 24 slots in the stator and the following is the table showing the number of the coil and the number of the slots in which it is placed:

Coil No.	Placed in slots No.
1	1 and 13
2	2 and 14
3	3 and 15
4	4 and 16
5	5 and 17
6	6 and 18
7	7 and 19
8	8 and 20
9	9 and 21
10	10 and 22
11	11 and 23
12	12 and 24
13	13 and 1
14	14 and 2
15	15 and 3
16	16 and 4
17	17 and 5
18	18 and 6
19	19 and 7
20	20 and 8
21	21 and 9
22	22 and 10
23	23 and 11
24	24 and 12

When the coils have been placed they are then divided into a number of groups which will be equal to the number of poles, and the following formula will be used:

$$\frac{\text{Coils} \times 2}{\text{No. of poles} \times \text{No. of phases} \times 2} = \frac{24 \times 2}{2 \times 1 \times 2} = \frac{48}{4}$$

= 12 coils in series per group.

By tracing the coil connections in Fig. 11, it will be seen that coils number 1 to 12 are connected in series forming one group,

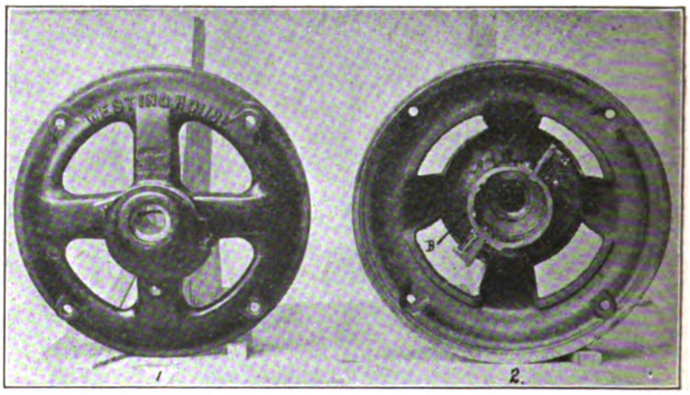

Fig. 10—End pieces showing bearings, Westinghouse induction motor.

and coils number 13 to 24 are connected in the same manner. The groups are then connected together by joining the end of the 24th coil to the end of the 12th coil. The beginning of the 1st and 13th coil are the line terminals into which a single phase alternating current will be impressed. This will set up a flux which will react on the rotor and will repel the coils in successive order, which will cause the rotor to run, and keep increasing its speed until it is almost up to synchronous speed when the centrifugal governor at *C*, Fig. 8, will throw, which will automatically lift the brushes and short circuit the commutator causing it to operate as a squirrel cage rotor.

Two questions which are often asked are: can direct current motors be operated on an alternating circuit? Can alternating current motors be operated on a direct current circuit?

A point to be kept in mind by the reader is that a winding which is designed to operate on an alternating current circuit has but one circuit per phase or winding. It is known as an open circuit winding because there will be no complete or closed circuit unless the external circuit is closed. All direct current windings have at least two circuits. They are known as closed circuit windings. Because of these reasons an alternating current winding will not operate on a direct current circuit; but some direct current windings will operate on an alternating current circuit. These motors must posses certain features in order to make it possible to operate them on either kind of circuit.

It can only be a series motor, with laminated pole pieces or an entirely laminated frame, so as to keep the eddy current losses to their lowest value.

In order to change the direction of motion of any direct current motor the direction of the current must be reversed in either the armature or the field winding. If the current in both the armature and field windings were reversed at the same time the direction of rotation would not be changed. From this it will be seen that by changing the polarity of the feeders of a series motor or any other motor it will not effect the running direction. In the feeders of a single-phase alternating current circuit the polarity constantly changes. As explained above, the changing of the polarity of the feeders will not affect the running direction; it will be observed, therefore, that this condition makes it possible to run a series direct current motor on a single-phase alternating current circuit.

It is not possible to run a shunt or compound motor on an alternating current circuit for the following reasons:

In a shunt motor, as in a compound motor, there are two circuits, the armature circuit and shunt field circuit.

The shunt field circuit has a much higher resistance than the armature circuit and they are in parallel with each other. On this account it is impracticable to change the directions of current in the armature and field circuits at the same time; while in a series motor there is but one circuit as the armature and field winding are in series with each other.

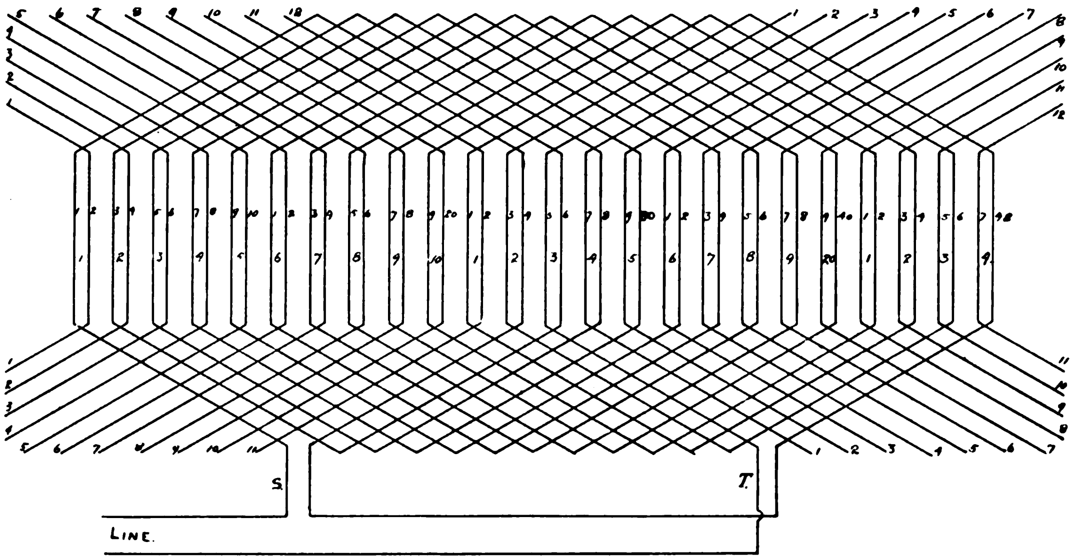

Fig. 11—Development of winding, induction motor.

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THAWING FROZEN MAINS

Thawing frozen water mains by electricity proved a profitable if somewhat trying side line of endeavor for the New York Edison Co. during the recent spell of arctic weather. More than three hundred cases were taken care of in Manhattan and the Bronx. Over in Brooklyn the Brooklyn Edison Co. was similarly employed.

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USES FOR ELECTRIC FANS

Many people have the idea that their electric fan is only usable for creating a cool breeze during warm weather. On the contrary there are many ways in which the fan will perform as a time and labor-saver in the home all the year round. For example, for drying sliced fruits and vegetables the fan is extremely useful. It also renders valuable service in speeding up indoor laundry drying on damp and rainy days, and in drying freshly painted or varnished surfaces. Placed near a wire-basket loaded with freshly washed dishes, the fan will eliminate the old-fashioned, mussy towel process. In homes heated with hot-air furnaces the fan will aid summer ventilation, if located in the cold-air shaft of the furnace. When turned on a steam radiator in winter the breeze from the fan will speed up the heating of the room. When a closet or cupboard is opened, after being closed up for a long time, an electric fan can be profitably applied to air it out thoroughly and promptly. Placed near and directed toward the open transom of a crowded office it will help to ventilate the office on cold winter days when no one wants the windows opened. The fan blows the vitiated air through the transom and into the hall.

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HEATING DEVICE WATTAGE

Toasters take 600 watts; household irons, 500 watts; laundry irons, 600 watts; hot plate, 350 watts; table stove, 600 watts; milk warmer, 500 watts; portable radiator, 600 watts; percolators, 600 watts; soldering irons, 250-400 watts; glue pots, 400-600 watts; immersion heaters, 425-660 watts.

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POLYPHASE SHUNT MOTOR

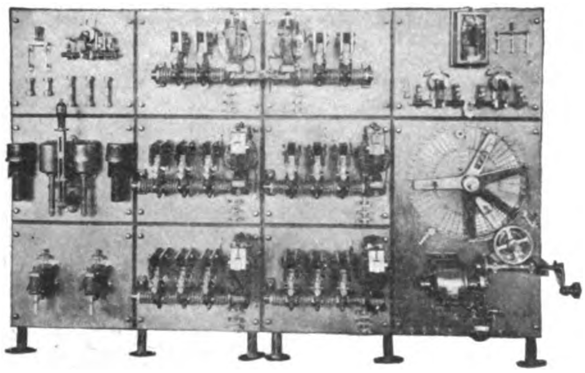
At the midwinter convention of the American Institute of Electrical Engineers in New York last month W. C. Korthals Altes presented a paper in which he said that there exists a demand for a reliable, adjustable-speed, alternating-current motor suitable for operation at a large number of speeds. He analyzed the neutralized motor with shunt field control and showed that it is not practical for commercial frequencies on account of the expensive control equipment required. He also discussed the induction motor with commutator on the secondary side. This motor may find some application for the larger outputs, he said, but the control is still too complicated to make this type of motor suitable for the smaller machine-tool drives. He concluded that the induction motor with commutator on the primary side offers the best solution for machine-tool motors. He discussed theory in detail, giving a complete description of the mechanism required to shift the brushes and the new type of armature winding used.

NEW AUTOMATIC SPEED CONTROL FOR CENTRALS

To maintain the given relative speed from roll to roll in centrals and to vary the speed of the crushing rolls as a whole without changing the predetermined relative speeds, the General Electric Company has developed a new system of electric drive and control for cane crushing rolls. The pioneer equipment is being installed in Central Cunagua, Cuba.

As the cane feed varies, the torque of the motors will also vary, and a means was necessary to maintain a given speed independent of the load. To gain these results this control was developed.

Previous practice utilized variable speed induction motors with manual speed central, through the adjustment of the secondary motor resistance, to obtain relative speed control and to reduce the output of the whole mill. With the variation



Contactor panel for controlling the speed of a form M motor by means of a balanced voltage relay and a three-phase motor-operated rheostat.

in torque experienced it was found difficult to maintain a given relative speed, and when it was desired to operate at reduced output it was found that the motors required the same power input. However, by reason of the small quantity going through the rolls, the refuse cane constituting the fuel was reduced and in order to maintain power it was necessary to make up the deficiency with wood or coal.

The new system provides for automatic control for the relative speed adjustments and a variable speed steam turbine generator to give reduced output of the mill. Each motor is served from an individual control panel which contains electrically operated switches for regulating the speed of the motor. Master controllers which control the motors through the panels are grouped at a convenient point on the mill platform and give the operator complete control of the motors, excepting that the general speed changes of the mill are made at the turbine governors. The several motors driving the individual rolls comprising a mill or tandem are operated from a turbine independent of the sugar house and speed changes of the mill will not, therefore, effect the normal operation of the motor-driven pumps and miscellaneous drives.

Operation of the whole mill over a range of 30 percent. is done efficiently by means of a change in the turbine generator speed. If the excitation of an alternating-current generator is maintained constant and the speed varied, the voltage and frequency will vary approximately. An induction motor operating at constant torque from such a generator will draw approximately the same current at different frequencies, and the power input will vary approximately as the speed. The power requirements of the mill are, therefore, in proportion to the fuel delivered by the mill and additional fuel is, therefore, not required.

NEW TRANSMISSION LINES

The Northern States Power Company has completed the transmission line connecting Franklin and Bird Island, which now connects practically all of the units of the southwestern Minnesota division of the company, serving 19 communities. With the completion of this line the steam plant at Montevideo has been shut down and will be held in reserve. Voltage regulators are being installed at Montevideo.

This improvement connects the entire southwestern division with the Minneapolis and Southern Minnesota transmission system with the exception of Pipestone and five adjacent communities.

LOUISVILLE'S SURPLUS ENERGY

The Louisville Industrial Foundation is advertising the fact throughout the country that there is at this time surplus electric power available in Louisville for industrial purposes, the power capacity referred to being that of the Louisville Gas & Electric Company. In an announcement to manufacturers of war materials the Foundation says:

"Louisville is one of the few cities of the United States having electric power for industries in excess of the present demand.

"This condition is largely due to the fact that the central station owns the mine from which it draws its coal supply and owns its coal cars. Its coal mine is just a night's run from Louisville, assuring a plentiful supply of fuel and continuity of electric power."

NEW CAPACITIES OBTAINED BY ELECTRIC CRANES

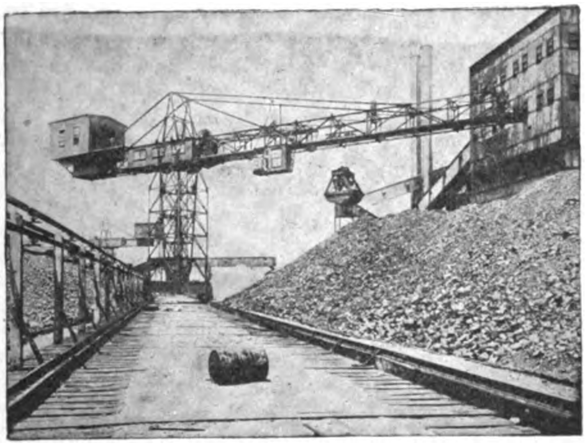
As a result of the speeding up of shipyards and industrial plants in 1917, there was a greatly increased demand for cranes, electrically operated and controlled. Six of the largest of these cranes were equipped with motors made by the General Electric Company and in most cases with G-E control. Two cranes were of 225-ton capacity the total motor rating of each aggregating 420 hp.

A third crane of the same capacity had motors with a total intermittent rating of 850 hp. The two main hoist motors each had a rating of 250 hp. for continuous, and 425 hp. for intermittent service, giving a hoisting speed for 225 tons of 40 ft. per minute, and 120 ft. per minute for 60 tons. Due to the high and variable speeds required, the large current demands could not be handled to the best advantage through the usual arrangements of rheostats and contractors, and Ward-Leonard control was, therefore, provided: this being the first application of this system of control on large cranes.

The remaining three cranes were the largest capacity units of this type ever built, being designed for a full load lift with the main hoist hook of 330 tons at 12.6 ft. per minute. The power equipment for each crane comprised two 200-hp. main hoist motors, two 105-hp. auxiliary hoist motors, and 80-hp. and a 30-hp. motor for main and auxiliary trolley, and two 50-hp. motors for bridge motion; all these capacities being intermittent ratings.

To high-speed alternating-current hammer-head coal handling gantry cranes, provided with a unique system of dynamic braking, were installed at the La Belle Iron Works plant at Steubenville, Ohio. Each crane is equipped with a 375-hp. slip ring induction motor direct coupled to a 40-hp. direct-current motor, and hoists a four-ton bucket of coal at 500 ft. per min.

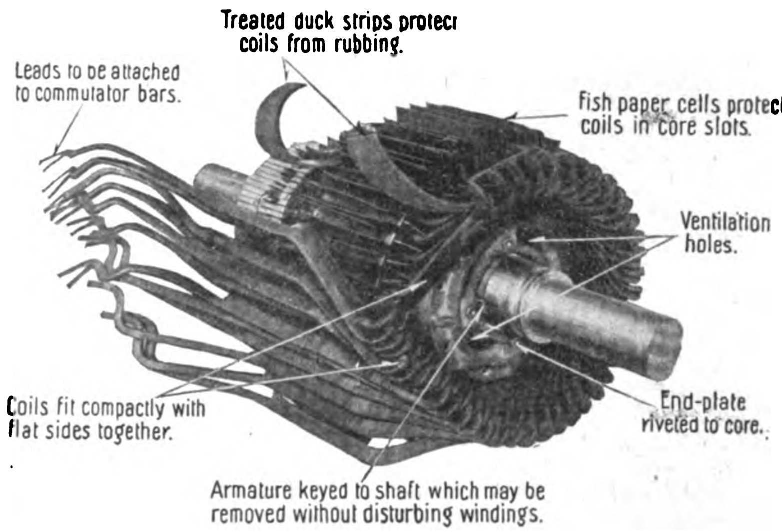
The dynamic braking is obtained by combining the small direct-current motor with the alternating-current motor so that the direct-current unit serves as an exciter and gives dynamic braking which is comparable with that ordinarily obtained with



Coal handling crane installed at the La Belle Iron Works plant at Steubenville, Ohio.

direct-current motors on this class of work. This is the first application on any large scale of this system of dynamic braking for cranes. It is more economical in first cost and has a number of practical operating advantages when compared with the method which utilizes a motor-generator set in addition to an exciter for securing dynamic braking for alternating-current hoist motors. Creeping speeds of 110 ft. per min. lowering, are obtainable with these cranes under ordinary service conditions.

TOLD IN A PICTURE



Method of putting together the modern type of armature. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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The Enid division of the Oklahoma Gas & Electric Co. is completing the transmission line to connect the Hennessey distributing system with the Enid, Okla., system. Current will be supplied from the Enid plant within a few days. Waukomis will also be supplied from this line. Several new power contracts are in prospect at the latter point and it is anticipated that the power load in this town will amount to 140 hp. in motors within thirty days after connection.

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An increase of 10 percent. in rates of power consumers of the Philadelphia Electric Company has been authorized by the Pennsylvania Public Service Commission. The advance in rates was approved by the commission on account of the higher expense of operation.

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DRYING OUT OF ELECTRICAL APPARATUS

This article was prepared originally by Chris. Jones, president of the Warwick and South Stafford Branch of the Association of Mining Electrical Engineers of Great Britain, for the benefit of those who are preparing at this time for the association examinations. It describes various methods of drying out alternating and direct current generators and motors, also alternating current transformers.

Moisture is a fruitful source of insulation failure, and no commercial insulating material suitable for windings of electrical machinery is immune from this weakness. Moisture may be absorbed in the following ways by such machinery: (*a*) in transit, (*b*) by standing for long periods out of commission and in damp atmosphere, or (*c*) by having been submerged. Before the working voltage or high voltage test is applied, all electrical apparatus should be tested for insulation resistance between the windings and frame work. For apparatus over 350 volts working pressure, the minimum insulation resistance should be above one megohm: for apparatus to work under 350 volts, the insulation resistance should be over half a megohm. This is with the apparatus cold. If moisture is suspected between successive turns, great precautions must be taken, for the writer has known cases of burnouts when the insulation resistance to earth showed a high value. When the insulation resistance values are below the above figures, it is necessary for the apparatus to be dried out.

Drying out may be accomplished, first, by passing current through the windings at low voltage; second, by placing the apparatus in an oven which is heated by steam or by hot air; third, by surrounding the apparatus with charcoal stoves or electric radiators or by incandescent lamps; fourth, by heating the apparatus over gas stove, or by means of blow lamps.

An alternating current generators may be dried out by means of its own current, as shown in Fig. 1. The stator windings A'A''A''' are short circuited at M, leaving the ammeter and circuit breaker in circuit. The machine is brought up to normal speed so as to be on the governors of the prime mover, and the field current is then varied until about 25 percent. more than normal full load current flows through the stator windings. When a safe temperature, of 70 to 90 centigrade, is reached, the field current is adjusted to maintain this at a steady value. During the drying out the stator connections are examined for excessive local heating. This may be due to poor rivetting or soldering. In the case of a turbo alternator it is best to stop up the air inlet in order to expedite the rise of temperature.

The field current may be from the exciter, or from an external source. In case the range of the exciter rheostat is not sufficient to allow the field current to be low enough, an additional temporary rheostat should be introduced.

The drying out may have to be carried out for 12 hours or possibly longer. No hard and fast rule can be laid down, as it is obvious two machines of equal output but of greatly different speeds may have very different insulation resistances. There are fewer coils and less total surface area of insulation in the case of the high speed machine than in that of the low speed machine.

A method which the writer adopted during erection of a

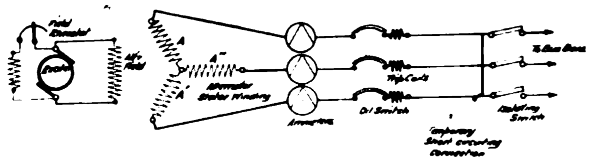

Fig. 1

standby plant was as follows: immediately the alternator was fixed on the bed plate, the drying out was proceeded with in order that the set could be put on load directly the steam side was complete. The neutral point and all the phase ends of the stator were accessible and the connections were made as in Fig. 2. Supply from a direct current lighting set was used; the period of drying out was 80 hours because the alternator had been transshipped during wet weather.

Direct Current Generator.—This can be dried out by short circuiting the armature through an ammeter and driving it at a low speed with a weak field, the field current and speed being adjusted to give the required temperature. As field coils are less vulnerable to moisture than the armature winding, the lat-

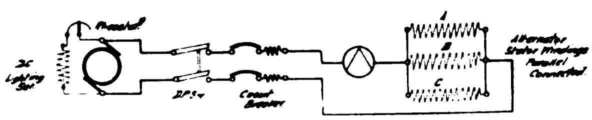

Fig 2

ter usually requires most attention. The field coils may be dried by connecting in parallel and passing through them low voltage current from an external. If the coils were connected in series, full line volts would have to be applied to obtain sufficient current, and this higher pressure might break down the insulation.

Direct Current Motor.—At one large direct current colliery plant a portable motor generator is available to give low voltage supply for drying out purposes. There is also a high voltage generator for double pressure tests of the cables and apparatus.

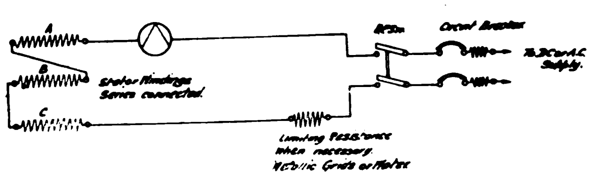

Fig. 3

Three-Phase Motor.—Motors having a short circuited rotor may be locked to prevent rotation and low voltage applied to stator winding sufficient to give full load current as shown in Fig. 3. About 10 percent. of the normal voltage is usually found sufficient.

The same procedure may be applied to a three-phase slip ring motor, the slip rings being short circuited. A slip ring motor may also be treated as a generator by short circuiting the stator windings and applying direct current to two of the rotor slip rings; the rotor being driven by external means. In this case care must be taken that the stator winding is not "opened" whilst pressure on the rotor.

Synchronous Motors.—These may be dried in the same way as an alternating current generator except that the machine must be driven by external means.

Incandescent lamps may be used to dry out motors The end shields of the motors are replaced by iron sheets and the lamps are placed inside. Small motors may be dried by covering the motor with an iron box, and fixing a bank of lamps inside the box.

In order to obtain low voltage current for three-phase motors, the writer uses a three-phase portable transformer giving on the low tensions side 3000, 1200, 1100, 1000, 900, 800, 600, 500, 400, 300, 200, and 100 volts. The 1200-volt tapping is to supply double working pressure for testing cables and apparatus. The transformer is designed to give suitable kilovolt-ampere rating at the low voltage, because it is used as a standby for certain underground substations. The kilovolt-ampere rating with the low volt tappings is at the expense of regulation. The transformer has been of great service and the outlay on it has been quite justified.

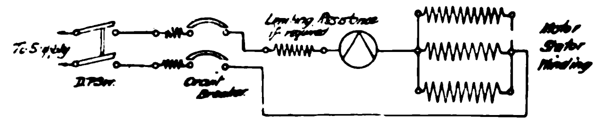

Fig. 4

The writer also uses a transformer to give 25 and 50 volts on the low tension side for drying out repaired windings.

Figs. 4 and 5 show methods of drying transformer windings. Drying of apparatus by low voltage current gets to the root of the matter. It is important that close supervision be kept on apparatus while it is being dried electrically since there is danger of overheating minor portions of the windings where temperature cannot be measured. Megger or insulation resistance tests are useful but it is necessary to take more than one reading. Even so, it is no criterion of the ability of the appartus

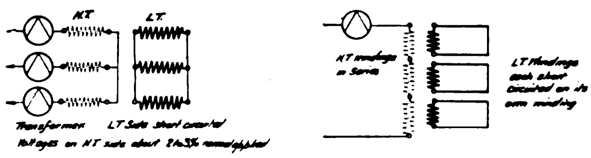

Fig. 5

to withstand punctures. When a series of readings has reached constant value, it shows that the apparatus is dry.

Care should be taken to make all measurements at the same temperature since the insulation resistance of commercial insulating material varies very considerably with temperature. The evaporation of moisture from a substance depends on the condition and temperature of the surrounding air and ceases as soon as the air becomes saturated. Capacity of air to contain moisture increases rapidly with the temperature. If moisture settles on the outside of copper, it may, in the drying process, work its way through the insulation and cause drop of insulation during drying. The insulation will subsequently increase to a steady value when the moisture has been completely dried out.

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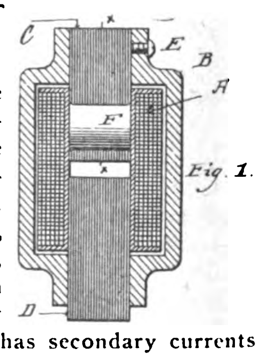
ALTERNATING CURRENT ELECTROMAGNET



The difficulties (as chattering of the armature etc.) of operating electromagnets by single phase currents have long been known and various expedients have been adopted to avoid them.

In a patent recently granted to him, Mr. David L. Lindquist, of Yonkers, N. Y., proposes a magnet as shown in the cut. A solid bar F extending through the laminations of the care has secondary currents induced in it. This and the primary current prevent the magnetic pull from falling to zero and avoids chattering. The device would be effective if the bar was placed in other locations. It might be in the movable plunger D. Patent No. 1,186,011.

EDITORIAL

A PLEA FOR ELECTRICITY

Due to the severe weather of the last two months, many of the gas pipes leading into homes in the Metropolitan district of Greater New York have become clogged with water of condensation. This has interfered with the free flow of gas and is directly responsible for more than two hundred deaths by asphyxiation in the short period of eight weeks. The gas jet turned down at night has, in all these cases, been snuffed out by a slight decrease in the pressure in the mains, however short this interval of subnormal pressure. With no one awake and at hand to attend to matters when the pressure came on again, the gas soon filled the room and despatched the unfortunate one who happened to be in it. So serious has become the menace from this source that both the health and school authorities have combined to instruct the public in the dangers in the use of this form of illuminant.

The time of the school and health authorities thus diverted could be devoted to the purposes for which they were more especially created could all householders be induced to take on electric service, and to substitute incandescent lamps for gas jets in all the living and sleeping rooms of the home. Unlike gas pipes, electric service wires do not condense and freeze; the electric pressure can go up and down at will without causing anything more annoying than temporary inconvenience; there are no fumes, nothing to prolong sleep indefinitely and send the witless one over the border. In this neighborhood electric service has so many advantages over gas service for every purpose except that of cooking that it is hard for anyone to keep patience with those who use gas for illuminating purposes when reliable and non-meanacing electric service can be had for about the same price.

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THE THIRD LIBERTY LOAN

We are on the verge of the greatest drive for money in the history of this or any other country. Beginning April 6, the U. S. Government will float the Third Liberty Loan, the amount to be somewhat in excess of the Second Loan floated last November which netted the Government close to four and a half billion dollars. Regardless of what one may think concerning the conduct of the war in this, that, or the other particular—we all think at times that we could do many things better than the other fellow seems to be doing them—it is our duty to stop fault finding and wasting valuable time and energy over ironing out wrinkles and help to get the money that the government needs for the thousand and one purposes incident to war. The main thing at issue now is not what is our politics, or our theory and practice in the line of social behavior and business activity, but to help the Government in its efforts to train, equip, and transport our fighting men to the other side. A Liberty Loan calling for five billion dollars means that about every person in the country will have to buy at least one fifty dollar bond in order to make the loan a success. In loyalty to those who are willing to give their lives for their country at this time, we are duty bound, come what may, to prove beyond doubt to those who have entered the service, that the rest of the country is backing them in spirit and with cash. Every dollar saved from now on will help. There is an infinite variety of ways of spending; there is only one way of saving, and that is not to spend. Not to spend, then, must be our shibboleth until the end of the war. When the war ends we will get our reward in three ways—in the consciousness of duty well done, in the shape of interest contributed semi-annually by Uncle Sam, and in acquired habits of thrift that will prove a bulkwark against the threatenings of illness, unemployment, and old age.

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WHITE COAL, AND BLACK

Every twenty-four hours, well-informed engineers tell us, energy equivalent to one million tons of coal is thriftlessly allowed to go to waste. In a pitiful sort of way we curtail our allowances for food, clothing, shelter, and recreation in order that we may have the wherewithal to help the Government in time of need by buying twenty-five cent thrift stamps. Just now, we buy about two million dollars worth of these stamps every day. In a way that smacks of the tragic, we supinely let the price of a million tons of coal slip through our fingers in the same interval of time. Crediting ourselves with two million and debiting ourselves with about five million dollars means, among other things, a distressful looking trial balance at the end of the month. All this because of prolonged blether year in and year out by our tireless talkers at Washington. What we want now, what we want all the time, in peace as well as in war, is less chin music and more coal, white coal or black, we are not particular which, so long as it comes as we need it and at a price within reach of our pocketbooks. Get it we

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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?

can if some one will find a way to harness the waters and bridle the talkers. The key to the fuel problem is more hydroelectric powerhouses, transmission lines, sub-stations, and efficient distribution and utilization of the electrical energy derived from this source. Utilizing the white coal in this way will do more than anything else to release black coal for use in places far removed from the electric zones; it will relieve the railroad situation by releasing cars; it will serve to move our base of supplies that much closer to the workers and fighters across the ocean. More than any other one thing, the prompt harnessing of our water powers will help win the war.

As the New York *World* well says, is it not amazing that it should have taken a great war, an unprecedented cold wave bearing death and disaster, and a nation-wide coal famine to bring this manifest economy within practicable reach? Between monopolists wishing to grab everything in sight and idealists unwilling to move until all their superfine scruples are satisfied, many millions of horsepower are being wasted for lack of legislation. Meantime it is saddening indeed to find page after page of the *Congressional Record* devoted to windy debate on the Garabed resolution—a resolution which has to do with producing something from nothing—while ton after ton of white coal slips past and is gone forever!

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PLATINUM COMMANDEERED

Late last month orders were issued from Washington commandeering for war purposes all the crude and unworked platinum in this country in the hands of importers, jobbers, and wholesalers. The rapidly increasing use of this comparatively rare metal in the manufacture of munitions is the reason for this step. The War Department will undertake to see that the orders are enforced. Owing to the increasing consumption and decreasing production of platinum since the outbreak of the war, the world's supply has continuously grown smaller. Most of the world's supply of platinum comes from the Ural Mountains in Russia, and this supply has been practically shut off by political strife and industrial paralysis in that troubled country. Used quite extensively in the manufacture of electrical goods, particularly as leading-in wires in incandescent lamps, this far reaching and unrestricted order from the Government cannot help but affect in serious measure those branches of the electrical industry in which this valuable metal is indispensable. The effect on the manufacture of lamps will be watched with more than ordinary interest.

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EFFICIENCY VS. CO-ORDINATION

About the time the war broke out, it was the fashion in engineering circles to talk a lot about and make an occasional stab at "efficiency." Made in Germany, but called by a more guttural name there, efficiency was utilized in creating the self-opinionated supermen to whom we are indebted for all of our present measure of distress. Like other things of German make, it has become unpopular over here. It is showing signs of decay. We do not find it used as frequently as we did three years ago. In place of it, we now have "co-ordination." Co-ordination demands a pulling together, while its Prussian predecessor implied a sort of every fellow for himself and the devil take the hindmost philosophy of life. An efficient person could be as selfish and arrogant as he dare be. A body who co-ordinates properly cannot very well be either selfish or arrogant. He must be so attuned morally and spiritually so as to synchronize in a useful and not inefficient way with his fellow workers and playmates. This change in fashionable diction is welcome for more reasons than one. An efficient bricklayer may lay seven and a half more bricks per half hour than an inefficient bricklayer, but he does not grow more lovable over the job. The highly efficient person is not an easy person to live with, even if he does take the cake as a bricklayer. Seeming to lose his human weaknesses he waxes self-righteous, is wont to belabor his associates, and ends by being socially intolerable. We think a properly co-ordinated body would be more to one's liking, because to co-ordinate he must be ready to work or play with the other fellow at the right time and in the right way. He is more of a human being and less of a machine, more like a Tommy or Poilu and less like the Boche of unpleasant memory. Give us, then, cheerful co-ordinates to work and play with in place of nervous, irritable efficients, even at the expense of seven and a half bricks per half hour.

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LIGHT, LIQUOR AND SMOKE

Commenting last month on the perverse nature of self-indulgent Americans, one of our illuminating experts told the members of the national illuminating society that as a people we spend more each year for wine that mocks and strong drink that rages than we do for lighting our towns. Between John Barleycorn, unconverted, and kilowatt hours, converted, J. B. has the call. In the opinion of this same authority, my Lady Nicotine is almost as seductive a siren as the more masculine demoralizer. Between the two seducers, converted kilowatt-hours have a depressing time of it. In company with John Barleycorn, Lady Nicotine consumes a billion dollars a year as compared with about half a billion for illumination. What this authority would like us to have, perhaps, is more light and less headache and smoke. Well, as the Bard of Avon says, instead of railing at what is, let us be thankful that things are no worse. Let us get what comfort we can from knowing that every time a lamp is turned on it means that much saved from the clutches of the twin demons, rum and tobacco. Strange to say, though, our wet goods emporiums are always brilliantly illuminated; and 'tis an undenied fact that no one can smoke in the dark. Where drinking and smoking are, there the lamps burn longest and brightest. Though the saloons are big revenue producers for the lighting companies, let us not be discouraged. Though men may drink and women smoke, there is some solace in knowing that every incandescent lamp that glows 'mid the fumes of alcohol and tobacco shines, as did Portia's candle, like a good deal in a naughty world.

CONTEST OF THE FREQUENCIES

By B. G. Lamme

(*Concluded from page 41, February issue*)

However, it is not this average voltage which fixes the flashing conditions, but it is the maximum voltage between bars, and this is dependent upon the average voltage and upon the ratio of the pole width to the pole pitch. Here is where one of the serious difficulties came in. As mentioned above the pole pitch is directly dependent upon the peripheral speed of the armature core and the frequency. Therefore, in a 60-cycle machine, if the peripheral speed is fixed, the pole pitch is at once fixed. For example, with an armature peripheral speed of 7200 ft. per min., which was considered high at that time, the pole pitch becomes 12 in., regardless of any other considerations, and here was where a most serious difficulty was encountered. If a sufficiently wide neutral zone for commutation was allowed the interpolar space became so wide that there was not enough left for a good pole width. For instance, if the interpole space was made 6 in. wide, in order to give a sufficiently wide commutating zone to prevent sparking or flashing, due to fringing of the main field, then this left only 6 in. for the pole face. With this relatively narrow pole face the ratio of the maximum volts to the average volts was so high that with the 36 commutator bars per pole the machine was sensitive to arcing between commutator bars, thus resulting in flashing. By widening the pole face this difficulty would be lessened or overcome, but with the fixed pole pitch of 12 in. the neutral zone would be so narrowed as to make the machine sensitive to sparking and flashing at the brushes. Thus, no matter which way we turned we encountered trouble. Obviously there were two directions of improvement, namely, by increasing the number of commutator bars, thus reducing the average voltage, and by increasing the pole pitch, thus allowing relatively wider poles with a given interpolar space. These two conditions look simple and easy, but it took several years of experience to attain them. When we have reached apparent physical limitations in a given construction, especially when such limitations are based upon long experience, we have to feel our way quite slowly toward higher limitations. For instance, in the case of the 60-cycle converters we could not boldly jump our peripheral speeds 20 to 25 percent. higher and simply assume that everything was all right. We first had to build apparatus and try it out for a year or so. Troubles, due to peripheral speed, do not always become apparent at once, and thus times tests were necessary. Therefore, while the peripheral speeds of the 60-cycle synchronous converters were actually increased 20 to 25 percent. practically in one jump, yet it took two or three years of experimentation and endurance tests before the manufacturers felt sure enough to adopt the higher speeds on a broad commercial scale. Thus, while the change from the older more sensitive type of 60-cycle converter to the later type occurred commercially within a comparatively short period, yet the actual development covered a much longer period.

Let us see now what an increase of 25 percent. in the peripheral speeds actually meant. As regards the commutator, the number of bars could be increased 25 percent., that is, from 36 to 45 per pole, which was comparable with ordinary d-c. generator practice. In the second place, an increase of 25 percent. in the peripheral speed of the armature core meant a 15-in. pole pitch, where 12 in. was used before. Assuming, as before, a 6-in. interpolar space, then the pole face itself became 9 in. in width instead of 6 in. or an improvement of 50 percent. In fact, this latter improvement was so great that some manufacturers did not consider it necessary to increase the number of commutator bars, although in our machines both steps were made.

The above improvements so modified the 60-cycle converter that it began to approach the 25-cycle machine in its general characteristics. It was still quite expensive compared with the 25-cycle, due to the large number of poles, and its efficiency was considerably lower than its 25-cycle competitor, on account of high iron and windage losses. However, due to the need for such a machine it was gradually making headway, in spite of handicaps in cost and efficiency.

Almost coincident with the initiation of the above improvements in the 60-cycle converter, came another factor which has had much to do with the success of this type of machine. This was the advent of the turbo-generator for general service. As stated before, one of the handicaps of the 60-cycle converter was in the non-uniform rotation of the engine type generators which were common in the period from 1897 to about 1903 or 1904. But, about this latter date, the turbo-generator was making considerable inroads on the engine-type field and within a relatively short period it so superseded the former type of unit, that it was recognized as the coming standard for large alternating power service. With the turbo-generator came uniform rotation and this at once removed one of the operating difficulties of the 60-cycle converters. However, in the early days of the turbo-generator, 25 cycles still was in the lead and many of the earlier generators were made for this frequency, especially in the larger units. But it was not long before it was recognized that 60 cycles presented considerable advantage in turbo-generator design due to the higher permissible speeds. In the earlier days of turbo-generator work, this was not recognized to any extent, as the speeds of all units were so low that the effect of any speed limitations was not yet encountered. For instance, a 1500-kw., 60-cycle turbo-generator would be made with six poles for 1200 revolutions, while a corresponding 25 cycle unit would be made with two poles for 1500-revolutions. This slightly higher speed at 25 cycles about counterbalanced the difficulties of the two-pole construction compared with the six-pole. However, before long, more experience enabled the six pole, 60-cycle machine to be replaced at 1800 revolutions, and a little later by two poles at 3600 revolutions. This, of course, turned the scales very much in the other direction. In larger units, however, the advantage still appeared to be in favor of 25 cycles, but in the course of development, 1500 revolutions was adopted quite generally for 25-cycle work, and this was the limiting speed, as such machines had only two poles, or the smallest number possible with ordinary construction. On the other hand, for 60 cycles, 1800 revolutions was adopted quite generally for units up to almost the extreme capacities that had been considered, consequently the constructional conditions in the large machines swung in favor of 60 cycles. Therefore, with the coming of the steam turbine and the development of high-speed turbo-generator units, the tendency has been strongly toward 60 cycles. This, with the greater perfection of the 60-cycle converter, had much to do with directing the practice away from the 25 cycles.

However, there were other conditions which tended strongly toward 60 cycles. In the early development of the induction motor, the 25-cycle machines were considerably better than the 60-cycle and possibly little or no more expensive. However, as refinements in design and practice came in, certain important advantages of the 60-cycle began to crop out. For instance, with 25 cycles there is but little choice in speed, for small and moderate size motors. At this frequency a four-pole motor has a synchronous speed of only 750. The only higher speed permissible is 1500 revolutions with two poles, and it so happens that in induction motors the two-pole construction is not materially cheaper than the four pole, consequently the principle advantage in going to 1500 revolutions was only in getting a higher speed where such was necessary for other reasons than first cost.

However, in 60 cycles the case is quite different, where a four-pole machine can have a speed of 1800 revlutions, synchronous, a six pole, 1200; an eight pole, 900; and a ten pole, 720 revolutions. In other words, there are four suitable speed combination where a 25-cycle motor had only one. Moreover, with the advance in design it developed that these higher speed 60-cycle motors could be made with nearly as good performances as with the 25-cycle motors of same capacity, and at somewhat less cost. However, leaving out the question of cost, the wider choice of speeds alone would be enough to give the 60-cycle motor a pronounced preference for general service.

However, there is one exception to the above. Where very low-speed motors are required, such as 100 rev. per min., the 60-cycle induction motor is at a considerable disadvantage compared with 25 cycles, or this has been the case in the past. It is partly for this reason that the steel mill industry, through its electrical engineers, adopted 25 cycles as standard some ten or fifteen years ago. At that time, it was considered that in mill work, in general, there would be need for very low-speed motors in very many cases. However, due to first cost, as well as other things, there has been a tendency toward much higher speeds in steel mill work, through the use of gears and otherwise, so that part of this argument has been lost. However, there still remain certain classes of work where direct connected very low-speed induction motors are desirable and where 25 cycles would appear to have a distinct advantage.

In view of the above considerations, steel mill work has heretofore gone very largely toward 25 cycles, particularly where the mills installed their own power plants. However, in recent years there has been a pronounced tendency toward purchase of power, by steel mills, from central stations, and the previously described tendency of central stations toward 60 cycles has forced the situation somewhat in the steel mills, particularly in those cases where the central power supply company can furnish power at more reasonable rates than the steel mill can produce in its own plant. This, therefore, has meant a tendency toward 60 cycles in steel mill work, even with the handicap of inferior low-speed induction motors. But, on the other hand, remedies have been brought forward even for this condition. The great difficulty in the construction of low-speed, 60-cycle induction motors is in the very large size and cost if constructed for normal power factors, or the very low power factor and poor performance if constructed of dimensions and costs comparable with 25 cycles. In the latter case the extra cost is not entirely eliminated because a low power factor of the primary input implies additional generating capacity, or some means for correcting power factor on the primary system. However, in some cases it is entirely practicable to correct the power factor in the motors themselves by the use of so called "phase advancers" of either the Leblanc or the Kapp type. Such phase advancers are machines connected in the secondary circuits of induction motors and so arranged as to furnish the necessary magnetizing current to the rotor or secondary instead of to the primary. In this way the primary current to the motor will represent largely energy and the power factors can be made equal to, or even much better than in, the corresponding 25-cycle motor; or, in some cases, the conditions may be carried even further so that the motor is purposely designed with a relatively poor power factor, in order to further reduce the size and cost, and the phase advancers are made correspondingly larger. In those cases where the cost of the phase advancer is relatively small compared with the main motor, there may be a considerable saving in the cost of the main motor and then adding part of the saving to the cost of the phase advancer.

One difficulty in the use of phase advancers is found in the variable speeds required in some kinds of mill work. In those cases where flywheels driven by the main motors are desirable to take up violent fluctuations in load, it is necessary to have considerable variations in the speed of the induction motor, in order to bring the stored energy of the flywheel into play. Unfortunately this variable speed in the induction motor is one of the most difficult conditions to take care of with a phase advancer, so that here is a condition where the 60-cycle motor is at a decided disadvantage.

Thus it may be seen from the above that even in the steel mill field, where the induction motor has the most extreme applications, there is quite a strong tendency toward 60 cycles, due to the purchase of power from central supply systems.

There remains one more important element which has had something to do with the tendency toward 60 cycles, namely, the transmission problem. In the earlier days of transmission of alternating current, 25 cycles was considered very superior to 60 cycles due to the better inherent voltage regulation conditions. At one time, it was thought that 60 cycles had a very limited field for transmission work. However, a number of power companies in the far west had installed 60-cycle plants, principally for local service and with the growth of these plants came the necessity for increased distance of transmission through development of water powers. At first it was thought they were badly handicapped by the frequency, but gradually the apparent disadvantages of their systems were overcome and the distances of transmission were extended until it became apparent that they could accomplish practically the same results as with 25 cycles. Part of this result has been obtained by the use of regulating synchronous condensers. It is a curious fact that the possibility of synchronous motors used as condensers for correction of disturbances on transmission systems, has been known for about 25 years, but it is only within quite recent years that they have come into general use as a solution of the transmission problem, and largely in connection with 60-cycle plants. In 1893 the writer applied for a patent on the use of synchronous motors as condensers for controlling the voltage at any point on a transmission system by means of leading or lagging currents in the condenser itself. A broad patent was obtained, but there was no particular use made of it until it had practically expired.

Another improvement came along which still further helped to advance 60 cycles to its present position, namely, the use of commutating poles in synchronous converters. The principal value of commutating poles in the 60-cycle converters, has not been so much in an improvement in commutation over the older types of machines, as in allowing a very considerable reduction in the number of poles with corresponding increase in speed, resulting in reduction in dimensions. As a direct result of this increase in speed the efficiencies of the converters have been increased. If, for instance, the speed of a given 60-cycle converter can be doubled by cutting its number of poles to one-half, while keeping the same pole pitch and the same limiting peripheral speed, then obviously the amount of iron in the armature core is practically halved and, at the same magnetic densities, the iron loss is also practically halved. Also with the same peripheral speed and half diameter of armature the windage losses can be decreased materially. Thus the two principal losses in the older converters have been very much reduced. There have also been reductions in the total watts for field excitation, and in other parts, so that, as a whole, the efficiency for a given capacity 60-cycle converter has brought up quite close to that of the corresponding 25-cycle machine, even when the latter is equipped with commutating poles. This gain of the higher frequency compared with the lower is due to the fact that the lower-frequency machine was much more handicapped in its possibilities of speed increase, and furthermore, the iron losses and windage represented a much smaller proportion of the total losses in the low-frequency machine. This improvement in the efficiency of the 60-cycle converter together with the lower losses in the 60-cycle transformer as compared with the 25-cycle, has brought the 60-cycle equipment almost up to the 25-cycle, so that the difference at present is not of controlling importance. This development has given further impetus toward the acceptance of 60 cycles as a general system.

Formerly a serious competitor with the 60-cycle converter was the 60-cycle motor-generator. This was installed in many cases because it was considered more reliable and more flexible in operation than the synchronous converter. Both of these claims were true to a certain extent. However, with improvements in the synchronous converter the difference in reliability practically disappeared but there remained the difference in flexibility. In the motor-generator set, the d-c. voltage could be varied over quite a wide range, while in the older 60-cycle rotaries the d-c. voltage held a rigid relation to the alternating supply voltage. However, with the development and perfection of the synchronous booster type of converter, flexibility in voltage was obtained with relatively small increase in cost and minor loss in economy. This has been the last big step in putting the 60-cycle converter at the front as a conversion apparatus, so that to-day it stands as the cheapest and most economical method of converting alternating current to direct current. Moreover, while the 25-cycle synchronous converter has apparently reached about its upper limit in speed, there are still possibilities left for the 60-cycle converter.

In line with the above it is of interest to note that for units of 1000 kw. and less, the 60-cycle converter has nearly driven the 25 cycle out of business from the manufacturing standpoint. For the very large size converters, 25 cycles still has the call, but largely in connection with many of the railway and three-wire systems, which have been installed for many years; that is, the growth of this business is in connection with existing generating systems. However, the 60-cycle converter, in large capacity units, is gaining ground rapidly and it is of interest to note that the largest converters yet built, namely, 5800 kw., are of the 60-cycle type.

One most interesting point may be brought out in connection with the above described "battle of the frequencies," namely, it was fought out in the operating field, and between conditions of service, and not between the manufacturing companies. This is a very good example of how such matters should be handled. Here the engineers of the manufacturing companies were expending their efforts to get all possible out of both frequencies, and consequently development proceeded apace. When 60-cycle frequency seemed to be overshadowd by its 25-cycle competitor, the engineers took a lesson from the latter and proceeded to overcome the shortcomings of the former. It was no innate preference of the designing engineers that has brought the higher frequency to the fore; it was the recognition that it had greater merits as a general system, if its weak points could be sufficiently strengthened; and, therefore, the engineers turned their best efforts toward accomplishing this result.

It must not be assumed, for a moment even, that because 60 cycles appears to be the future frequency in this country, that 25 cycles was a mistake. Decidedly it was not. In reality it formed a most important step toward the present high development of the electrical industry. Many things we are now accomplishing with 60 cycles would possibly never have been brought to present perfection, if the success of the corresponding 25-cycle apparatus had not pointed the way. The success of the 25-cycle converter, and the high standard of operation attained, gave ground for belief that practically equal results were obtainable with 60 cycles. Therefore, the 25-cycle frequency served a vast purpose in electrical development; it was a high class pacemaker, and it isn't entirely outdistanced yet.

There has been considerable speculation as to what two standard frequencies would have met the needs of the service in the best manner, and would have resulted in the greatest development in the end. It has been claimed by some, that 50 and 25 cycles would have been better than 60 and 25. In the earlier days possibly the former would have been better, but as a result both standards might have persisted longer. In any case, the general advantages would have been small. In one class of machines, namely, frequency changers, consisting of two alternators coupled together, the 25-50 combination would certainly have been advantageous.

Again it has been questioned whether 30 and 60 cycles would not have been a better choice. This was the original Westinghouse choice of requencies, but not on account of frequency changers. As stated before, it was felt that 30 cycles could do about all that 25 cycles could, and would give an advantage of 25 percent. higher speed in motors and converters, with correspondingly higher capacities. Also for direct coupled alternators, the two-to-one ratio of frequencies would fit in nicely with engine speeds, in most cases. Possibly, from the present viewpoint, the choice of 30 cycles, would have longer retained the double standard.

Something further may be said regarding the 40-cycle system, brought out by the General Electric Company. This contained many very good features for the time it was brought out. It was then believed that if the 60-cycle frequency was retained, the double standard was necessary. The 40-cycle system was an attempt to eliminate this double standard. It apparently furnished a better solution than 60 cycles then promised for the synchronous converter problem, and was a fair compromise in about everything else. But it came too late for the 25-cycle system was too firmly entrenched, and for further development, the designing engineers preferred to expend their energies in seeing what could be accomplished with 60 cycles, as this seemed to present greater possibilities than either 25 or 40, if it could be sufficiently perfected. Thus the 40-cycle system probably missed success due to being just a little too late.

As to 50 cycles, it was stated that this is still in use to a limited extent. Most of the 50-cycle plants in this country are in California. Such plants were started during the nebulous period of the frequencies, and have persisted, to a certain extent, partly because certain 60-cycle apparatus could be easily modified to meet the 50-cycle requirements. Also, as 50 cycles is the standard in many foreign countries to which this country exports equipment, the use of 50 cycles in some home plants has not been unduly burdensome from the manufacturers' standpoint.

In addition to the preceding, there have been certain classes of electric service which have depended upon frequency, but which have not been a determining factor in fixing any particular frequency. Among these may be considered commutating types of a-c. apparatus. The first a-c. commutating motors of any importance, which appeared, were, of course, the 25-cycle, single-phase railway motors. These as a rule have operated from their own generating plants, or from other plants through frequency-converting machinery. One exception in the railway work may be noted in the use of 15 cycles on the Visalia plant in California. There is a pretty well defined opinion among certain engineers experienced in such apparatus that some low frequency, such as 15 cycles, would present very considerable advantages in the use of single-phase railway motors in very heavy service, such as on some of the western mountain roads. Here the problem is to get the largest possible motor capacity on a given locomotive, and the main advantage of the lower frequency would be in allowing a very materially higher capacity within a given space. This does not imply reduced weight or cost compared with the 25 cycles, but simply means greater motor capacity. With the modern, more highly developed, single-phase types of railway motors, it would appear that there may be very considerable possibilities in 15 cycles.

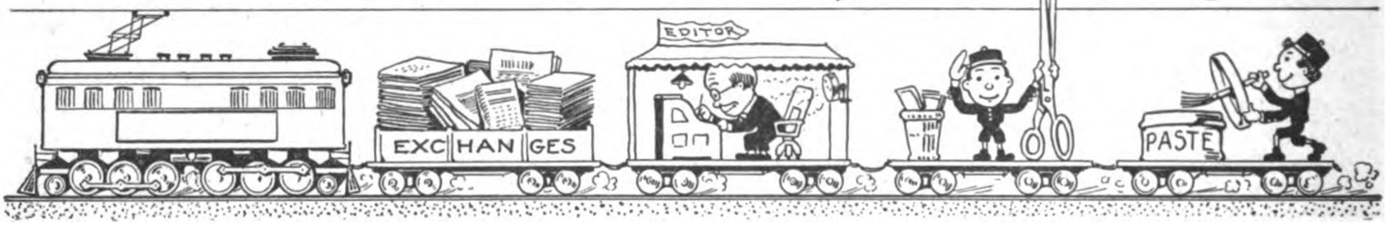
Outside of the railway field, there has been more recently a development of various types of a-c. commutating apparatus, principally in connection with heavy steel mill electrification work. Such apparatus has been largely in the form of three phase commutating machines and these have been used principally in connection with speed control of large induction motors. As these regulating machines are usually connected in the secondary circuits of induction motors, the frequency supplied is represented by the slip frequency. Consequently where the slip frequency never rises to a large percentage of that of th primary system, such commutating motors are applicable without undue difficulties. Such motors, presumably are better adapted for 25-cycle mill equipments than for 60-cycle, but due to the tendency, already described, for steel mill to go to 60 cycles on purchased power, it has been necessary to build these three-phase commutating motors for the regulation of 60-cycle main motors, in many cases.

There is still another class of service which has come in recently, where the choice of frequency is of much importance, but where there is no great necessity for adhering to any standard, namely, in heavy ship propulsion by electric motors. As each ship equipment is a complete system in itself, and as it cannot tie up with other systems, there is not any controlling need for maintaining any definite frequency or voltage. Except in similar vessels, there is little chance for duplication in parts, as the various equipments vary so much in size and capacity. In consequence it has been found advisable, at least up to the resent time, to design each propulsion equipment for that frequency which best suits the generator and motor speeds, taking into account the various operating conditions and limitations, such as the different running speeds, steaming radius, etc. In consequence, different manufacturers bidding on such equipments may specify different frequencies, depending upon the constructional features of their particular types of apparatus. At the present time with the relatively small amount of experience obtained with the electrical propulsion of ships, it looks as if it would be a considerable handicap to attempt to adopt some standard frequency for all service. Later with wide experience, it may be possible to adopt some compromise frequency, which will not unduly handicap any of the service.

Conclusion

It has been the writer's intention to show that, as a rule, the choice of frequency has been a matter of most serious consideration, based upon service conditions at the time. Moreover, in view of the wide range of conditions encountered, it is surprising how few frequencies have been seriously considered in this country. Occasion has arisen, times without number, where an obvious solution of a given problem would lie in modification of the frequency to allow the use of apparatus and equipment already designed, but the engineers of the manufacturing organization have steadily held out against such policy, regardless of the apparent need of the moment. The swing of the pendulum from 60 cycles to 25 cycles and back, has covered a period of many years and, therefore, cannot be considered as a fad of the moment, but is the result of well defined tendencies, backed by the best engineering experience available. As a rule no manufacturer has made any particular frequency his "pet," but all have worked to develop each system to its utmost.

VIA THE SHEARS AND PASTE-POT ROUTE



Items of Interest Gleaned From Various Sources

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.

SAVING COAL IN GEORGIA

Some idea of the economy in fuel and collateral economies which have been produced through the use of hydroelectric power may be gained from statistics available from one power company alone in Georgia. The hydroelectric power actually furnished by the Georgia Railway & Power Company in 1917, if generated by the customers of that company into steam power, would have required 11,875 cars of coal of forty tons capacity, or a total of 475,000 tons for the year 1917.

The company further estimates that the power which will be generated annually by new plants now being constructed will be equivalent to 10,000 cars of coal of 40 tons capacity each, thus making in the near future a possible total annual fuel saving of 21,875 cars of coal of 40 tons capacity each, or 875,000 tons.

In addition to this, this power company controls 300,000 hp. of undeveloped waterpower in Georgia, which, if it were developed and put to work, would result in an annual saving of coal two and one-half times as great as the present potential total annual saving, or a total of 54,687 cars of 40 tons capacity each year. That is to say, the present, prospective and possible fuel saving through the hydropower holdings of this company, if all were utilized, would amount to 2,187,480 tons of coal a year.

All this does not take into consideration the similar service of the Central Georgia Power Company, the Columbus Power Company, and other smaller companies and developments serving middle and south Georgia, nor does it take into consideration the horsepower in Georgia streams for which no plans of development have been made.

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THE LOAD CURVE

Did it ever occur to you, says C. A. Collier in *Here We Are,* that a picture of the commercial and industrial activities and home-life of your city is reflected in what is called a "load curve" of the local light and power company's daily run? Probably not, yet a more or less jagged line, drawn on a piece of paper, divided into little squares, can, when understood, present most graphically what is going on about you for the 24 hours of each day.

Physicians tell us that man's vitality is at its lowest ebb about 3 o'clock in the morning. Is it surprising, therefore, that the activity on the company's system, as reflected by the curve, is at its minimum at the same time of day? Shortly thereafter the flow of energy increases. The early birds are turning on the lamps in their homes for breakfast before they leave for the factory or store. Then, at 6 a. m., the line on the load curve begins to climb at a tremendous rate, for lights and motors in the stores and factories come into greater and greater use, until, between 8 and 9, when the elevators in all the office buildings are loaded with men and women beginning their day's work, and lights are still burning in the dark corners, the company is approaching the period of the "morning peak."

Did you ever notice that between 11 and 12 o'clock in the morning seems to be the busiest part of the morning? Look at the "hump" or "peak" that the power graph assumes at that hour, and you will see how the demand for electric energy keeps pace with the activities of the city. Then business, and therefore the load, settles down to a lower level while the factories and shops slow down for lunch.

After lunch, it is only a short while before the dark spots in offices, stores and homes must be lighted. Then the windows offices, stores and homes must be lighted. Then the window lights in the stores are turned on, lamps are put in use in the homes and factories, the elevators in office buildings are again filled to capacity, emptying the buildings of their occupants. The demand for more light and more power, but principally more light, quickly climbs to almost twice that of the morning and noon, and the "afternoon peak" begins, reaching its maximum usually between 4.30 and 5:30 o'clock (at this time of year). By 7 o'clock the day's work is nearly done. The closing of the stores, office buildings and factories has curtailed the use of electricity and the "load" falls off rapidly, continually declining until the next day's work begins.

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THERMAL STORAGE DEMAND METER

At the midwinter convention of the American Institute of Electrical Engineers last month, P. M. Lincoln, past-president of the Institute, explained the principle of this device and told how it is made and operated. Unlike other demand meters, which always indicate the "arithmetic average' of power consumption, the thermal storage demand meter always indicates the "logarithmic average" of power consumption. In developing his topic the author described the faults of the arithmetic average or block interval meter, and he showed by analysis that the thermal storage meter alone takes account of the true heating effect that fixes the capacity of equipment, and therefore the cost that should be assessed against the customer.

In introducing his subject he gave the following brief and lucid explanation of the fundamental reasons for measuring maximum demand. The incorporation of maximum demand in a rate for electric service, he said, is an attempt to assess upon the user of that service his proper share of the annual cost of the equipment necessary for giving the service. Let us assume a concrete case as an example. Assume, for instance, that the consumption of a given customer is 1000 kw-hr. per year. If this load is taken at a perfectly steady rate throughout the year it means a steady consumption of 114 watts continuously. The amount of equipment to supply the load as thus take is fixed by this continuous load of 114 watts. But let us now assume that our customer insists on taking his entire year's supply in a single day. Instead of equipment to supply 114 watts, we must now provide equipment to supply 41.7 kw, that is, the equipment must be 365 times as large as before.

Let us go further and assume that our customer insists on having his entire year's supply in thirty minutes; this would mean an equipment able to deliver 2000 kw for one-half hour. Obviously, the cost of the equipment for this condition would be enormously greater than that for the supply of 114 watts continuously, and it is only just that the customer that takes his entire year's supply in a day or an hour should pay more for his service than the one who distributes his demands more evenly. Our illustration is, of course, exaggerated, but the exaggeration is one of degree and not one of kind. It is the object of the demand rate to recognize automatically this variation in the equipment necessary with variation in load factor and to assess this equipment cost against the customer. Also, it is the "maximum demand" and not the kilowatt hours of consumption that determines the amount of equipment that must be installed to carry a given customer's load. It is to determine this maximum demand that demand meters are used.

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WIRELESS AND THE WAR

In taking over and building many cargo ships the government has also acquired the ownership, control and operation of the radio apparatus upon them says the *Electrical World*. Some hundreds of vessels using a large eastern port are now entirely in the hands of the naval radio service as regards the inspection and maintenance of their radio apparatus and the supply of operators for them. The various wireless companies have already become manufacturers for the army and navy, since their operating and research branches cannot continue on anything approaching the pre-war basis. Development of new inventions is directed almost entirely toward their utility in war work, and only those which are of the greatest actual or potential value to the military and naval services can justly be given full attention.

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THE ENGINEER

When the earth was young and our race was crude,
  And the needs of the world were few,
The man of skill found no place to fill—
  There was nothing for him to do.

But time in its steady, unceasing whirl,
  Wrought changes both far and near,
And the wants of man grew by span and span,
  Making work for the engineer.

And so by year and from age to age,
  With the growth of wealth and thrift,
There arose a demand for the skillful hand
  Of the man of mechanical drift.

As science and craft and the useful arts
  Increased in scope each year,
Came a call for the man who could build and plan,
  And they called him an engineer.

Theo. A. Leisen, in *Journal of Electricity*.

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Once upon a time there was an office boy who seemed to hate hard work worse than anything in the world. He used to spend his spare time in thinking up ways to get his work done quicker, with the result that he was often left with nothing to do. At last his boss got tired of trying to invent jobs to keep him busy, and made him a clerk.

As a clerk, he seemed worse than ever. He would sit up nights studying routines and figuring out short cuts, and finally got his job running so smoothly that he could sit back and watch it run itself. So his executives decided to cure him of his idle ways by making him a department head.

But somehow their plan had no effect. He reorganized his department in such a way that everybody else did the work, and there didn't seem to be much left for him to do. Sometimes he would leave early, or come in late; and the department ran just as well without him.

He's a general manager now, and apparently has nothing to do but sit at an empty desk and sign a few letters. The officials have given up trying to find enough work to keep him at that desk all day long. It can't be done.

Ever hear the term "executive ability?"

That's it. — *The Salt Seller*.

RECENT PROGRESS IN TELEPHONY

(*Concluded from page 46, February issue*)

It is well known that a body having a certain period of vibration responds to this vibration more easily than to any other and often it is difficult to force the body to vibrate in any other than its natural period. A series of small impulses imposed upon a body, capable of vibration, will set this body in vibration providing the impulses be timed to correspond to the period of the body. Also a small amount of energy applied at a little different interval from the period of the body will not cause it to take up its free movement.

Kempster B. Miller has given a simple example of this action in his book, American Telephone Practice, which is as follows:

"A familiar example of this is found in one person pushing another in a swing. The swing has its natural period of vibration, depending on the length of the ropes, and a gentle push applied at proper intervals by the person on the ground will cause the swing to vibrate with considerable amplitude. If the pushes are applied at intervals not corresponding to the natural period of vibration of the swing, many of them tend to retard rather than help its vibrations, so that a useless bumping results, producing but little motion."

In the case of the telephone ringers, four different pendulums or armatures are provided, each having a different period of vibration which is controlled mainly by the different sizes of the metal balls placed upon the ends of the striker rods, used as tappers for the bells. It is necessary in this system that a source of alternating current be provided which will give four different frequencies and also a suitable ringing key at the operator's switchboard for throwing any one of the four frequencies out to the line.

Harmonic Ringing Dynamo

At first, the only commercial way to produce these four different frequencies was by mounting four armatures on a shaft with a governed motor which was capable of running at a constant speed of 1,000 revolutions per minute or 16 2/3 revolutions per second.

One of these armatures is placed between two pole pieces and hence furnishes a current of 16 2/3 cycles per second. The second armature is placed between four pole pieces. Since it has the speed of the first one, it has double the frequency or 33 1/3 cycles per second. The third armature has six poles and the fourth one eight poles and these furnish frequencies of 50 and 66 2/3 cycles, respectively.

It was in this way that the four frequencies of approximately 16, 33, 50 and 66 cycles per second were selected and have since become standard for harmonic party-line ringing.

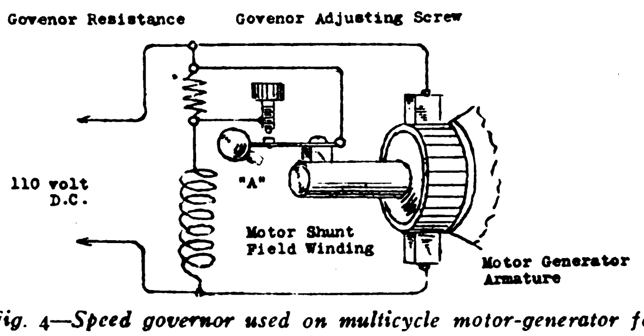

Fig. 4—Speed governor used on multicycle motor-generator for harmonic ringing.

The governing device used for maintaining the speed of the motor generator shaft at 1,000 revolutions per minute is shown in Fig. 4. The driving motor is so designed as to run slightly under 1,000 revolutions per minute. Then a non-inductive resistance is inserted in series with the motor field winding, so as to increase this speed to slightly above 1,000 revolutions per minute.

A centrifugally closed contact is arranged on the end of the motor shaft and so adjusted that when the speed reaches 1,000 revolutions per minute, this contact will be automatically closed and thus short circuit this external field resistance. The action which finally results, is a continual opening and closing of this governor contact as the speed of the armature changes slightly from the desired 1,000 revolutions per minute.

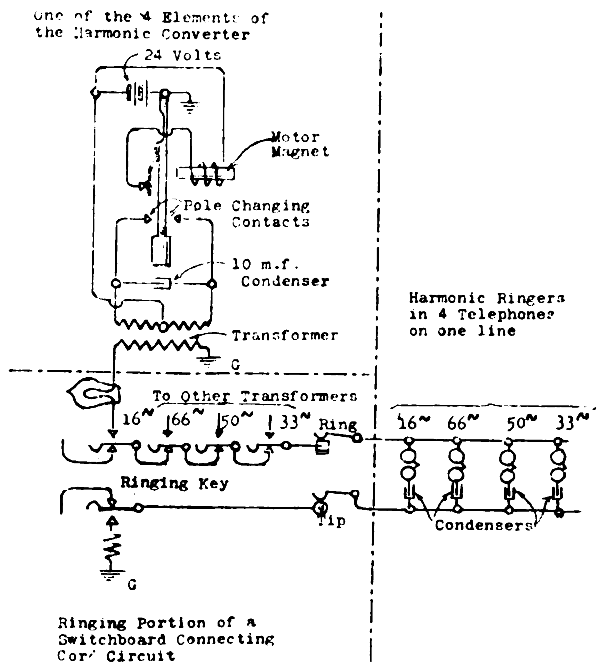

Fig. 5—Complete harmonic ringing system using a harmonic converter to supply the frequency ringing currents.

By correctly selecting the different elements entering into this governor, it is possible to regulate the considerable variation in the voltage of the direct current circuit used for operating the motor as well as for the variations in the load imposed upon the various ringing generators.

Harmonic Ringing Converter

The demand for a less expensive means for producing the four harmonic ringing currents and one which can be used in small exchanges where a suitable primary power is not available, lead to the designing of a vibrating pole changer device which is known as the "harmonic converter."

The upper portion of Fig. 5 shows the circuit arrangement of one element of the harmonic converter ringing equipment, the other three elements being the same, but arranged to vibrate at the three other frequencies. Each element is provided with a vibrating reed which is driven in the same manner as the armature of an ordinary vibrating door bell. These reeds are carefully designed and adjusted so as to work continuously night and day at a constant speed without the aid of any governing or compensating means.

Contacts are provided on each reed so as to connect the battery current first through one-half of the split primary of a transformer and then through the other half in the opposite direction. A condenser is used across the primary windings to prevent sparking at the contact points. The secondaries of these transformers go direct to the switchboard through the customary protecting lamp resistances.

The no-load power required by the harmonic converter when all four frequencies are in operation, but with no ringing current being used at the switchboard, is about eight watts and it has been found from experience that these machines can safely handle a telephone switchboard serving over 6,000 subscribers' lines. For larger exchanges, or for heavy duty purposes, the switchboard ringing circuits, are divided and each division served with a harmonic converter.

The small power consumption of the harmonic converter has made it possible to operate harmonic ringing equipment in small exchanges where outside electric current supply is not available or where the outside supply is irregular or unsatisfactory. In this case the direct current supply is through the use of ordinary dry cells or other primary battery.

Improvements in Speech Transmission

The improvements which have made it possible to conduct telephone conversations over longer distances apply to the refinement of small details in almost all of the apparatus entering into the so-called talking circuits.

The use of loading has made commercial transmission over the extremely long distance aerial circuits and the transcontinental lines possible. Loading coils and vacuum tube repeaters also have made it possible to use the all-cable type of line for fairly long distance circuits.

Telephone lines are loaded by the insertion of impedance coils in series in the line wires and at sufficiently close intervals to avoid appreciable piling-up of the current and voltage waves (reflection losses) which results when there is much of a discontinuity in the circuit. The object of this loading is the balancing of the bad effects of the distributed capacity of the line by the impedance of the loading coils.

Transmission Standards

When loading is properly applied, the result is a great improvement in both the quality and volume of received transmission. On the other hand, if the loading is incorrectly applied or the line conditions are unstable, then the presence of the loading coils interferes with, rather than assists the transmission.

Unfortunately there are no accepted standard instruments of precision yet devised for measuring articulate telephonic transmission. However, the work of producing such usable and reproducible standards for this purpose has been started by the United States Bureau of Standards.

The present scheme of measurements is not only arbitrary but inaccurate, in that the transmitting and receiving terminal instruments are ordinary commercial transmitters and receivers. The erratic action of carbon, which is used as the resistance-varying element in the commercial forms of transmitters, precludes any possibility of precise and reproducible results, when this type of instrument is used as a standard.

The Standard Cable

There is one element in the present standard transmission testing circuit which is accurately defined and which is commonly employed. It is the "mile of standard cable." In this case the primary standard chosen was a certain No. 19 B. & S. gauge, non-loaded copper wire cable, having a mutual electrostatic capacity of 0.054 microfarad per mile. The secondary standards of the cable, made up of resistances and condensers mounted in a box, now are in common use for transmission measuring purposes.

It is customary for these artificial standard cable boxes to include the equivalent of 32 miles of the No. 19 gauge cable, for this has been taken as the longest line through which it is possible to obtain good commercial transmission, when the standard type of terminal circuit and apparatus is used.

How the Standard Cable is Used

Fig. 6 is an example of how the standard circuit and artificial standard cable is used in testing the transmission loss of repeating coils. The terminal apparatus here employed at each end of the test circuit is that regularly used with the standard cable.

The fixed amount of line is a 16-mile section of artificial standard cable and is used to avoid transmission errors which can exist on a shorter length of test circuit. This amount of line also cuts down the volume of transmission to a degree where it is easily comparable.

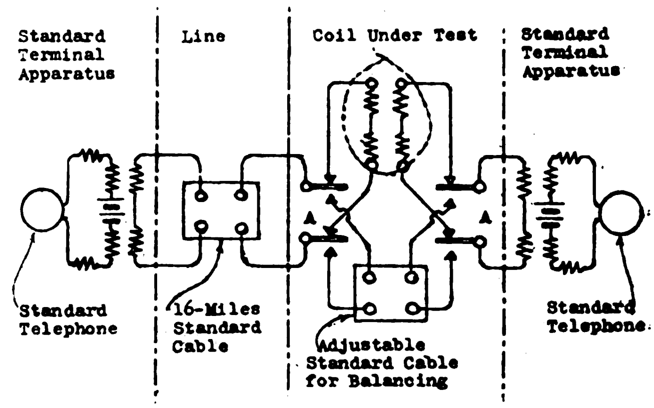

Fig. 6—One arrangement of standard artificial cable and standard terminal apparatus for a telephone transmission test.

Switching keys are arranged in this test circuit so as to connect the line, first through the coil under test and then quickly to connect an adjustable artificial standard cable, which is used for balancing purposes.

The actual testing is done by a person talking in one terminal instrument with a uniform tone of voice and with the mouth always at the same distance from the transmitter mouthpiece. This tester also does the switching, keeping the observer at the distance terminal instrument always in ignorance of the condition of the circuit. These precautions are necessary to avoid any error due to personal equation or opinion of the observer.

The balancing artificial standard cable is gradually added to the test circuit until the observer finds no difference in the volume of the transmission when the switch is in either position. Then the amount of balancing cable in circuit will represent a measure of the transmission equivalent of the coil under test. The result then can be expressd as a "certain number of miles of standard cable of loss."

It takes a trained observer to at once pick a difference in volume of transmission equivalent of less than one mile of standard cable. However, the average of a large number of tests will show the results in fractions of a mile of standard cable. The untrained observer, also, often mistakes a difference in quality for a difference in volume.

The use of the artificial standard cable allows such losses as that due to the incorrect use of the telephone to be expressed in terms which are easily comprehended by the regular telephone subscriber. For example, it has been determined from a series of carefully made tests, under a certain circuit condition, the equivalent value of the losses in transmission due to holding the mouth at varying distances from the transmitter of a particular telephone.

These results are given in tabular form on the next page, expressed in terms of miles of standard cable and in the equivalent miles of non-loaded open wire line:

Distance of mouth from transmitter mouthpiece	Loss in miles of standard cable	Loss expressed in miles of No. 10 B. & S. copper wire line
0.5 in.	3.6 miles	45 miles
1.0 in.	11.0 miles	137 miles
1.5 in.	17.0 miles	212 miles
Limit of commercial transmission	32.0 miles	400 miles

Thus if the speaker's lips are held 0.5 in. away from the mouthpiece of this particular transmitter, the volume of the resulting transmission will be reduced an amount equivalent to talking through a No. 10 B. & S. gauge copper wire, non-actual intervening circuit.

We can express one of these results in another way: If the speaker's lips are held 1.5 in. away from the mouthpiece, over 50 percent. of the available commercial transmission is lost, the limit being taken as 32 miles of standard cable.

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ST. PAUL ELECTRIC LOCOMOTIVES

With the extension of the Chicago, Milwaukee & St. Paul Rocky Mountain electrification there is an increased demand for motive power, thus making necessary a number of new units. The original 440 miles of electrification will eventually have all the passenger trains handled by Baldwin-Westinghouse electric locomotives. These locomotives are now being built and embody many novel features not existing in the present engines.

These are the most powerful locomotives running in passenger service. A single unit is able to haul a 950-ton train (12 coaches) over the entire mountain section at the same speeds as called for by the present schedules. The one-hour rating for one of these locomotives is 4000 hp. and its continuous rating is 3200 hp. with a starting tractive effort of 112,000 lb. The normal speed on level track is 60 miles per hour; on a 2 percent. grade about 25 miles per hour.

Nine running positions are secured without rheostatic loss, ranging from 8 to 56 miles per hour, depending on the load. This feature affords greater flexibility in the economical handling of a train, and is of value in governing the load of the system during peak load conditions. This is accomplished by the use of six 1500-volt twin motors on the locomotive, arranged for three-speed combinations as follows:

Position No. 1—1 set 6 motors in series.
Position No. 2—2 sets 3 motors in series.
Position No. 3—3 sets 2 motors in series.

During the change from one speed combination to another, a tractive effort is maintained. Two additional running speeds are obtained on each speed combination by means of inductive shunts on the main motor fields, which assists in cutting down current peaks as well as save rheostatic losses, and enabling the power demand over the varying profile to be kept more nearly constant.

The use of regenerative control for holding trains on descending grades is such an important function in these locomotives that special arrangements have been perfected to secure positive operation of this feature over widely varying speeds. The same main motor combinations for "motoring" are used for regenerating except that the fields of the main motors are separately excited over a wide range by axle driven generators. These are so connected that balancing resistance with inherent stability in the motor characteristics during regeneration is assured, irrespective of whether the changes in line voltage are sudden or gradual.

While the regenerative braking of trains lessens the duty on the air brake equipment, further safety in braking with electric engines is introduced with the axle driven generators. These machines are mounted on the pony trucks of the locomotive, and in addition to exciting the motors during regeneration, furnish the power for operating the air compressors and blower motors when the locomotive is hauling. This method insures a current supply to the air compressor motors irrespective of the overhead trolley supply, and provides that compressor air will always be available for use of the air brakes.

One of the most noticeable features of these new locomotives is the concentration of all the auxiliary and control apparatus in a central cab, although the power capacity is much greater than for double cab engines now running. This emphasizes the modern tendency in design toward the conservation of weight and space for a maximum output of power.

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FACTS ABOUT LIGHT

The sensation we call light is, in reality, a vibration or wave motion of some substance, that we have as yet no conception of. For want of a better name we call it the "ether." This vibration is set up by the sun and artificial light, and these different lights contain many different waves of varying speed. Just as the violin strings give varying tones to our ears when vibrated more or less rapidly, so do different waves of light give different sensations to the eyes. But light has this difference from sound; that is, natural objects have the property of absorbing some of the waves and reflecting others. The reflected ones come through the eye and give us a certain sensation. Snow and white paper reflect nearly all the waves and we call them white, but an ordinary brick wall only reflects some of them and we call these red.

Sunlight, then, is a perfectly blended mixture of all the different light waves or, as we call them, colors.

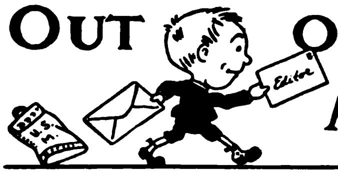
Artificial lights are somewhat similar to sunlight but are usually deficient in certain waves, hence do not give quite the same color sensation to the eye as sunlight. The length of a wave determines its color: thus, waves of 26 millionths of an inch are red, of 22 millionths are yellow, of 20 1-2 millionths green, of 18 millionths blue and of 14- millionths violet.

These five colors—red, yellow, green, blue, and violet—are the principal ones that we see in the rainbow. But there are waves mixed up with these that do not give any sensation of color to the eyes and are therefore invisible—these are the chemicals, or ultra-violet waves, beyond the violet; and the heat, or infra-red rays, beyond the red. If we make a rainbow—scientifically called the spectrum—by splitting up a beam of white light with a prism and hold a photographic plate close to the colored band on the screen, we shall find on developing the plate that it has blackened some distance beyond the violet, where our eyes did not see any light at all, thus proving the existence of ultra-violet rays.

More convincing still we can show up these ultra-violet rays by letting them fall on a certain organic chemical—anthracene—on the screen. The chemical then responds to the rays and shines, or fluoresces, very brilliantly.

Red waves do not affect the photographic plate, neither is there any known chemical sufficiently delicate to detect their presence; but as they excite the sensation of warmth they will act on a sensitive thermometer, causing a rise of temperature, and if we explore with this delicate thermometer, beyond the red waves—where our eyes see nothing—we find there are more invisible waves affecting it. These waves we call infra-red, or heat waves.

So with these varying color waves streaming into the eyes from many distant luminous objects, we can easily understand what a combination of colors light is, and how they range themselves within it, from red, of 26 millionths of an inch wave length, down through orange, yellow, green, blue and indigo to violet, of 14.4 millionths of an inch wave length. The red, it is seen, is the longer and slower vibration. The violet, at the other end, is short and rapid.



OUT OF THE MAIL BAG

FROM OUR CONTRIBUTING EDITORS

I read your comment on the word "insofar," page 48 of the February number of ELECTRICAL ENGINEERING with much interest and, of course, couldn't help looking it up. I find that it means the same as "inasmuch" according to the standard dictionary except that it is given as three words instead of one. If common usage has not yet made one word of it, it doubtless will in time in the same way that the words "in, as and much" have been combined into a single word "inasmuch."

As for the pronunciation, I would simply speak the three words "in, so and far" one after the other.

W. F. Schaphorst.

NUTS FOR THE KNOWING ONES

QUERIES AND ANSWERS IN TECHNICS

Please tell me how to construct a lifting magnet that will lift about 100 lb.

Jos. Graziano, Jersey City, N. J.

✣ ✣ ✣

Will you kindly give me the folowing data for making a transformer, input 120 volts, 60 cycles, and output at secondary, at the following steps:

15 amperes, 8 volts.
12 amperes, 10 volts.
10 amperes, 12 volts.
8½ amperes, 14 volts.
7½ amperes, 16 volts.
6½ amperes, 18 volts.

Kindly give me the size of the core that is necessary, also the size of primary, and secondary wires, stating how I can get the various outputs as above explained.

J. Louis Lange, Jersey City, N. J.

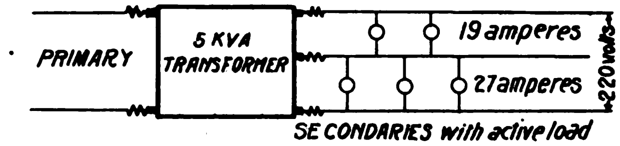
✣ ✣ ✣

Question 1—Will a modern potential, pole type, oil-cooled transformer, 2200 volts primary 60 cycles, single phase, 220 and 110 volts secondary three-wire distribution 5 kva capacity handle a load that has 35% more amperes on one leg than on the other and keep the voltage the same on both circuits?

The way it is handled now is as follows: There is one 10-kva transformer handling 23 kva. connected load. The voltage on one leg is 90 volts; on the other it is 130 volts on Saturday night peak load. When there is no peak load the high voltage is on the opposite side. This transformer is 10 years old.

I am thinking of putting in to replace this a modern transformer of 5 kva. to handle 11.3 kva connected load, and dividing the other 11.7 kva (which is wired on the two-wire system) to a two-wire distribution that is within reach. But these changes leave an unbalanced load of 35% which cannot be changed without tearing the building to pieces to get to the connections.

The sketch shows secondaries with 19 amperes on one side and 27 amperes on the other. (This is what the active load is



approximately.) The voltage is 220 on the outside wires. What will the voltage be between the outer and center wires?

Question 2—In figuring load factor. Do you take for maximum load the capacity of the generator, or the maximum load carried at the peak load?

E. Barnott, Fort Saskatchewan,
Alberta, Canada.

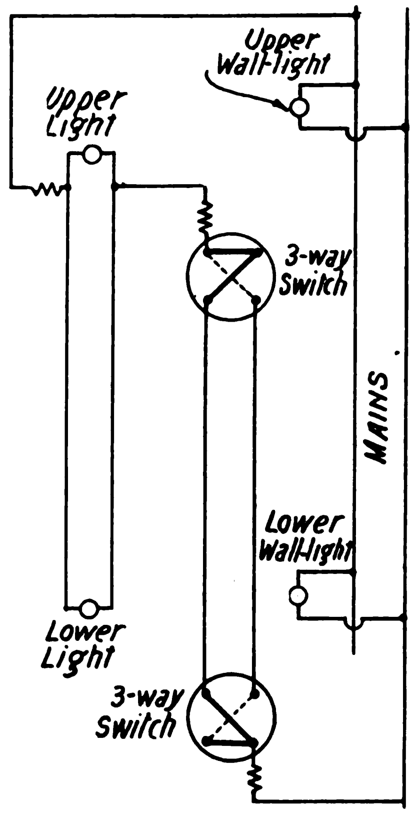
✣ ✣ ✣

We have one light upstairs and one light downstairs to be controlled by one switch upstairs and one switch downstairs. We want the switches to control the lights, upstair light on by itself, and downstair light on, then off, and both on, then both off, the lights to be controlled the same way from both switches.

Can it be done, and if so, what kind of switches can be used? And of course the lights are to be turned on by the upstair's switch, and turned off from the downstair's switch, or vice versa.

W. J. Cameron, Daytona, Fla.

I, too, have been interested in the correct or most simple method of this switching arrangement. A short time ago I had occasion to install this same arrangement. Being a contract job for a stated sum, I of course wanted to do it the most economical way and still bring about the desired result. Not having any switches designed for such an arrangement—if there are such—I wired the job in the way shown in the accompanying sketch.



Method of wiring to obtain results asked for above by W. J. Cameron.

Note that the wall brackets are entirely separate from the hall ceiling lights, are controlled by the pull sockets only, but are located in such position that one can readily turn them on or off by approaching the usual switching point. The idea is that a person wanting light can use the wall light, say in the upper hall when passing from one chamber to another. If the lower hall is to be used, only that bracket may be used. If there is to be passing up and down the stairs, use is to be made of the three-way switches, one of which is located up stairs and one down stairs, each being located directly under its respective wall bracket and at a convenient location.

Note that the upper hall ceiling light and the lower hall ceiling light are wired together as one unit and are controlled by the set of three-way switches.

Albion C. Barker, Mechanic Falls, Me.

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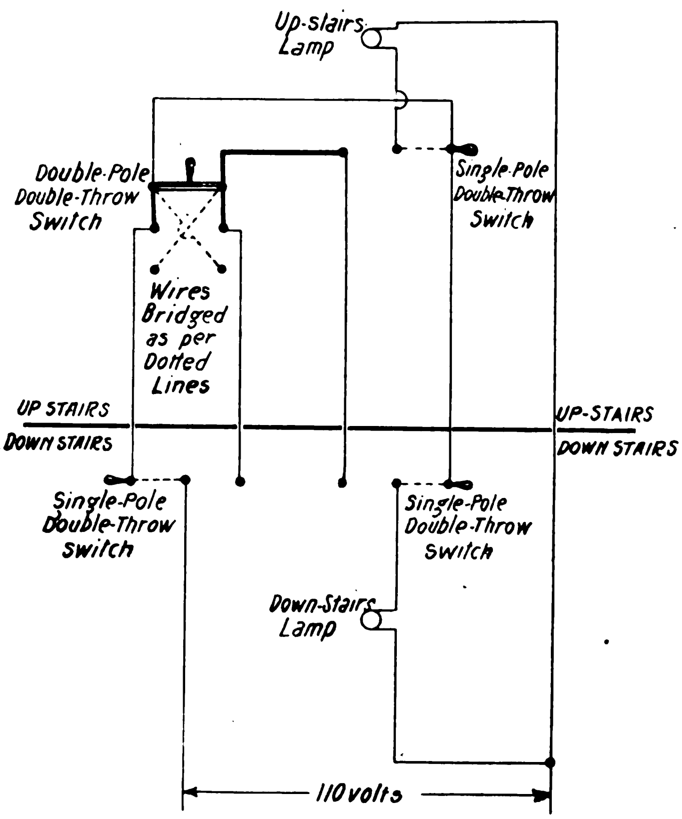
In your February issue W. J. Cameron, of Daytona, Florida, wants a wiring nut cracked. Here it is. For clearness, I have sketched the circuit using knife switches, but recommend the use of push button switches, as they are more convenient to operate with one hand.



Another method of solving the W. J. Cameron problem.

The circuit as sketched will give you absolute control of either of the lamps, or of both, whether you are up stairs or down stairs. It is essential to remember that all of the switches must remain closed all the time.

F. P. Miller, Lafayette, La.

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What are current transformers used for?

E. K. Knowles, Peoria, Ill.

According to Bulletin 46013 of the General Electric Co., a bulletin that treats of instrument transformers and their use, current transformers are used in connection with meters, instruments, and other switchboard appliances where it is necessary to increase their ampere capacity, or to insulate them from the line potential. Since they are connected directly in series with the line, if not properly insulated they produce a weak point in the line, and if failure results the entire system may be tied up with serious losses. Insulation and mechanical strength are therefore extremely important.

If the transformers are inaccurate, the meters and instruments to which they are connected are affected accordingly. It is evident, therefore, that current transformers are of extreme importance, and should be selected with great care.

The primary of current transformers should never be left in the line with the secondary open-circuited, as this will set up a heavy flux through the core, over-saturating the iron and causing it to overheat.

If for any reason it becomes necessary to remove the meter or any current-carrying device from the secondary circuit of a current transformer, the secondary should be short-circuited by a wire or some other means.

Current transformers should be considered as a part of the line circuit. When it becomes necessary to change secondary connections, the ground wire should be inspected to see that it is in good condition, also the operator should stand on a dry board or other insulating material. If a current transformer must be installed where an attendant might come in contact with it, it should be surrounded by a protective case.

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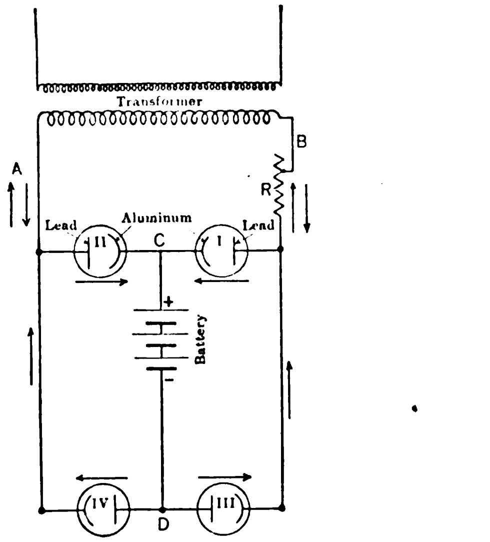
What is an electrolytic rectifier? How does it operate to change alternating into direct current?

E. L. Allan, Providence, R. I.

The electrolytic rectifier is based on the fact that some metals when immersed in a chemical solution offer a high resistance to the passage of current when the current flows from the metal to the solution, but a very low resistance when the current flows from the solution to the metal. Aluminum is such a metal, and it is used commercially for rectifying alternating currents of relatively small value.

In constructing an electrolytic rectifier a plate of aluminum and a plate of lead are placed in a solution of neutral ammonium sulphate. The connections are made as shown in the accompanying sketch. The aluminum allows a current to pass from the lead through the solution to the aluminum plate, offering but slight resistance to such passage. But, on the contrary, it offers a high resistance to the current when it attempts to pass from the aluminum plate through the solution to the lead plate. This is another way of saying that the electrolytic rectifier changes an alternating into a direct current by smothering the negative loops, allowing only the positive loops to become effective.

When an alternating current is to be rectified for charging



Method of connecting four aluminum cells to be used as an electrolytic rectifier.

storage batteries or for operating a direct current motor four rectifier cells are used. They are arranged as shown in the sketch.

When the side *B* of the supply circuit is positive, current flows from the lead plate in cell No. I through the solution and on through the aluminum plate. Cell No. II is arranged so as to prevent the passage of current. The current therefore passes downward at the point *C*, into the storage battery, and through cell No. IV to the other side of the supply circuit.

When the side *A* is positive, current flows from the lead plate in cell No. II through the solution and on through the aluminum plate to the point *C*. Cell No. I now refuses to let it pass that way, so it goes down at the point *C* into the battery and out to the other side of the supply circuit through cell No. III.

In order to prevent the aluminum plates from becoming too hot each plate should have an area of about 2 sq. in. for each ampere that is delivered to the battery. To charge a battery at the rate of 10 amperes each rectifier cell should have an aluminum plate of 20 square inches (4 x 5 in.), a lead plate of the same size, and there should be about one quart of neutral ammonium sulphate.

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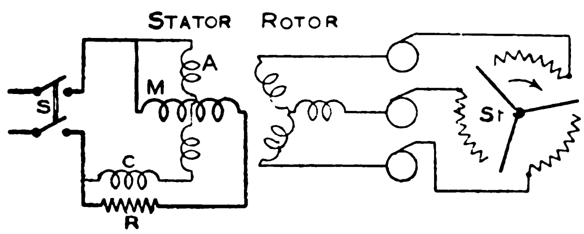
What is a split-phase starting device.

N. A. Rowe, Oswego, N. Y.

The principle underlying all methods of starting single-phase induction motors is that the single-phase current is split up into two or three currents which differ in phase. The connections of the stator and rotor circuits for one such method are shown in the accompanying cut. *M* is the main or running phase, and *A* is the auxiliary or starting phase. During the period of starting, a non-inductive resistance, *R*, is connected in series



Winding diagram showing split-phase method of starting induction motor.

with *M*. Choke coil, *C*, can be inserted in series with *A*, but this is often rendered unnecessary by winding the starting phase with a sufficiently large number of turns. The result is that when the main switch, *S*, is closed, the current flowing through *A* lags considerably behind that through *M*, so that a rotating magnetic field is produced, somewhat similar to that in a two-phase motor. As the motor runs up, the starting resistance is gradually cut out by rotating the arms of *St* in a clockwise direction. When the last stud is reached, the starter automatically opens the starting phase, *A*, and either short-circuits or cuts out resistance, *R*, thereby leaving the running phase directly across the supply mains.

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I want a brief history of the incandescent lamp. Can you give it?

R. A. Hoyle, Erie, Pa.

It took the electrical industry 26 of its 33 years to improve the incandescent lamp 50 percent.; that is, to cut in half the amount of energy necessary to give a candle-power of light.

And then came a revolution.

The lamp makers discovered three new or improved lamps in rapid succession—the gem, the tantalum and finally the mazda. To-day with current at ten cents a kilowatt-hour, one cent an hour will buy not 16 candle-power of electric light, as in 1882, nor 32 candle-power as in 1908, but 125 candle-power—just eight times as much as the first lamp gave. And the light is whiter, clearer, more pleasant in every way.

BRIEF TIDINGS FOR THE BUSY MAN

Sales Department of the Minneapolis General Electric Company sold 8 percent. more electrical appliances during 1917 than in 1916 with an increase of 59 percent. in the electrical consumption capacity of the appliances.

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Up to three years ago, the most satisfactory electrical contacts used in ignition apparatus for automobiles, gas engines, etc., was made from platinum or platinum-iridium alloys. These platinum contacts have been replaced in great part by tungsten which gives in some cases better results than the more valuable metal at a distinct saving in cost.

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To remove marks left on wall paper after installing electrical fittings mix up four ounces of ordinary flour and one-half ounce of 90 percent. ammonia and one-half ounce of water; mix into a dough. Roll this mixture over the marks. It will almost invariably take up the dirt.

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The use of telegraph lines for telephone service, an arrangement by which there is obtained both a telephone and telegraph use of two wires at the same time without either service interfering with the other, has advanced considerably during the year. This utilization of facilities is rapidly coming forward. The development of this long distance telephone service has been particularly rapid in the south and southwest.

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The secondaries and castings, or frames of current transformers should be grounded whenever possible. The switchboard wiring should be carefully considered to see if this can be done without interfering with the proper operation of the instruments connected to transformers. The instrument cases should likewise be grounded. This serves the double purpose of protecting the switchboard attendant, and freeing the instruments from the effects of electrostatic charges which might otherwise collect on the cases and cause errors.

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Dents made by misdirected hammer blows or tool operations in old-house work, telephone cases, and instrument boxes, can be raised and resurfaced as follows: pour enough alcohol or gasoline on the dented spot just to cover it, then light the alcohol or gasoline carefully and let it burn. The heat of the flame will expand the wood, raising it higher than the original surface if the dent is not too deep. The raised surface can be sandpapered or chiselled to a smooth surface and finished in color to match the rest of the surface.

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Co-operation between the Government and the industries was the theme of an address made by E. W. Rice, Jr., president of the American Institute of Electrical Engineers, at an informal dinner in New York on February 15. To win the war, he said, everyone must do his share, be he great or little, heroic or humble. We must discipline ourselves until a shirker in any field of useful effort will be regarded with the same contempt as a shirker in the military service of the country, for there is no difference, or if there is any difference, a shirker behind the lines is worse than one in the trenches.

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The annual report of the New York Telephone Company for the year ended December 31, 1917, shows a surplus of $16,377,490 after all expenses and charges, including $546,626 in taxes, compared with a surplus of $17,265,341 for 1916. Last year's surplus was equal to $13.10 a share on $125,000,000 capital stock outstanding, as against $13.81 a share earned in 1916. Dividends paid in 1917 amounted to $10,000,000, the same as the year before.

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The household economics department of the University of California is planning next term to conduct an investigation into the economics of laundry methods as practiced in Berkeley families with a view to testing the merits of the electric washing machine in comparison with other practices. The cost of sending out wash to wet, dry and regular laundries, the cost of the wash woman or Japanese boy who does the wash in the home and the cost of an electric washing machine are all to be tested out and statistics compiled. The effect on the clothes and the general satisfaction expressed are further to be taken into consideration.

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During recent years Mobile has steadily lost shipping due to a variety of reasons, but it now appears that the city will not only regain its importance as a port, but will soon handle vastly more tonnage than in the past. With excellent railroad facilities, including the Louisville & Nashville, the Mobile & Ohio and the Southern Railroad, with good harbor and dockage accommodations and with an exceptionally fertile back country, rich in coal, iron and timber, Mobile unquestionably is destined to become a very important deep water terminal, coincident with the revival of the South, now apparent as an inevitable result of the war with Germany.

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Compound-wound motors are varying speed motors, having both a shunt and a series winding for field excitation. They are intermediate in characteristics between the shunt and the series motors, resembling more closely the one which the field winding most nearly approximates. These motors are used where the required torque varies considerably, being high at starting or during some part of the cycle of operations, and where at the same time the speed limiting characteristics of shunt motors is desirable. A compound-wound motor should once adjusted, is practically unaffected by the motor load. These motors are used where the speed requirements vary for different classes of work, particularly in machine shops, on lathes, boring mills, drills, and milling machines.

THE TRADE IN PRINT

What The Industry is Doing in a Literary Way

Instrument Transformers, Switchboard Type, are covered in Bulletin 46013 recently issued by the General Electric Co.

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Pass & Seymour, receptacles and splicing links, are covered in loose-leaf sheets 24-A, 46-A, and 58-A issued last month.

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Breco Converters for rectifying alternating current are illustrated and described in a 16-page catalogue now being distributed by The Breco Electric Co., Toledo, Ohio.

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Bureau of Standards, Washington, D. C., has published Circular No. 67 entitled "Wire Gages." It is dated January 17, 1918, covers 5 pages, and sells for 5 cents.

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George Cutter Co., South Bend, Ind., is distributing Bulletin 3337 on Sol-lux industrial lighting reflectors and fixtures and Bulletin 3338 on Universal and Standard floor-lighting projectors. Both bulletins are dated January 21, 1918.

✤ ✤ ✤

Safety for the Household, published by the Bureau of Standards, Washington, D. C., was issued on January 10, 1918. It contains 127 pages, 16 plates, 7 text figures, and sells for 15 cents. It contains a description of hazards to be met in the home from electricity, lightings, gas, fire, chemicals, etc. Also what to do and what not to do when emergency arises.

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Safety Auto-Lock Switches, the kind manufactured by the Krantz Mfg. Co., Inc., of Brooklyn, N. Y., are illustrated and described in special publication 1585-A, recently issued by that company. Operating characteristics are shown by sectional cuts on the second page.

✤ ✤ ✤

National Service Record of employees of H. M. Byllesby & Company and affiliated employees as of Jan. 1, 1918, shows: Number of male employees at properties, all ages, 4839; number enlisted, 317; number drafted, 79; number subject to draft not yet called, 996; total number of men in active service, 393; percentage of men in service of entire male forces employed, 8.1 percent.

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Vertical Type Alternators form the subject-matter of Bulletin No. 176, now being distributed by the Electric Machinery Co., of Minneapolis, Minn. Accompanying this bulletin is a list of users of these alternators in the states ranging alphabetically from Illinois to Wisconsin. This company is also distributing a chart which shows at a glance the sizes and speed of all its lines of vertical alternators.

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Safety Auto-Lock Switches are described and illustrated in some detail in special publication No. 1585-A just issued by the Krantz Mfg. Company, Inc., of Brooklyn, N. Y. These switches are designed for use on circuits wherever the ordinary knife switch may be applied. They are especially designed for safety, it being absolutely impossible to touch the live parts regardless of the position of the switch or of the door. They are particularly adapted for use in steel mills, factories, mines and other similar locations where men are employed who have no practical knowledge of electricity.

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An Artistic Calendar of unusual merit was distributed last month by the Edison Lamp Works, of General Electric Co. It is a reproduction in seventeen printings of an oil painting by Maxfield Parrish now in the possession of the above named company. It breathes the spirit of youth amid the fiords of the far north, the land of the midnight sun, basking in the rays of a mazda lamp.

✦ ✦ ✦

Fundamentals of Illumination Design is the title of a 66-page bulletin just issued by the Engineering Department of the National Lamp Works of General Electric Company. In simple and readable language it discusses the broad principles which underlie illuminating engineering practice. This bulletin should prove of value to schools and colleges, particularly to those in which a course in illumination is included as a part of the regular study program. Its value is not limited to students, however, for much of the material presented is the result of recent investigations. The data will bear the closest scrutiny of the practicing illuminating engineer.

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Emerson Electric Mfg. Co., St. Louis, Mo., urges each one of its customers who orders, or has ordered apparatus or material for Government use or indirectly for use in completing Government contracts, to furnish the company with the Government requisition or order number, so that such orders may be given preferred attention. Where priority certificates for the movement of such goods have been issued, the certificate class and number should also be given. This information appearing on orders, or given in regard to orders already placed, will definitely assist the company in giving the special service which Government orders deserve, and will in some cases make it possible to secure material otherwise unobtainable.

BITS OF GOSSIP FROM THE TRADE

Diehl Mfg. Co., Elizabeth, N. J., is open to appoint agents and wholesale distributors and will be pleased to hear from any firms who wish to handle its well known products.

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H. M. Byllesby & Company announce the creation of the position of vice-president in charge of operation of Northern States Power Company, and the appointment of H. W. Fuller to this office, with headquarters at Minneapolis.

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The Gateway of Electric Service is the way Pass & Seymour, Inc., of Solvay, N. Y., phrase their ability to get electrical energy from a line into a lamp by way of P. & S. sockets and receptacles.

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Cooper Hewitt Electric Co., Hoboken, N. J., announces that its Cincinnati office has moved into larger quarters at No. 1406 First National Bank Building, of that city. Geo. W. Walker, who has been with the company for the last ten years, continues as district sales manager.

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About 5,000 Homes were warm during the week of Jan. 28 because the Louisville Gas & Electric Company, through Donald McDonald, vice-president and general manager, threw on the open market at cost a reserve supply of 3,500 tons of high-grade West Virginia bituminous coal.

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Westinghouse Electric & Mfg. Co. announces the removal of its office from Phoenix, Arizona, to Tucson, Arizona. Its representatives, Messrs. J. H. Knost, and W. G. Willson, will have headquarters in the Immigration Building at the latter place.

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W. F. Irish Company, a new electrical supply house, has started in business at 130 West 32nd Street, New York. The firm is composed of Wm. F. Irish, F. S. Gardner, F. V. Hann, and N. Sanders. All these men were formerly connected with the Sibley-Pitman Electric Corp., Mr. Gardner being sales manager for a number of years.

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National X-Ray Reflector Co., 235 West Jackson Boulevard, Chicago, announces the appointment of G. F. Evans, as supervising engineer in Ohio (except Toledo and Cincinnati), West Virginia, and Western Pennsylvania. He is located at 825-826 Columbus Savings and Trust Building, Columbus, Ohio.

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Westinghouse Automobile Equipment Department removed their manufacturing operations to the company's Newark Works, Plane and Orange Streets, Newark, N. J., on February 15. At this works the company has for many years been manufacturing small motors and instruments. At the same time the general sales offices of this department were removed to 110 West Forty-second street, New York City, where the Eastern District sales office will also be located.

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The Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa., has recently secured the exclusive sales agency for the United States for Frankel solderless connectors, widely used for jointing electrical wires and cables. Manufacturing facilities have been increased by the Frankel Connector Company, in order to care for the new business to be secured through the Westinghouse sales organization. The Westinghouse Company will act also as a distributor of Frankel testing clips.

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PURELY PERSONAL

A. B. Boynton, district manager of the Electric Machinery Company of New York and New England, was recently commissioned a captain in the Engineer Officers' Reserve Corps.

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Frank Carder has been appointed manager of the Oklahoma Gas & Electric Company, Norman, Okla., succeeding W. P. Jones, resigned.

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Charles R. Underhill, chief electrical engineer of the Acme Wire Company, New Haven, Conn., recently received a commission as captain in the aviation section of the Signal Reserve Corps.

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S. D. Levings has resigned as eastern representative of the automobile equipment department of the Westinghouse Electric & Mfg. Co.

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J. M. Hannaford, Jr., vice-president and sales manager of the Northwestern Electric Equipment Company, St. Paul, Minn., has resigned to enter the firm of Gordon & Ferguson, St. Paul.

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H. W. Stortz, for many years connected with the Edison Storage Battery Company, Orange, N. J., has resigned to become vice-president and general sales manager of the Swartz Electric Company, Indianapolis, Ind.

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Francis L. Gilman, assistant chief engineer of the Western Electric Company, New York, has resigned to take charge of the manufacturing departments of the National Conduit & Cable Company, West Brookfield, Mass.

James B. Olson, formerly assistant secretary and general sales manager of the Habirshaw Electric Cable Co., is no longer associated with that concern. He expects to continue in the insulated wire and cable business. His present address is Hotel Chatelaine, Bedford Avenue, Brooklyn, N. Y.

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Frank J. Foley, manager of the mining section of the industrial department, Westinghouse Electric & Mfg. Company, has accepted a position as manager of the mining and traction department of the Edison Storage Battery Company, located at Orange, N. J.

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W. H. Thompson, for many years prominent in the heavy electric traction work of the Westinghouse Electric & Mfg. Co., has resigned to accept the position of works manager of the Fairmont Mining Machinery Company, of Fairmont, W. Va., makers of coal mining equipment.

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J. H. Pardee, president of The J. G. White Management Corporation, New York, and J. P. Ripley, engineer, have returned to New York from a general inspection of the Manila Electric Railroad & Light Company, and other interests in the Philippine Islands, operated by The J. G. White Management Corporation.

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Bassett Jones, consulting electrical engineer, associated with Henry C. Meyer, Jr., of New York City, presented a paper on "Standardized Flexible Distributing Systems in Industrial Plants" at a meeting of the Schenectady Section of the A. I. E. E. held last month.

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George Fudakowski formerly associated with the Westinghouse Electric Co. in France and Russia, and for the last three years as head of the steam turbine department of the Siemens Electrical Co., in Petrograd, Russia, has just arrived in this country. He speaks English, French, and Russian. He is open for engagement as a commercial engineer, being experienced in the matter of making tenders and contracts and conducting correspondence. He is located at 173 West 73rd Street, New York.

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W. C. Austin, auditor of the Eastern Pennsylvania Railways Company, Pottsville, Pa., has been elected assistant secretary and assistant treasurer of that company. In 1917 Mr. Austin was transferred from the staff of traveling auditors of The J. G. White Management Corporation, New York, N. Y., to the accounting department of the Eastern Pennsylvania Railways Company, which company is being operated by The J. G. White Management Corporation. For a number of years Mr. Austin was treasurer and auditor of the Otsego & Herkimer Railroad Company (now Southern New York Power & Railway Corporation,) Cooperstown, N. Y.

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OBITUARY

William Temple Emmet, a member of the Public Service Commission for the Second District of New York since March, 1914, died on Feb. 4 at the age of forty-nine years.

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Henry H. Hodell, president of The Cleveland Galvanizing Works Company, and The Van Dorn & Dutton Company, and a director of several other large, successful institutions—such as the Van Dorn Electric Tool Company, and The Equity Savings and Loan Company, of Cleveland, Ohio, died in Cleveland last month. He was born 68 years ago in Alsace, France, and removed to Cleveland with his parents when he was 4 years old. At one time he was actively associated with twenty of the leading industries and banks of that place. Unlike most men who achieve success, sincerity, charity, and kindness characterized all his dealings with his fellow men throughout life.

ASSOCIATION NEWS

San Francisco Electrical Development and Jovian League at a meeting held on February 6, celebrated the birthday of Thomas A. Edison. Frank D. Fagan, Pacific Coast manager Edison Lamp Works, talked on happenings to Edison since he entered the electrical field.

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New York Electrical Society held a wartime meeting on Tuesday evening, February 26 in the auditorium of the Engineering Societies' Building, 39 West 29th Street. The speakers were: Major Frederic Palmer, of General Pershing's staff; Captain Alexander Macomber, of the Searchlight Regiment; and Major Edward B. Kratz, of the Electrical Regiment.

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Electrical League of Cleveland, with W. D. Clark as secretary, is as active as it was formerly under the direction of R. S. Dunning. This year, in addition to the regular Thursday noonday meetings the league is having Sunday evening concerts. The volunteer Red Cross workers of the league gave a valentine dance in the league rooms in the Hotel Statler on February 14.

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New York Edison Savings & Loan Association has closed its sixth business year with a total membership of 2453, and with assets of more than half a million dollars. At the sixth annual meeting dividends of 6¼ and 5 percent. were declared, and officers for 1918 were elected. The association was organized in 1912 to encourage the saving habit among the employees of the lighting company. The unfavorable conditions caused by the war have not prevented the association from keeping pace, with respect to its earning power, with its previous records.

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The Monad, official publication of The American Association of Engineers, is thinking of changing its name, and is asking the association members to suggest a new one. A member with a sense of humor thinks that the present name should be retained, for anagrammatic reasons. Anagrammatically considered, he says, the word Monad furnishes a descriptive term which applies to engineers in general and to those engaged in railway work in particular; namely, Nomad. In the same manner is derived a magical formula which is often used by engineers when the ink bottle is upset on a finished drawing, or when the rodman pulls up a turning point; namely, O damn!

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The Following Candidates have been proposed for nomination by petition in the American Institute of Electrical Engineers: for president, Comfort A. Adams, Cambridge, Mass; for vice-president, Allen H. Babcock, San Francisco; William B. Jackson, Chicago; F. B. Jewett, New York; Raymond S. Welsch, Montreal; Harold Pender, Philadelphia; John B. Taylor, Schenectady. For managers: Charles I. Burkholder, Charlotte, N. C.; G. E. Faccioli, Pittsfield, Mass.; Morton G. Lloyd, Washington; Frank D. Newbury, Pittsburgh; Walter I. Slichter, New York.

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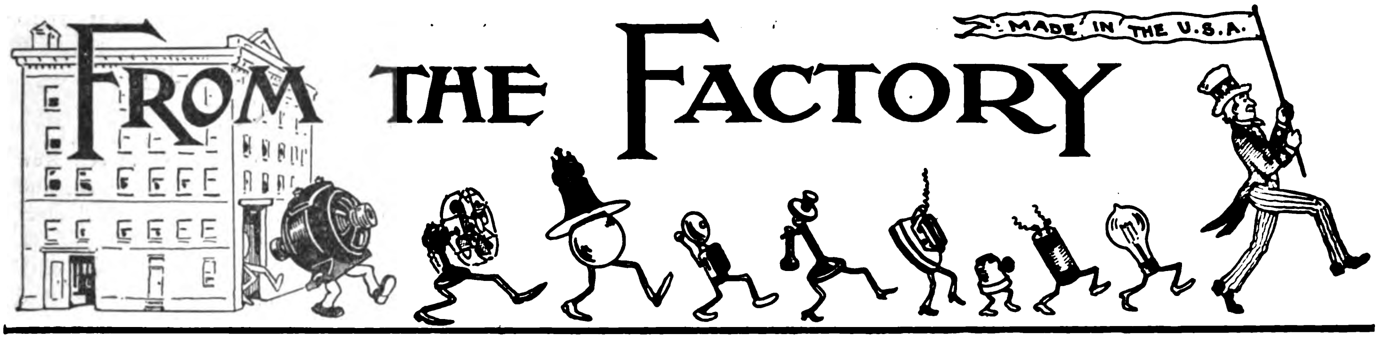
The 338th meeting of the A. I. E. E. will be held in Cleveland, March 8. It is an intersection meeting in which the Cleveland, Pittsburgh, Toledo, Toronto, and Detroit Sections of the institute will participate. The meeting will include two technical sessions, one in the afternoon and one in the evening, and an informal dinner will be held between the two sessions. The papers to be presented on behalf of the A. I. E. E. cover the subjects of underground distribution, capacity of rolling-mill motors, and selection of auxiliary motors for steel mills. There will also be a paper presented on behalf of the A. I. & S. E. E. entitled "Steel-Industry Motors Standardized," by Standardization Committee of A. I. & S. E. E.

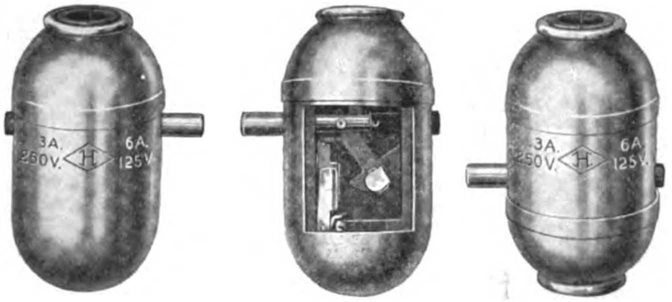


Short Stories About Electrical Goods Offered By Manufacturers

PENDANT AND FEED THROUGH SWITCHES

These switches, both of which are depicted in the annexed cuts, have recently been developed and put on the market by The Hart Manufacturing Co., of Hartford, Conn.

The pendent switch is of the single pole type, will carry 6 amperes at 125 volts or 3 amperes at 250 volts, is 2½ in. long,



"Diamond H" feed through and pendant switches. The Hart Manufacturing Co., Hartford, Conn.

and 1⅜ in. in diameter. The push buttons are made of unbreakable metal—one white, the other black. It is finished in brush brass, polished brass, and nickel.

The feed through switch is also of the single pole type, and carries 6 amperes at 125 volts or 3 amperes at 250 volts. It is designed specifically for controlling small electric heating devices and vacuum cleaners, but is adaptable to many other uses.

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BENCO PULL CHAIN SOCKET

The Benco pull chain socket has been in process of building for several years. The pull member is vertical and direct in action. The chain passes down inside the socket, completely insulated from live parts of the device which are molded in an insulating composition. It is approved by the Underwriters' Laboratories for use in damp places.

Benco pull chain socket. Benjamin Elec. Mfg. Co., Chicago, Ill.

The shell in the weatherproof form of this socket is made in either aluminum or copper; the asbestos composition base of the molded parts is non-absorbtive, so that there is no possibility of the molded portions becoming conductors from the live parts to the pull member. The composition of the molded parts will stand a considerably higher temperature than the socket will reasonably ever have.

These sockets are provided with a special lamp grip feature which prevents lamps from falling. The device is approved for a rating of 660 watts, 250 volts, and the operating mechanism is of a quick make and break type. The threaded portion at the base of the shell is designed to receive all of the Benjamin type "S" fixture connectors and reflectors. Made by the Benjamin Elec. Mfg. Co., Chicago, Ill.

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BAY STATE PORTABLE SEARCHLIGHT

The electrical energy for operating this searchlight comes from a storage battery located in the case which forms a base for the lamp itself to stand on. This makes it a self-contained unit. The lamp will burn continuously about 2½ hours before the battery is exhausted to the point where it will need recharging. A less powerful bulb will burn from 5 to 7 hours on one charging. The battery can be recharged in 10 or 12 hours from any direct current house-lighting

Bay State portable electric searchlight. The Portable Electric Searchlight Co., 87 Haverhill St., Boston, Mass.

circuit by inserting one or more incandescent lamps as a resistor. Recharging from an alternating current lighting circuit requires of course, the use of a rectifier.

Under ordinary conditions, the Bay State will throw its rays a distance from 2,000 ft. to half a mile. Equipped with a 7½-in. adjustable focus, single shell reflector, on a recent photometer test, one of these serchlights gave 453,000 beam candle power.

This outfit weighs 16 lb. and can be carried about almost as readily as an ordinary hand lamp. It is made by the Portable Electric Searchlight Co., 87 Haverhill St., Boston, Mass.

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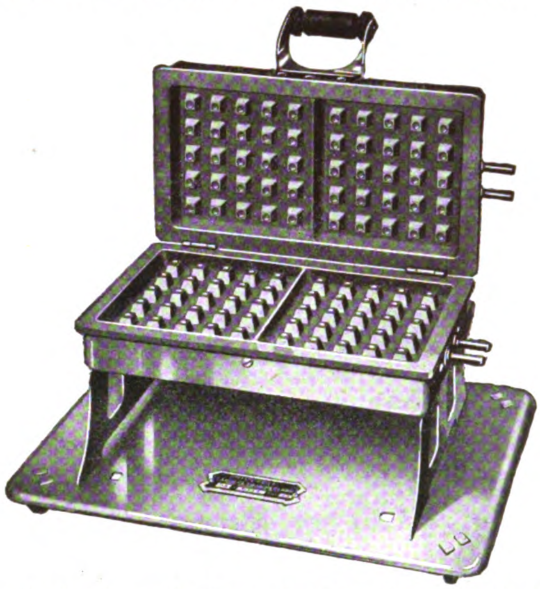
ELECTRIC WAFFLE IRON

Landers, Frary & Clark, New Britain, Conn., have placed on the market an electric waffle iron which can be used on the table and from any lamp socket. It is made of steel, is nickel plated and polished, and has aluminum grids which



Universal electric waffle iron. Landers, Frary & Clark, New Britain, Conn.

require no grease and operates without smoke or disagreeable odors. The waffles are 3½ in. square and two can be produced every minute and a half.

It comes compact with 6 ft. of heater cord and attachment plug. It consumes 600 watts, or about 5½ amperes at a pressure of 110 volts.

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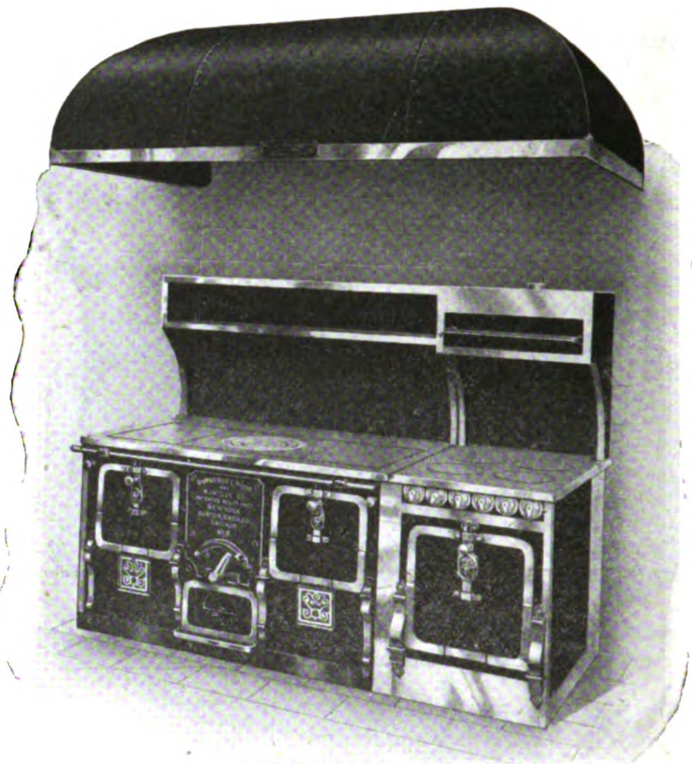
AJAX PLURAL PLUG SOCKET

This device has recently been brought out by the Ajax Electric Specialty Co., 310 North 11th Street, St. Louis, Mo. The makers call it "The Plug of a Thousand Uses." Several of these uses are shown in the annexed illustrations. It is made of hard rubber composition, is finished in polished black, allows the use of a shade, and sells for 75 cents. By means of it two energy consuming devices can be operated from any lighting circuit at the same time. It will accommodate a lamp and a heating device, a lamp and a small motor, a motor and a heater, or two lamps, one stationary and one portable. It will be found handy in the bathroom, where light and heat are often required simultaneously.

COMBINATION GAS AND ELECTRIC RANGE

Duparquet Huot & Moneuse Co., 108 West 22nd Street, New York, are marketing a 6 ft. 6 in. long, 2 ft. 10 in. deep, and 2 ft. 7 in. high French imperial combination coal and electric range.

The coal section measures 4 ft. 6 in. long, is equipped with a patent revolving shaking and dumping grates, and is lined with 3½ in. fire brick. There are two ovens, each measuring

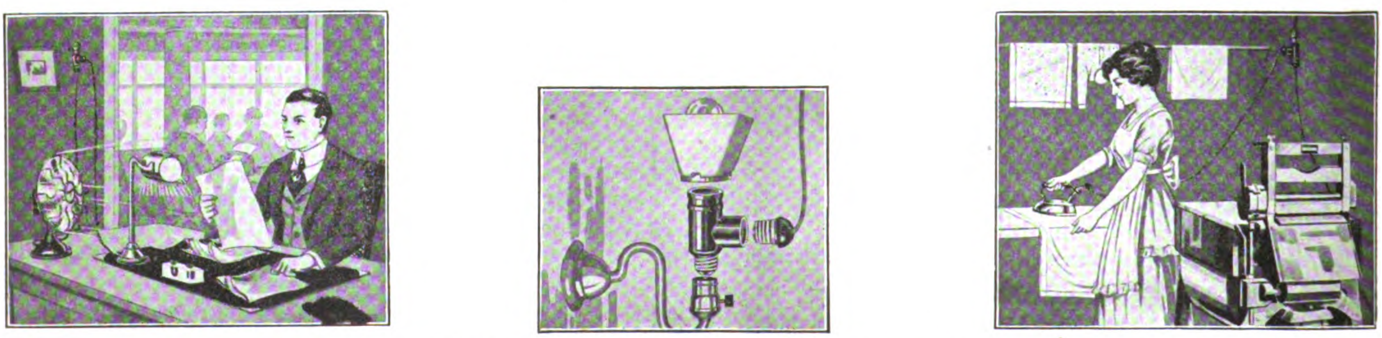


Combination gas and electric range. Duparquet, Huot & Moneuse Co., 108 West 22nd St., New York City.

21½ in. wide x 28 in. deep x 16 in. high, with heavy semi-cast steel non-warping bottoms and wrought iron oven racks.

The electric section is 24 in. long, contains one oven measuring 15 in. wide x 21 in. deep x 15 in. high, and is equipped with General Electric sheathed wire units. The body of the range is constructed of No. 18 U. S. gauge box annealed sheet steel. The oven is double walled and is heated by both bottom and top or broiling unit, each consuming 1500-750 watts.

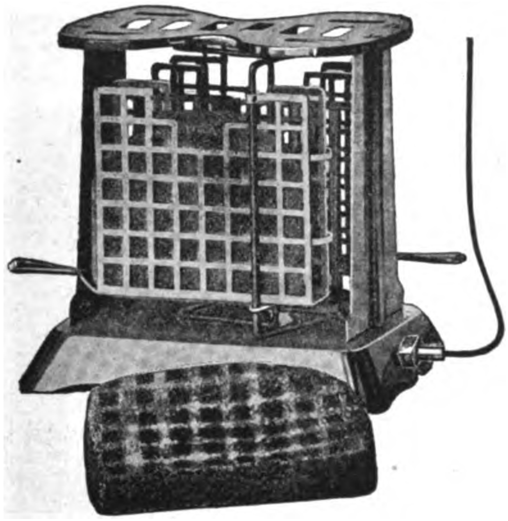
The cooking top is equipped with two 1500-700-375 watt and two 100-500-200 watt 8½ in. cast iron discs, the heating element being cast in the wire, leaving no exposed current carrying wires. All heating units are controlled by three-heat switches mounted on shelf.



Ajax plural plug socket and applications. Ajax Electric Specialty Co., 310 No. 11th St., St. Louis, Mo.

REVERSO ELECTRIC TOASTER

A new type of electric toaster that turns over the bread to be toasted is announced by The Electro Weld Co., of Marlboro, Mass. By mechanical means, other than taking the hot product in the fingers—merely by manipulating the levers shown in



Reverso electric toaster. Electro-Weld Co., Marlboro, Mass.

the cut—the bread to be toasted is reversed in position as often as desired. This insures an even degree of toasting on both sides of the bread. It comes equipped with a specially designed Hubbell connector. The design of the slice holder is such as to produce an appetizing checker board slice of toast.

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ELECTRIC POLISHING MACHINE

This machine is designed to save time and effort in the polishing of wax-finished, hardwood floors. It supersedes the

Electric floor polishing machine. Dale-Rey Corporation, 25 Church St., New York.

old-time method of pushing a heavy polishing block to and fro, an operation that takes time and muscle.

The essential apparatus consists of a cylindrical brush, propelled by a ¼-hp. motor. The brush revolves at high speed, and not in the same plane as the floor, but at right angles thereto. This buffing action produces a hard surface—resulting in a reduction in the amount of wax required.

The brush is made up of two semi-circular aluminum cylinders, mounted upon an aluminum drum, running upon ball bearings, and is propelled from a motor by a chain and sprocket. A counter-balanced weight upon the handle of the machine may be adjusted so as to alter the pressure upon the floor. The motor is operated by electric energy from the lamp socket, the machine being connected by a cord that permits of a wide radius of action. This machine was designed by the Dale-Rey Corporation, 25 Church Street, New York.

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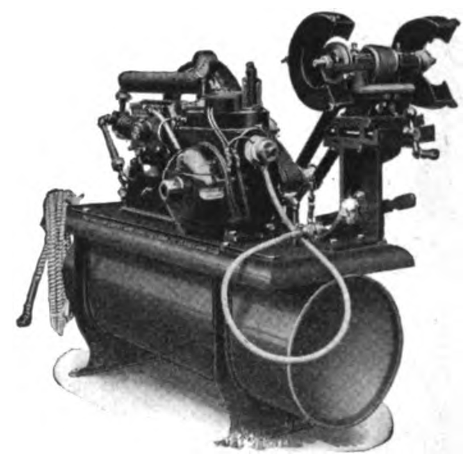
AIR COMPRESSOR AND BUFFING AND GRINDING HEAD

The United States Air Compressor Co., Cleveland, Ohio, has recently announced a new combination air compressor and grinder outfit which is especially suitable for service in garages and similar places where compressed air is required.

The outfit consists of a self-oiling air compressor with filtering trap, check valve and safety valve, buffing head, 30-gallon tank, air pressure gauge, needle point valve, pipe and fittings,



Combination air compressor and grinding outfit United States Air Compressor Co., Cleveland, Ohio. Operated by Robbins & Myers motor.

armored hose, automatic air chuck, 6 ft. of armored cable with plug, all mounted on a metal base to form a compact unit which requires but 48 x 20 in. floor space. The height overall is 40 in. The capacity of the compressor is 4 cu. ft. per minute. The compressor operates at 250 to 300 r.p.m. It is provided with an intake silencer which muffles the intake noise and tends to force air into the intake valve.

A trap is provided in the starting tank which extracts any moisture or oil that may be discharged from the compressor, assuring pure, dry air, free from oil.

The buffing and grinding head is suitable for wheels of 8-in. diameter. The outfit is equipped with a 1 hp. Robbins & Myers motor.

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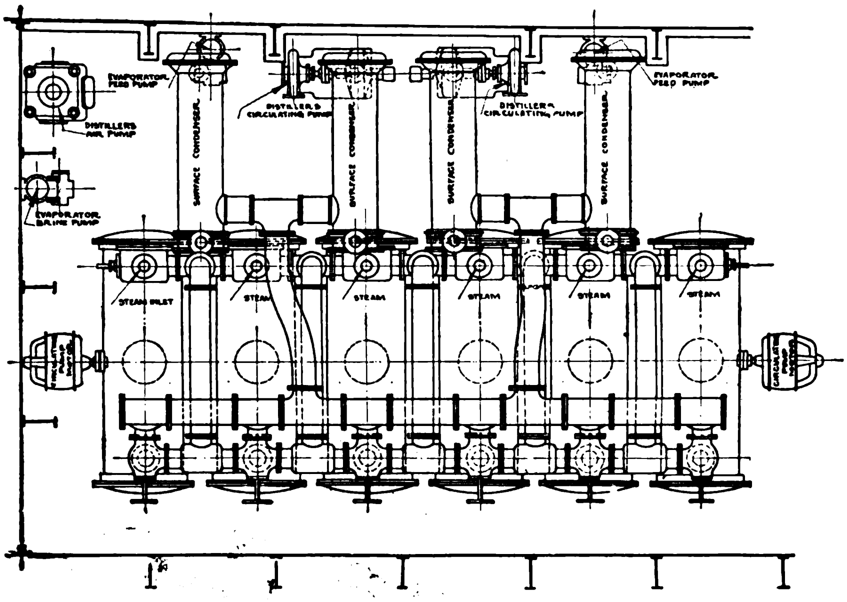
DISTILLER FOR SEA WATER

Those who have to deal with the distilling of sea or other water or with evaporation problems of almost any kind, will be interested in this design of Lillie Evaporator now being built by the Wheeler Condenser & Engineering Co., of Carteret, N. J.

It is a modification of a regular Lillie sextuple effect sea water distilling apparatus. Two of these now under construction are to be operated by steam up to 60 lb. pressure, or at any lower pressure.

As shown in the illustration, four condensers are employed, placed side by side. This unusal arrangement of condensers permits seven different combinations of operation.

It can be operated as one single effect or more single effects; it can be operated as one or more double effects, with vapors reversible in each; it is possible to operate it as a triple effect, or as two triple effects, with vapors reversible in each.



Motor driven apparatus for distilling sea water.

It is impossible, of course, to operate it as two quadruple effects, but every effect may be utilized by grouping as one quadruple effect and one double effect, in both of which the vapors are reversible.

It can be operated as one vapor reversible quadruple effect with both end effects or either end pair of the section cut out; and with one effect at either end cut out, it can be operated as a vapor reversible quintuple effect.

It can be operated as a vapor reversible sextuple effect.

✤ ✤ ✤

VACUNA CLEANER

The Vacuna cleaner is manufactured by the Kent Vacuum Cleaner Company, Inc., of Rome, N. Y. A turbine mounted on the extension to the armature shaft insures a constant flow of air and maintains the suction pressure at practically the same value whether the opening of the cleaning tube is closed by contact with the surface to be cleaned or whether it is free. The turbine operates at very high speed and is carefully balanced so as to run steadily without vibration. Westinghouse A. C. universal motors are used throughout. This motor is designed on the principle used in the manufacture of large motors such as used in railway work. It is of the concentric compensating type which insures very long brush and commutator life. Variation of speed at the same load between direct and alternating current service is very small.

The Kent Company manufactures a small portable machine which is intended to be wheeled over carpets and rugs; a semi-portable model for heavier work which is to be used with hose and hand tools and a number of sizes of stationary plants for permanent installation.

HOBART KITCHENAID

An electrically driven mixer and kitchen unit, called a "Kitchenaid" by its makers, is announced by The Hobart Mfg. Co., of Troy, Ohio. It is a light portable device and is adaptable for either hotel, club, restaurant, or home. A motor with a capacity of ½ hp. is used to drive it. It has been tried out experimentally for several months and is pronounced a mechanical and electrical success.

"Kitchenaid" motor driven mixer and kitchen unit. Hobart Mfg. Co., Troy, Ohio.

✤ ✤ ✤

HEAT DISSIPATING CABLE

Under the Hochstadter United States patent which was allowed in October, 1916, and now owned by the Standard Underground Cable Co., of Pittsburgh, Pa., this company is manufacturing a new line of cables that promises effectively to meet the urgent need for cables with ample thermal conductivity for carrying away the heat generated at the central portion. The new type cables, after the teaching of Hochstadter and Davis, have a wrapping made of copper tape ½ in. wide and 0.002 in. thick. They have a degree of flexibility which is entirely suitable for most purposes and, while the wrappings are thin enough to make good contact with the insulation, they are sufficient in thickness to give ample thermal conductivity for carrying away the heat generated at the central portions of the cable.

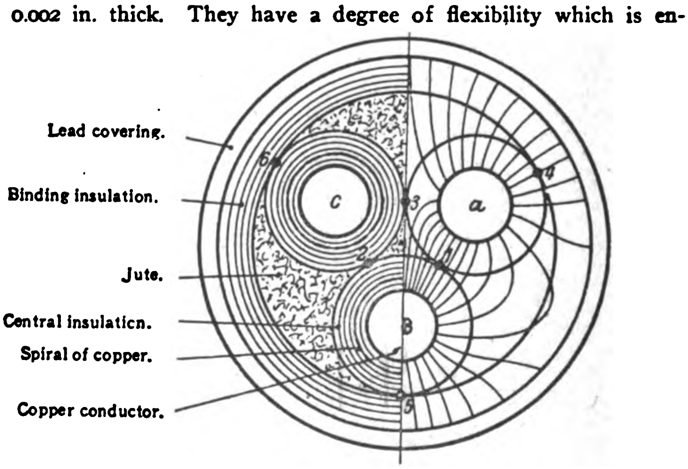


FIG. 1.—SECTION THROUGH A THREE-CORE CABLE OF THE USUAL CONSTRUCTION, TOGETHER WITH THE ARRANGEMENT OF THE ELECTRIC FIELD ON POLYPHASE CURRENT.

It will be noted that while this type of construction more directly applies to high voltage cables it may, under certain conditions, be advantageously used on low voltage cables of three conductor construction since, even where the dielectric loss may be inappreciable at high temperatures, there will nevertheless be an advantage in securing the lower insulation temperatures attainable by this method. Obviously, the greatest gain in low voltage cable using this type of construction will be where only one or two cables are installed and where it is desired to operate them at very heavy current loads. Where a great many low voltage three conductor cables are operating in adjoining ducts, the advantages attainable by this type of construction are less pronounced and in some cases

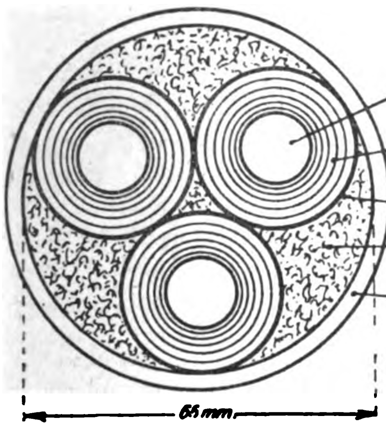


FIG. 5.—NEW TYPE OF THREE-CORE CABLE.

hardly warranted by the increased expense, because in congested duct systems the temperature drop between the conductors and the cable sheath is usually but a small portion of the total drop of temperature between the conductors and the surounding earth, and thus even if the copper wrappings increased the thermal conductivity of the insulation to infinity, the gain in carrying capacity for equal insulation temperatures would of necessity be small. Were the metallic wrappings nothing but heat conductors, their presence would be of the same but no greater value in high voltage cables than just indicated for low voltage cables. The fact that they are electrical conductors also, however, entirely changes the matter and high voltage cables thus constructed are advantageously used either when operating singly or when operating in large groups in close proximity as may be necessary in congested duct systems. The manufacturing company expects to issue a bulletin and other data in the near future giving more details concerning these cables.

◆ ◆ ◆

KRANTZ SAFETY SWITCHES

Krantz safety auto-lock enclosed switches are intended for use as main-circuit switches, and wherever the ordinary knife switch may be applied. These switches are safe under all conditions; it being impossible to touch live parts regardless of the position of the switch or of the door. They are desirable for use in steel mills, factories, mines, and similar places employing men with practically no knowledge of electricity and its attendant dangers.

Among the special advantages claimed for this switch are that it is 100 percent. safe as compared to switches having parts and fuses in the same part of the box; that the use of brush-type contacts, which cannot weld shut from slow closing, increases safety to circuit; that all parts are removable from the front, and, being interchangeable, are readily replaced without disturbing the connections, should any part become worn or burned.

Brush contact is made directly with incoming-terminal block and fuse-terminal blocks, thus eliminating all splices, soldering, joints, and unnecessary connections.

These switches are made by the Krantz Mfg. Co., Inc., Brooklyn, N. Y.

H-B BATTERY CHARGER

This battery charger is designed for use in garages and similar places that cater to the needs of motorists, both gas and electric. Equipped with a special form of automatic universal voltage control, it will recharge any automobile battery quickly and successfully. It automatically takes care of 60-volt, 12-volt, or 24-volt batteries at the same time. It recharges from 1 to 7 batteries similtaneously, with a cost for energy of from 12 to 15 cents per battery.

This charger has a capacity of 500 watts or ½ kilowatt, 10 amperes at 50 volts. It is furnished to operate on standard electric service pressure of 110 volts, either direct or alternating. It is 26 in. high, 27 in. long, and weighs 280 lb. Further particulars can be obtained from Hobart Bros. Co., Troy, Ohio.

◆ ◆ ◆

TRAVELLING ANTI-WASTE EXHIBIT

In a large manufacturing plant where thousands are employed, it is surprising to learn of the food products and material wasted each day. To give the employes of the Westinghouse Electric & Mfg. Co. some idea of the waste, the management devised the novel scheme of fitting up a storage battery truck, as a travelling exhibit. Upon it was a collection of food wasted, also a quantity of manufacturing material such as copper, zinc, mica, rubber, felt, gum, and similar material which could be used to advantage.

Travelling anti-waste exhibit in shops of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

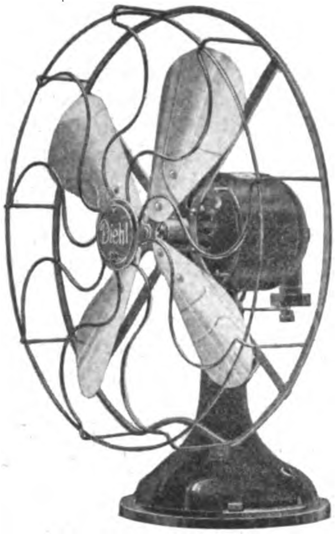
It is estimated that the foodstuffs wasted per day amounts to between $35 and $50 the cost of which, of course, comes out of the employes' pocket. The waste of material, amounting to hundred of dollars per day, is a loss to the company, all of which is due largely to the thoughtlessness and carelesseness of the employes.

This truck is driven through the shop aisles so the employes can see the amount junked. It is an object lesson to all employes who lack thrifty habits and are prone to waste.

◆ ◆ ◆

DIEHL 1918 FANS

The line of 1918 fans manufactured by the Diehl Mfg. Co., Elizabeth, N. J., has been increased by the addition of a 6-in. fan and a 9-in. fan, the latter superseding the 8-in. fan which was formerly widely used. The 9-in. fan is offered in both desk and bracket fans, 9-in. oscillating and non-oscillating fans, 12-in. and 16-in. oscillating fans, 56-in. 4-blade ceiling fan, and the usual line of exhaust and flat-blade ventilating fans. The 6-in. fans are supplied with a 6-ft. cord and attachment plug; all other fans with an 8-ft. cord and plug.



16-in. *oscillating fan. Diehl Mfg. Co., Elizabeth, N. J.*

The 6-in. fan, a practical, sturdy built machine and not a toy, is now manufactured independently for direct current and alternating current circuits. The fan is adaptable for either desk or bracket use and can be instantaneously converted by turning the thumb screw which is situated in the stem. It is now painted green.

All Diehl fans intended for tropical climates will be provided with special windings and insulation to insure durability in the tropics.

◆ ◆ ◆

GENERAL ELECTRIC 1918 FANS

A number of lesser changes, dictated by engineering experience, are noticeable in the General Electric fans for 1918. One novel departure is in the finish, as all metal parts are now enameled a dark green, and the blades are lacquered brass. All of these fans are readily adjustable for either desk or bracket use. They are furnished with standard cords and plugs.

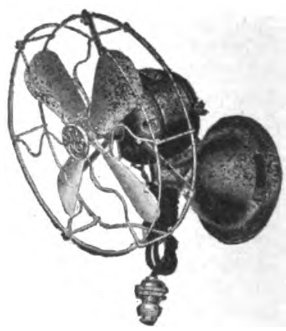
The complete line of General Electric Company's fans for this season will include 9 in. 12 in. and 16 in. oscillating, and non-oscillating, four-blade fans in both direct and alternating current. Six blades, oscillating fans in 12 and 16 in. sizes are made for alternating current only.

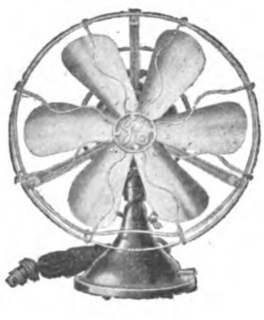
Ceiling fans are furnished in 52-in. and 56-in. sizes for both alternating and direct current respectively. They are finished in dark green enamel, except the blades which are in mahogany.

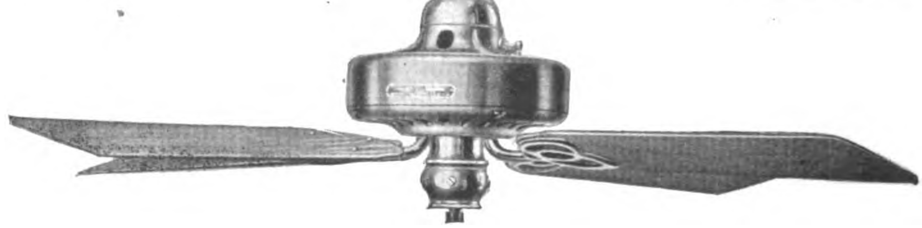
Ventilating fans for 1918 will be handled in 12 and 16 in. sizes, six blades, in both alternating current and direct current. These fans, finished in green enamel, with lacquered brass blades and trimmings can also be furnished with special bearings to operate in a vertical position.

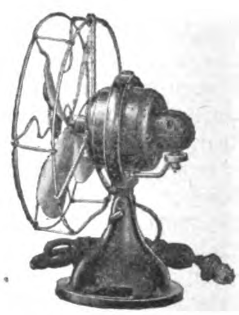
All G-E fans can be converted from desk to bracket type by simply turning a thumb screw.

The G-E fan blade is wider at the hub end than the ordinary blade and has a pitch that increases toward this point. The effect is to project more air from the center of the fan, and thus increase the air velocity at this point, preserving a broad distribution. The large radius at the advancing tip or cutting edge of the blade reduces the noise of high-speed fans. The blades are formed to shape under heavy pressure, and riveted to a rigid spider whose outer ends are spread out to embrace a large surface of the blades. The result is a very strong fan, free from vibration and consequent noise. The liberal space allowed between the fan blades and the motor body insures a free air intake.









These cuts show a full line of oscillating, non-oscillating, ventilating and ceiling fans for the 1918 season, made by the General Electric Co., Schenectady, N. Y.

WARTIME TELEGRAPH SERVICE

Clarence H. Mackay does not believe that Government control of the telegraph lines of the United States is on the way. In his annual message to stockholders of the Mackay companies, in which he presents a record of the company's work and its earnings for the year 1917, he points out that the telephone and telegraph lines represent an entirely different situation from the problem which the Government faced with the railroads.

"A point was reached where the railroad managers admitted they were helpless and the Government was compelled to take control," says Mr. Mackay. "The case of the telegraph business is entirely different. The telegraph business of the country is being handled to-day in a manner which reflects credit on the telegraph organizations. The public is being served to its complete satisfaction and there is absolutely no reason for the Government interfering with the present conduct of the telegraph business, nor any desire on the part of the public that the Government should interfere. The trustees believe that whatever is the outcome of the present railroad situation in the absence of any real demand on the part of the public for Government control or ownership of the telegraphs, shareholders may feel reasonably certain that the telegraph will remain under the present private control."

One notable achievement of the year by the Postal Co. which is mentioned by President Mackay, is the transmission of President Wilson's message to Congress on the purpose of the war from Washington westward to Shanghai, China, and eastward to Paris, all by the land lines and ocean cables of the company. The message was of 2,755 words and was transmitted in one hour and thirty-six minutes.

INCOME TAX RETURNS

At the request of the Government, we wish to call attention of our readers to the necessity of making the income tax return before April 1. The request reads:

"Did your salary, or wages, or income amount to $83.33 a month (that is, $1,000 a year or over) during 1917? If so, and you are not married, you must make a statement of this income to the Government. If you are married, or support a family, it will not be necessary for you to make an income tax return unless it amounted to $166.66 a month (that is, $2,000 a year or over).

"You should immediately see the Internal Revenue expert in your community (ask the postmaster or your banker where his office is) and he will tell you how to make out your income tax return on the form which he has. He will also tell you what deductions you can make in figuring up your income."

NAVY NEEDS WORKMEN

The Navy offers citizens a splendid opportunity to enroll for the period of the war. It needs a number of men for aviation repairs, such as boat builders, fabric and wire workers, machine repairers and wood workers.

This is an urgent call for highly important work. Pay is good; food, clothing and quarters are furnished, also Government insurance up to $10,000.

If you are trained in one of these trades go at once to any Navy recruiting station throughout the United States or to: 225 West 42nd Street; 34 East 23rd Street; U. S. S. Recruit, Union Square, New York City, or 115 Flatbush Avenue, Brooklyn, N. Y.

You are badly needed. Go right away. Do it to-day. If of draft age get a letter from your local board.

THE CLEARING HOUSE

Advertisements on this page 5 cents a word. No advertisement accepted for less than $1.00. Electrical Engineering reserves the right to open all letters addressed in its care and agrees to forward only answers that are germane to the product or subject advertised.

FOR SALE

FOR SALE—Motors for sale. Twelve 1 to 35 h.p., 500 volts D.C. Address I. K. care ELECTRICAL ENGINEERING, 1642 Woolworth Bldg., New York.

FOR SALE—75 kw. Generator. G. E. form D, class 8-75-900 2300 volts three phase 900 r.p.m. serial number 62249, direct connected exciter burned out and equipped with belted exciter size 3 kw. 60 volts 50 amp. 1500 r.p.m. Price $550. Address Lexington Mill & Elevator Co., Lexington, Neb.

AN established electrical construction and supply business, in a town of 15,000 population. Satisfactory reason for discontinuing. Address: J. E. B., care of ELECTRICAL ENGINEERING, 1642 Woolworth Bldg., New York City.

HELP WANTED

WANTED—Experienced electricians wanted to inspect and repair induction motors in a large industrial plant. Must have experience with 3 phase, 25 cycle, 600 volt motors up to 200 hp. Wages 43 cents per hour for 8 hour shift. Good prospects for advancement. New York & New England Cement & Lime Co., Hudson, New York.

MISCELLANEOUS

SALESMEN, NOTE THIS!
A Money Making Side Line.

FOR Salesmen who represent manufacturers or supply houses. You will find quick, additional profit in co-operating with us. Our service helps hold good-will of old customers—makes friends of prospects, and adds to your income. Endorsed by firms and salesmen alike. Worth investigating. No samples. Mida's Trade-Mark Bureau, Est. 1889, Rand-McNally Bldg., Chicago, Ill.

Request us to send you free our new booklet, "Is Your Trade-Mark Valid?"

Agencies wanted throughout the United States.

STEAM APPARATUS FOR SALE—1 30 in. Cochrane Oil Separator. 2 Westinghouse Machine Co.'s 6½ x 6 Vertical Engines complete with governors and direct connected to size 8 Alberger Centrifugal pumps both mounted on common bedplate.

1 Ideal Engine 15¼ in. bore and 14 in. stroke, double fly wheel 14½ in. face on eccentric end of crank shaft, 12 in. face on opposite side.

1 American Blower No. 8 with pulley 9 in. diameter, 7 in. width.

Can make immediate delivery. Price upon application. Wisconsin-Minnesota Light and Power Company, La Crosse, Wis.

STEAM MATERIALS FOR SALE—Large quantity of new standard cast iron flanged fittings including tees, crosses or four way tees, elbows, side outlet elbows, off-set, taper reducers, short sections of pipe-gate valves, check valves in 2-3-4-5-6-8-10 and 12 in. sizes.

Can make immediate delivery. Price upon application. Wisconsin-Minnesota Light and Power Company, La Crosse, Wis.

ELECTRICAL MATERIALS FOR SALE:

140 ft. 4 in. Iron Conduit (New)

40 ft. 1½ in. Iron Conduit (New).

250 ft. 1¼ in. Iron Conduit (New).

250 ft. 1 in. Iron Conduit (New).

Can make immediate delivery. Price upon application. Wisconsin-Minnesota Light and Power Company, La Crosse, Wis.

FOR SALE

40-K.W. Generator Garwood Type
3-Wire System. 125-250 Volts
Speed 275 Revolutions.
Switch Board 1-panel with instruments marble type.

All in first class condition

Address:

THE PASTIME AMUSEMENT CO.,
17 S. High St., Columbus, Ohio

FOR SALE

GAS ENGINES

For Natural Gas—Illuminating Gas or Distillate

1 100 H. P. Weber Engine
2 150 H.P. Rathbun Jones Engines

For Producer Gas

2 100 H.P. Rathbun Jones Engines
Smith Gas Producers

All machines perfect condition

A. H. COX & CO., Inc.
307-309 First Ave. So. Seattle, Wash.

FOR SALE

REFRIGERATOR PLANT

18-ton complete plant consisting of Wolf compressor, 3000 ft. of 2 and 2½" coils, and engine.

P. R. LINKER
LA CROSSE WISCONSIN

Immediate Delivery

50 KW. 125 volt, G.E. generator, 6 pole 280 RPM. direct connected to a 13 x 12 G.E. ideal engine.

10 KW. 125 volt, G.E. generator, direct connected to an 18 HP. Metz & Weiss kerosene engine.

400 KVA. 3 phase, 60 cycle, 480 volts, Westinghouse alternator. 400 RPM.

125 KW. 3 phase 60 cycle, 2300 volts, G.E. alternator.

75 KW. 3 phase, 60 cycle, 440 volts Westinghouse alternator.

2-100 HP. 110 volt, Holtzer-Cabot D.C. motors.

Large stock of smaller sizes.

JOSEPH MYERSON
270 Commercial Street
BOSTON, MASS.

ENGINE AND DYNAMO FOR SALE

Nash 30 hp. Gas Engine, with General Electric double generator, 160 volts direct, 60 cycle, alternating switchboard, air compressor, air tanks. Excellent condition, suitable for testing purposes or isolated plant.

S. S. HEPWORTH CO.,
2 Rector St., New York City.

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Southern Electric Co., Baltimore, Md.
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Sanderson & Porter, N. Y. City.
Stone & Webster Boston, Mass.
White & Co., J. G., New York City.

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Western Electric Co., New York City.
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FROSTING SOLUTION
Union Electric Co., Pittsburgh, Pa.

FUSES, Electric
Delta-Star Electric Co., Chicago, Ill.
Economy Fuse & Mfg. Co., Chicago.
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City.

FUSES, Refillable
Economy Fuse & Mfg. Co., Chicago, Ill.

FUSE BOXES
" See Boxes—Fuse

GAS ENGINES
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

GENERATOR BRUSHES
" See Brushes—Motor and Generator

BUYERS CLASSIFIED INDEX (Continued)

GENERATORS and Motors
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, O.
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GLOBES, SHADES, Etc.
General Electric Co., Schenectady, N. Y.

GRAPHITE
Dixon Crucible Co., Jos., Jersey City

HAND LAMPS, Electric
Southern Electric Co., Baltimore, Md.

HANGERS, Cable
Standard Underground Cable Co., Pittsburgh, Pa.

HEATING Apparatus, Elec.
General Electric Co., Schenectady, N. Y.
Russell Electric Co., Chicago, Ill.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

HOISTS, Electric and Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

HYDRAULIC MACHINERY
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

INDICATORS
Duncan Electric Co., Lafayette, Ind.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

INSTRUMENT, Electrical
Duncan Elec. Mfg. Co., Lafayette, Ind.
General Electric Co., Schenectady, N. Y.
Norton Electrical Inst. Co., Manchester, Conn.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Inst. Co., Newark

INSULATORS
General Electric Co., Schenectady, N. Y.
Locke Insulator Co., Victor, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

INSULATING MATERIAL
Continental Fibre Co., Newark, Del.
General Electric Co., Schenectady, N. Y.
Moore, Alfred F., Philadelphia, Pa.
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

INSULATOR PINS
Southern Exchange Co., The, N. Y. C.

IRONS, Electrical
General Electric Co., Schenectady, N. Y.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMP CORD
Moore, Alfred F., Philadelphia, Pa.
Samson Cordage Works, Boston, Mass.
Standard Underground Cable Co., Pittsburgh, Pa.

LAMP GUARDS
McGill Mfg. Co., Valparaiso, Ind.

LAMPS, Carbon Arc
General Electric Co., Schenectady, N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Flaming Arc
General Electric Co., Schenectady N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Incandescent
General Electric Co., Schenectady. N. Y.
National Lamp Works, Nela Park. Cleveland, Ohio
Southern Electric Co., Baltimore, Md.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Westinghouse Lamp Co., N. Y. City

LAMPS, Miniature
General Electric Co., Schenectady. N. Y.
Southern Electric Co., Baltimore, Md.

LANTERNS, Electric
Southern Electric Co., Baltimore, Md.

LEAD-COVERED WIRES
General Electric Co., Schenectady. N. Y.
Okonite Co., The, New York City
Roebling's Sons Co., John A. Trenton. N. J.
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co. New York City

LIGHTNING ARRESTERS
Delta-Star Electric Co., Chicago, Ill.
General Electric Co., Schenectady N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LINE MATERIAL
General Electric Co., Schenectady N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LUBRICANTS
Calebaugh Self-Lubricating Carbon Co. Inc., Philadelphia, Pa.
Dixon Crucible Co., Jos., Jersey City.
Galena Signal Oil Co., Franklin, Pa.

MACHINERY GUARDS Perforated
Erdle Perforating Co., Rochester, N. Y

MAGNET WIRE
American Steel & Wire Co., N. Y. C.
Moore, Alfred F., Philadelphia, Pa.
Roebling's Sons Co., John A., Trenton. N. J.
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co. New York City

MECHANICAL STOKERS
Westinghouse Machine Co., E. Pittsburgh, Pa.

MERCURY RECTIFIERS
Cooper-Hewitt Electric Co., Hoboken N. J.

METAL, Perforated
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METAL PUNCHING
Erdle Perforating Co., Rochester, N. Y

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American Platinum Works, Newark

METERS
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General Electric Co., Schenectady, N. Y.
Norton Elec. Inst. Co., Manchester, Conn.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

MINING MACHINERY
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.

MOLDING, Metal
National Metal Molding Co., Pittsburgh, Pa.

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OILS
" See Lubricants.

OILS, Illuminating
Galena Signal Oil Co., Franklin, Pa.

OZONIZERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

PAINTS, Insulating
General Electric Co., Schenectady, N. Y.
McGill Mfg. Co., Valparaiso, Ind.
Standard Underground Cable Co., Pittsburgh, Pa.

PANELBOARDS
Adam Electric Co., Frank, St. Louis
Columbia Metal Box Co., N. Y. City
General Electric Co., Schenectady. N. Y.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

PERFORATED METALS
Erdle Perforating Co., Rochester, N. Y.

PHOTOMETER Standards
Electrical Testing Laboratories, New York City

PINS, Iron
Southern Exchange Co., The, N. Y. C.

PLATINUM
American Platinum Works, Newark.
Baker & Co., Newark, N. J.

PLUGS, Flush & Receptacles
Adam Electric Co., Frank, St. Louis
Benjamin Elec. Mfg. Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

POLES, Ornamental Street
Brady Elec. & Mfg. Co., New Britain, Conn.

POLES, Brackets, Pins, Etc.
Brady Elec. & Mfg. Co., New Britain, Conn.
Southern Exchange Co., The, N. Y. C.
Western Electric Co., New York City

POT-HEADS
Brady Elec. & Mfg. Co., New Britain, Conn.
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.

PRODUCERS, Gas
Westinghouse Machine Co., E. Pittsburgh, Pa.

PUMPS
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

RAIL BONDS
American Steel & Wire Co., N. Y. C.
General Electric Co., Schenectady, N. Y.
Roebling's Sons Co., John A., Trenton, N. J

RECEPTACLES
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RECTIFIERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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Minneapolis Elec. & Cons. Co., Minneapolis, Minn.

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General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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RESISTANCE UNITS
Dixon Crucible Co., Jos., Jersey City
General Electric Co., Schenectady, N. Y.

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" See Wires

RHEOSTATS
Erdle Perforating Co., Rochester, N. Y.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

ROSETTES
National Metal Molding Co., Pittsburgh, Pa.

SCREENS AND SIEVES, Perforated
Erdle Perforating Co., Rochester, N. Y.

SEARCHLIGHTS
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Western Electric Co., New York City

SEWING Machine Motors
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.
Wisconsin Elec. Co., Milwaukee, Wis.

SOCKETS and Receptacles
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.

SOCKETS, Turndown
General Electric Co., Schenectady, N. Y.

SOLDERING IRONS
General Electric Co., Schenectady, N. Y.
Pittsburgh Elec. Specialties Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SOLDERING MATERIAL
Alex. R. Benson Co., Hudson, N. Y.

SOLENOIDS
General Electric Co., Schenectady, N. Y.

STAGE Lighting Apparatus
General Electric Co., Schenectady, N. Y.

STAPLES, Insulating
American Steel & Wire Co., N. Y. C.

STARTERS & CONTROLLERS, Motor
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

STEEL Armored Wire
Okonite Co., The, New York City
Roebling's Sons Co., John A., Trenton, N. J.
Standard Underground Cable Co., Pittsburgh, Pa.

STOCKS AND BONDS
Electric Bond & Share Co., N. Y. City

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Erdle Perforating Co., Rochester, N. Y.

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SUBSTATIONS, Outdoor

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Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SUPPLIES, Electrical

Delta-Star Electric Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

SUPPLIES, Telephone

Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City

SURFACING, Steel and Tin

Erdle Perforating Co., Rochester, N. Y.

SWITCHBOARD Supplies

General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SWITCHBOARDS, Light and Power

Adam Electric Co., Frank, St. Louis
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SWITCHBOARDS, 'Phone

" See Telephone Equipment

SWITCHES, Flush and Snap

National Metal Molding Co., Pittsburgh, Pa.
Southern Elec. Co., Baltimore, Md.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Fuse

General Electric Co., Schenectady, N. Y.

SWITCHES, Knife

Adam Electric Co., Frank, St. Louis
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Oil

General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Pole Top

Delta-Star Elec. Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.

SWITCHES, Remote Control

General Electric Co., Schenectady, N. Y.

TAPE

Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.

TELEPHONE Equipment

Western Electric Co., New York City

TERMINALS, Cable

Dossert & Co., New York City
Standard Underground Cable Co., Pittsburgh, Pa.

TESTING, Electrical

Electrical Testing Laboratories, New York City

THEATER DIMMERS

General Electric Co., Schenectady N. Y.

TOOLS, Linemen's

Western Electric Co., New York City

TRANSFORMERS

Allis-Chalmers Mfg. Co., Milwaukee Wis.
Duncan Elec. Mfg. Co., Lafayette, Ind
Enterprise Electric Co., Warren, O.
General Electric Co., Schenectady N. Y.
Kuhlman Electric Co., Bay City, Mich
Moloney Electric Co., St. Louis, Mo
Packard Electric Co., Warren, O.
Pittsburgh Transformer Co., Pittsburgh
Thordarson Elec. Mfg. Co., Chicago
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

TRANSFORMERS, Bell Ringing

Southern Electric Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

TURBINES, Steam

Allis-Chalmers Mfg. Co., Milwaukee Wis.
General Electric Co., Schenectady N. Y.
Leffel & Co., James, Springfield, O.
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

VACUUM CLEANERS

Western Electric Co., New York City

VENTILATORS

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WASHING MACHINES Electric

Western Electric Co., New York City

WASHERS, Iron, Steel and Mica

Erdle Perforating Co., Rochester, N. Y.

WATER Wheels and Turbines

Allis-Chalmers Mfg. Co., Milwaukee Wis.
Leffel & Co., James, Springfield, O

WATTMETERS

" See Instruments, Electrical

WIRES AND CABLES

American Platinum Works, Newark
American Steel & Wire Co., N. Y. C
Detroit Insulated Wire Co., Detroit
General Electric Co., Schenectady N. Y.
Lowell Ins. Wire Co., Lowell, Mass
Moore, Alfred F. Philadelphia, Pa.
Okonite Co., The, New York City
Roebling's Sons Co., John A., Trenton N. J.
Phillips Insulated Wire Co., Pawtucket, R. I.
Rome Wire Co., Rome, N. Y.
Southern Electric Co., Baltimore, Md
Simplex Wire & Cable Co., Boston
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co., New York City

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Volume 51. No. 4 APRIL, 1918 20 Cents per Copy

Electrical Engineering

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

The 1st Of May THRIFT STAMP DAY In The U. S. A.

The Active Co-operation of Every Reader of *Electrical Engineering* Is Urgently Requested to Make It A Success

May 1st, 1918, will be observed throughout the United States as Thrift Stamp Day! On that day, retail stores everywhere in every line of business will ask customers to take part of their change in Thrift Stamps! It will be patriotic for every man, woman and child to accept at least one Thrift Stamp as change on every purchase made that day—and to make as many purchases as possible on May 1st.

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Electrical Engineering

Incorporating Electrical Age and Southern Electrician

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CHAS. B. THOMPSON, President

GEO. A. WARDLAW, Editor

Volume 51 **APRIL 1918** **Number 4**

In This Issue:

Other Items of Interest:

MEMBER ABE

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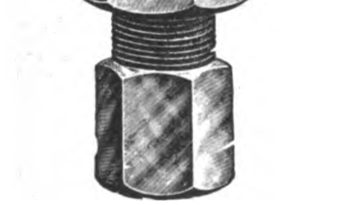

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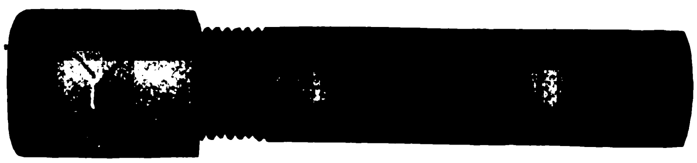

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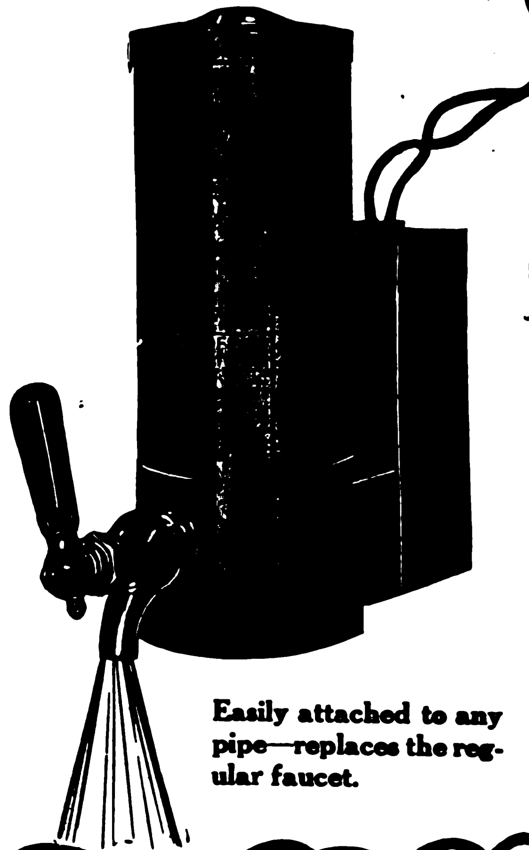

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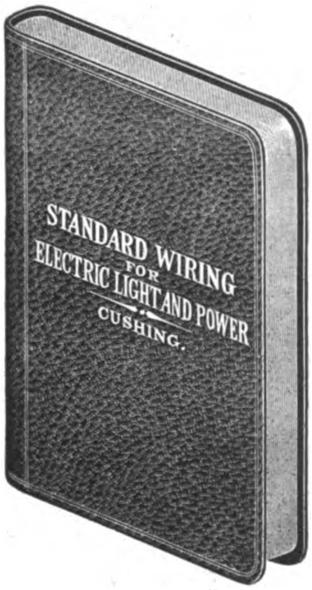
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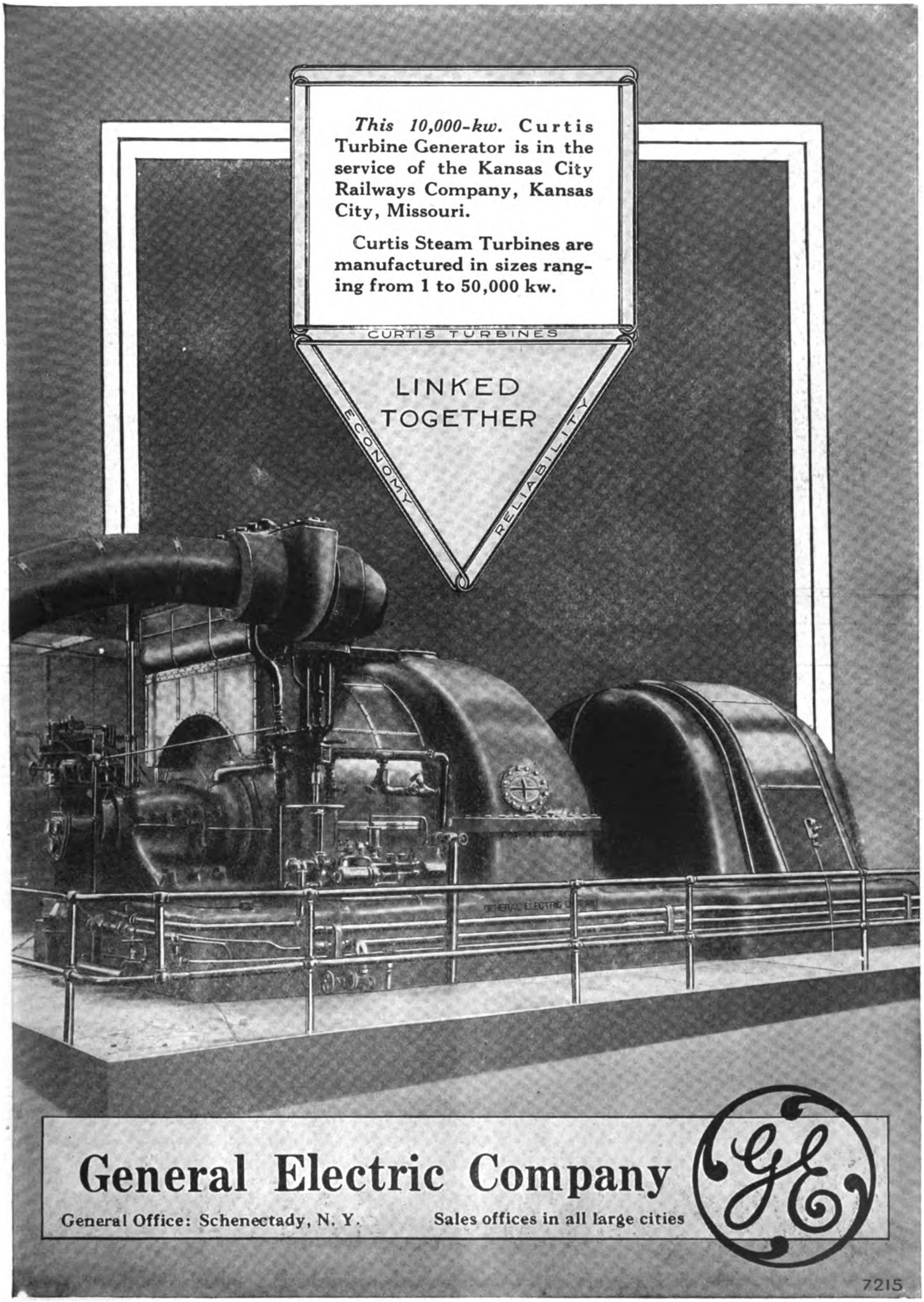

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Electrical Engineering

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

Technical Journal Company, Inc., New York

Vol. 51 **APRIL, 1918** **No. 4**

ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

By H. A. Hornor

(*Continued from page 28, March issue*)

Strap Hangers and Kicking Box

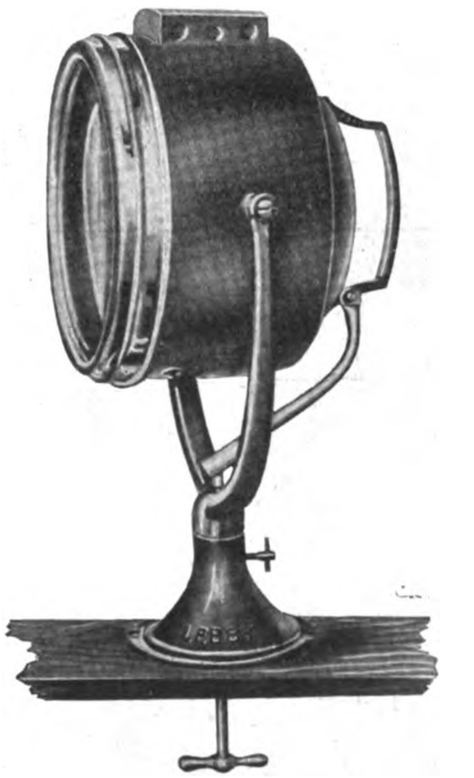
With these hangers ready, the lead bushings and stuffing tubes in place, the armored-cables may be laid in. A length of lead run off the cable reel and cut is carefully coiled and carried to a point convenient to the threading of the lead through the holes. It is most important to cover and keep covered the ends of the wire whenever it is cut. This is easily done with tape. If it is not done the chances are that moisture or water will find its way into the cable, being absorbed by the jute filler. As the cable is threaded through the holes, the straps are secured and with a wooden hammer the cable is straightened of any kinks that may have formed in handling it. In all leads that pass through decks a piece of steel conduit about 18 in. long is fitted for the steel-armored wire to pass through. This is called a "kicking box" and acts as a preventive against mechanical injury.

Wiring Feeders, Distributing Panels, and Junction Boxes

The feeders are led directly without break from the main switchboard to a distribution panel or similar terminal apparatus. The mains are run from the distribution panels to junction boxes from which branches are taken to groups of lights. In the equipment here selected the mains would probably be so small as regards load carried that they would be the same size of wire as the branches.

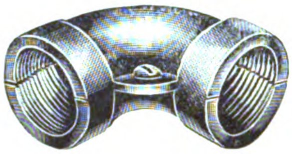
Branch leads for any size of equipment are always No. 14 B & S gauge, because this is the smallest wire size permitted by the Fire Underwriters. In order to tap off a light, or outlet, branch boxes are used. These are a simple, usually round, cast iron box with bosses for the stuffing tubes where the wires enter and a brass, screwed-on cover provided with a rubber insertion gasket. Sufficient wire must be allowed when cutting-in a branch box so that the joint may be safely made. In the event that the wire is cut too short, a new lead must be laid in. The lead-covered steel-armored wire must be carefully stripped of the outer steel braid, retaining enough of the steel braid so that this is fully covered when the cap of the stuffing tube is screwed firmly "home." The lead cover must be cut with the same care, so that the lead sheath will come flush with the interior of the branch box. A special tool has been devised for stripping and cutting the steel and lead covers of this cable. It is shown herewith. After the tape and rubber are removed from the wires they are threaded into the branch box and a good twisted mechanical joint made. This joint is then soldered, wrapped with rubber, and friction tape and then shellacked.

Marine fixtures are not fitted with fixture wire as in land practice. In this case the branch lead is taken to the fixture

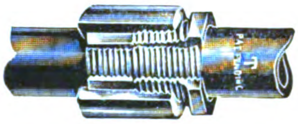


Navy type searchlight, 10 in. and 14 in. Lebby Engineering Co., 151 Meeting Street, Charleston, S. C.

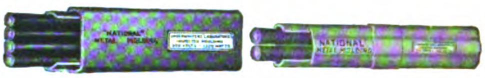
PART OF THE ELECTRICAL EQUIPMENT OF A MODERN SHIP



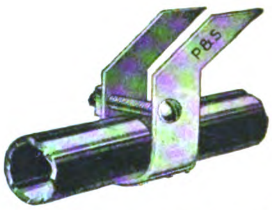

Conduit clamp. Columbia Metal Box Co., New York.



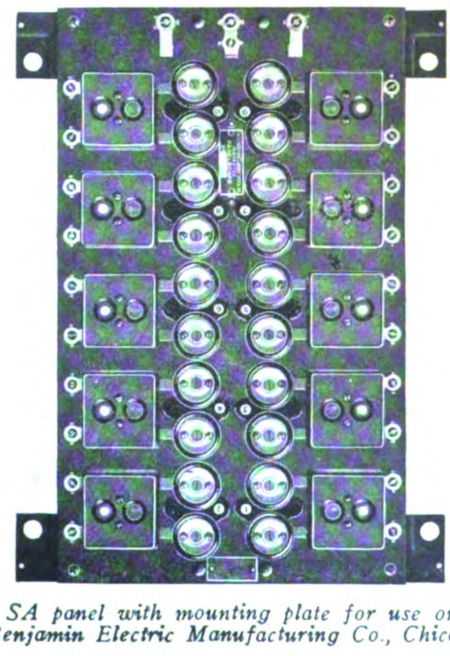

T & B bushing, locknut Erickson coupling, split elbow, split coupling and split tee. Thomas & Betts Co., 105 Hudson street, New York.



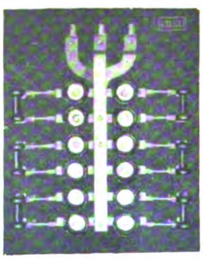
Sheraduct conduit, Nos. 222 and 333 metal moldings, and typical outlet box with cover for use on shipboard. National Metal Molding Co., Pittsburgh, Pa.



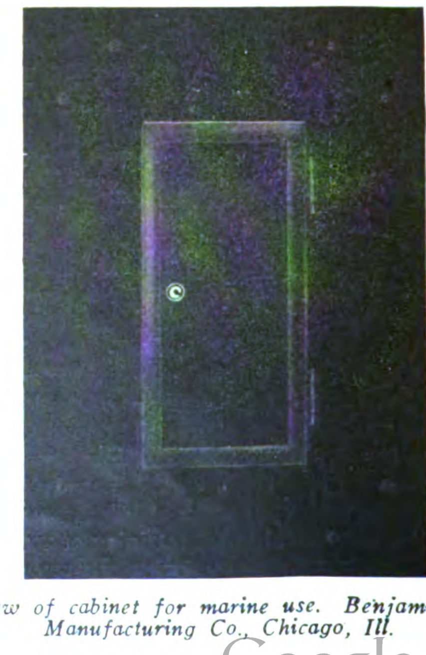
Galvanized conduit clamps for use on shipboard. Pass & Seymour, Inc., Solvay, N. Y.



Type SA panel with mounting plate for use on shipboard. Benjamin Electric Manufacturing Co., Chicago, Ill.



Marine distributing panel. Geo. Cutter Co., South Bend, Ind.



Front view of cabinet for marine use. Benjamin Electric Manufacturing Co., Chicago, Ill.

This Is Where I Need You, Lad!

WHAT is the paramount need of the hour?

The answer is Ships—Ships—and More Ships.

The only way to get "Over There" is by ships.

The only way we folks, we loyal Americans "over here" can send supplies and munitions and men "Over There" is by ships—ships—and more ships.

The only way in which we can prevent further stoppages in our business life, keep factories working full time, and assure the continuous employment of American workmen, is to build ships and build them at once.

The slimy German submarine has already sunk approximately ten per cent of the ships afloat at the beginning of the war. Think of it!—yes 1 in every 10 has gone down before the devilish cunning of the hellish Hun.

Without mercy, yes with diabolical premeditation, and that means "Murder in the First Degree," hospital ships, unarmed merchantmen, Red Cross relief ships and peaceable neutrals have received their death blow and thousands of innocent women and children and non-combatant men have gone before that Great Judgment seat to testify to the need on earth of a victory by America and her Allies over the forces of murder, rapine, destruction and treachery represented by the military party of Germany and Austria.

Scores—nearly a hundred, loyal Americans—men every inch of them—have just been ambushed and slain by the Hun assassins of the sea—and another ship lies in the ocean depths.

And the other question you have asked heads the next column.

THIS IS WHERE I NEED YOU, LAD!

How Can I Best Serve My Country?

The answer comes almost before the question is asked.

By helping Uncle Sam build ships.

Who says we can't build ships!

Come on, you loyal American mechanics, masters of familiar trades, and brand this "made in Germany" insinuation by building a bridge of ships to Pershing.

You can't do your country a greater service than by exchanging your good American brawn and skill for good American dollars—in the shipyard. And you'll do as much to win the war as the men dependent upon you in the trenches. Ships, men, are the pivot on which the destiny of this country turns, and Uncle Sam is looking for 250,000 U. S. shipyard volunteers to build them.

Every rivet driven in th shipyards brings us nearer the successful termination the war.

To do our fair share c shipbuilding program calls f 6,000,000 tons a year, or over a thousand ships. We must have them to win. We must have them to keep the wheels of American industry moving and American labor employed.

The Shipping Board has the money, the materials and the yards to carry out this 6,000,000 ton program, but it needs men to assure these thousand yearly launchings which will hurl their tidal wave toward Germany. There must be an immense reserve of earnest skilled labor to draw on as fast as plants are completed in the yards and housing provided.

This, then, is the purpose of this message—to ask your enrollment as a shipyard volunteer, for work in the shipyards when needed.

SEND THIS ON

"Official" Business

YOURS AND UNCLE SAM'S

No Stamp Required

United States Shipping Board
Washington

Official Business
Penalty for private use
$300

POST CARD

Mr. Edward N. Hurley

Chairman United States Shipping Board

Washington, D. C

This does not mean that you are to give up your regular job and rush off to some shipyard which at the moment may not be able to accommodate you. Quite the contrary! Your enrollment simply shows that you stand ready, when called upon, to do a particular job for a particular wage in a particular place. Everything will be in readiness for you, and you will lose no time.

"But," you say, "I've never worked on shipbuilding."

That's exactly why Germany thinks that America cannot build ships. Germany knows that there are not enough men in America who have actually worked on ships to make more than a tenth of the ships we need if we are to do any fighting worth while.

Here is where you American workmen can fool the Kaiser.

Ships are not things of mystery; they are merely big buildings afloat—the product of everyday skill and industry—and the American mechanic (hats off to him) can build them.

Familiar trades—YOUR trade—are the ones that build ships; and almost all trades are represented. Two-thirds of the occupations used in shipbuilding are common to other industries, like boiler making, car building, bridge building, carpentering, machine shop work, etc. The list given indicates some of the classes needed.


U. S. Shipyard Volunteers

Public Service Reserve

Certificate of Enrollment

This is to Certify That

YOUR CERTIFICATE OF AMERICANISM

If you possess the right sort of training now is the time to rally around this movement and wear a Badge of Honor. The button, issued by the United States Shipping Board, shows that the wearer, through enrollment in the United States Shipyard Volunteers, has placed the welfare of the Nation above all else and stands ready by his labor to help throw across the seas a bridge of ships by which the armies of the United States can pass to do their duty on the fields of France.

To wear this button is a sign of distinction. It truly stamps the owner as the MAN OF THE HOUR in whose hands rest the happiness and security of every man, woman and child in this country.

Come on, men—250,000 of you! Your Government is asking that you answer the rattle of German machine guns with the rattle of the riveter. It is asking you to prove that you are the marrow of Americanism by going on record with an expression of your willingness to help build ships where you are needed. And it meets you half-way with good wages and all honor.

Can you turn a deaf ear to the call? Where can you qualify in the following list?

ENROLL NOW

WEAR THIS BUTTON

The Badge of an American Ready to Do His Duty

Acetylene and electrical welders	Reamers	Laborers, all kinds	Coppersmiths
Asbestos workers	Carpenters	Loftsmen	Shipfitters
Blacksmiths	Ship carpenters	Template makers	Structural iron workers
Anglesmiths	Dock builders	Machinists and machine hands, all sorts	Riveters
Drop-forge men	Chippers and calkers	Helpers	Erectors
Flange turners	Electrical workers	Painters	Bolters up
Furnace men	Electricians	Plumbers and pipe fitters	Other trades
Boiler makers	Wiremen	Sheet-metal workers	Cementers
Riveters	Crane operators		Crane men
	Foundry workers		

Sign this Card and Get the Full Story

EDWARD N. HURLEY, Chairman,
U. S. SHIPPING BOARD,
WASHINGTON, D. C.

I wish you would send me at once further information, telling me how I can enroll as a member of the U. S. Shipyard Volunteers of the Public Service Reserve for employment in shipyards and so help win the war.

My Trade is ....

My Name is ....

Street Address ....

...own ....

SEND THIS ON
"Official" Business
YOURS AND UNCLE SAM'S
No Stamp Required

box, or block, it is stripped in the same manner and the two wires are formed into an eye large enough to fit over the screw-connection of the lamp socket. This same precedure applies to switches and receptacles. The non-watertight type used in this class of work is the same as land but mounted on a wooden block. The watertight type is enclosed in a watertight brass or iron box.

The connections of the feeder wires to the main switchboard are all made with copper or brass lugs. The wires are stripped in the same manner and the lugs soldered on the bare copper ends. These lugs are secured by double locknuts to the threaded studs on the back of the switchboard. In order to preserve the cable the wires are "seized" with heavy hemp cord on top of the tap. "Seizing" is a nautical expression for twisting the ends of a rope with twine so that it will not unravel, and gives to the electrical wiring a ship-shape appearance which though possibly insignificant to those not versed in marine refinements, adds greatly to the quality of the workmanship.

Usually all the work of running and connecting up the various circuits is completed before the engine or boiler installations are ready for making steam. When steam is available on the auxiliary steam line the main generators may be "turned-over" for the first time. The steam end of the generating sets is handled by the ship installation department so that the electrical foreman devotes his entire attention to the electrical end. Preparatory to starting the set it is well to look over the connections of the generator field, as these may loosen due to handling.

Searchlight for marine uses. National X-Ray Reflector Co., Chicago, Ill.

Testing Generator Circuits

The foreman is usually careful to see that all the circuits between the generators and the switchboard are clear. This he assertains by means of a portable magneto. He also traces out his circuits so that if possible the instruments on the switchboard will tally with the direction that the generator builds up.

When the engine is brought up to speed he cuts resistance out of the field circuit, and as the generator is compound-wound it gradually builds up its voltage. The set is allowed to run without load for a little while and then one of the nearby circuits, say the engine room lights, is thrown on. If this shows that the ammeters are functioning in the right direction, the other circuits may be thrown in. It is rarely possible to overload a generating set on this type of equipment, as the power is proportioned for safely carrying the full rated requirements.

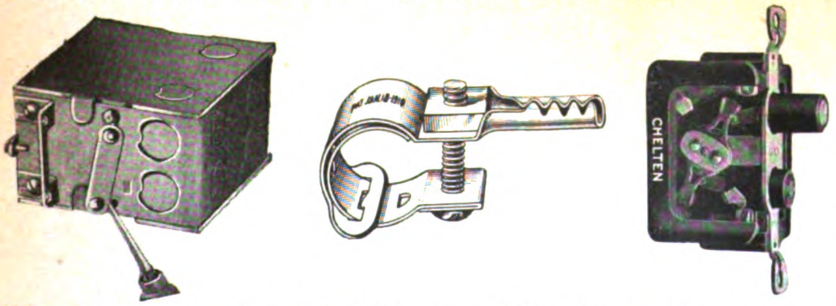
The second generating set is always a spare, though it may in most installations be thrown in multiple with the other set and so aid in any emergency. Such emergency might arise in the long continued use of the searchlight or the wireless apparatus if such is afterward installed. Of course there are many accidental conditions that may arise in starting a generating set, such as a "dead" field due to the fact that the magnetic iron of the field poles has remained idle for some time. This can be quickly and easily remedied by the application directly to the fields for a short time of an outside supply of electricity. When load is first thrown on it may be found that the two fields are "bucking" each other; that is acting in opposite directions. This merely means a cross in the connections or the changing of the polarity of one of the sets.

With the generating plant running the electrical foreman tries out all the circuits and all the apparatus, applying the normal precautions in each case supplied him by the manufacturer. Grounds and short circuits are hunted to their sources and the proper cure made by adding more or proper insulation. In this particular installation the foreman will find great freedom from these defects except in junction boxes, distribution panels and main switchboard, because the lead-covered steel-armored cable obviates any such trouble. This is the main argument for its employment.

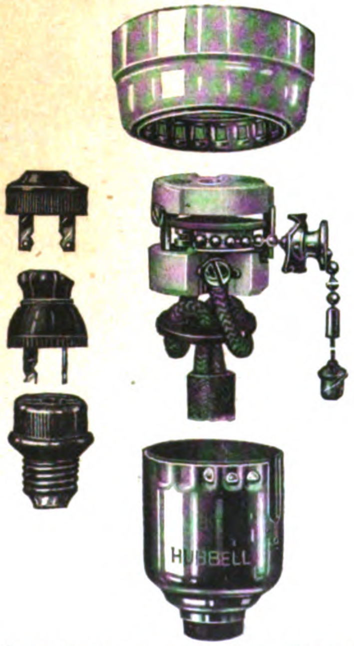
There is a minimum of upkeep in such a new installation, but a maximum of convenience of every one on the ship. For this reason the electric plant after it is once started is never stopped. When the trials of the vessel are over and the owners are ready to accept the ship from her builders, the electrical plant still remains running. The owner's representatives steps up to the switchboard and the shipbuilder's operator retires. So well do these plants run that cases are on record where a generating set has not been stopped for over a month of continuous operation. It is quite possible that they would under normal shipload operate for even much longer periods. Their reliability, as with human beings, stamp their character.

Details of Installation

This brief survey of the typical application of electricity to a small cargo vessel clarifies the way for a general discussion of the various methods that have been and are pursued in the



Three of the marine fittings made by the Chelton Electric Co., 314 Armat St., Philadelphia, Pa.



Lamp fittings for use on shipboard, Harvey Hubbell, Inc., Bridgeport, Conn.

installation of such an equipment. Variety holds a power in this line of endeavor as in all others, and up to the present time it cannot be said that any such installation is an exact duplicate of another. In the well established shipyards the organizations have been operating for such length of time that they have "ground down their bearings." They have established their own traditions and upon a foundation of empirical knowledge have built their success. Although the men in charge of this work are associated and well known to each other, their opinions do not in every respect coincide, mainly because their experience is not the same or the general policies of the companies are marked by a difference. The practice as shaped by some ship owner may come to one of the shipbuilders and though of the greatest concern to that particular trade will be of no use if followed on a vessel for some other service. Yet by the unalterable laws of association and contiguity this practice may be followed on every subsequent vessel built by that particular firm. The interpretation and decision of some mooted question in one shipyard by the representatives of the Classification Societies will at once occasion the settlement of this method as a fixed policy. If this same question does not arise in another yard the work would doubtless proceed on entirely different lines. These characteristic differences are sometimes so clearly indicated that those who are intimate with this work can often tell the builder of the ship without looking for the nameplate.

Protection of Wires

Historical installations used parafine as the only insulation and only protection to the copper conductor. They were probably only installed in very safe places and mounted on wood. Rubber insulation was unknown at that time. Until recently American practice was definitely settled. Galvanized iron pipe, called conduit, was employed as a runway and mechanical protection to all leads below deck or those exposed on the weather deck. In the quarters, public spaces, or where in general, wood was used for partitions or for concealing the steel structure, wooden moldings were used. These moldings were carefully specified as to dimensions of the grooves, etc., into which the wires were laid. Several coats of shellac were required before the wires could be installed. In addition to this the molding itself must be secured by screws to the steel structure, or woodwork, and the capping must also be screwed to the molding. Taps for branch leads were permitted in the molding but not permitted to come opposite to each other.

The requirements for the conduit installation were not exacting, but as experience was gained general practice established the following fundamentals, which are in operation to-day:

1—All galvanizing of steel conduits must be by the electric-plating or sherardizing process. The interior must be enamelled, or galvanized and enamelled.

2—All bends must be made cold.

3—No pipe fittings to be used.

4—Couplings to have both ends right-hand thread.

5—Unions to have spherical ground joints. They must have one face of the joint copper or bronze. The inner surface must be perfectly smooth. They must be made of malleable iron.

6—Unions must be installed at bends and a number introduced in very long leads.

7—In vessels with engines located aft requiring long leads to the amidships house and forecastle, slip joints and loop boxes must be installed. This is a preventive against the working of the ship breaking the conduits and the wire.

8—All conduit connections must be made up with white or red lead.

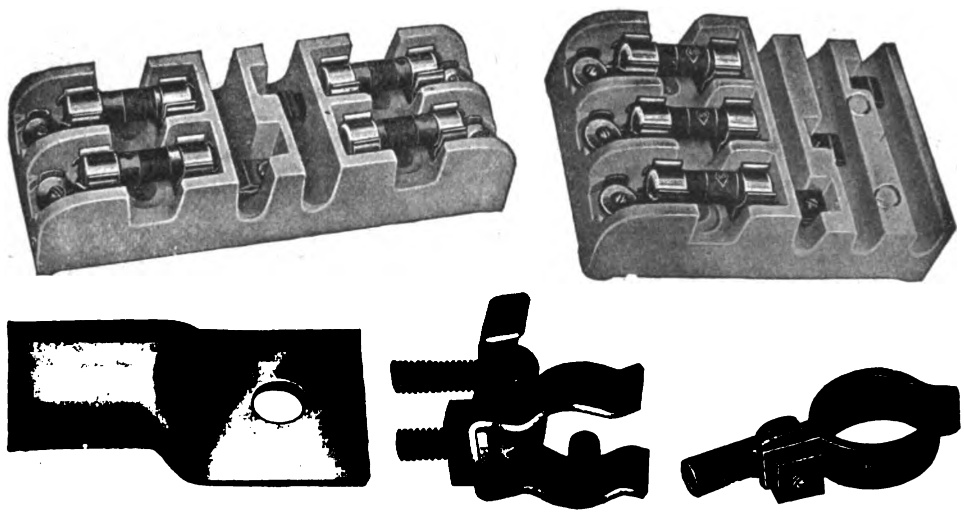
9—The ends of the conduit must be reamed before assembling.

10—The number of wires pulled into a given size conduit must proportioned so as to avoid the use of grease or occasion some severe strain on the wires.

11—Double braided wire is required by Fire Underwriters for conduit work. Single braided may be used in molding.

12—All conduit work must be installed and completely secured in place before the wire is pulled in.

Many experiments were made to perfect the conduit system. It is true that for appearance and "ship-shapeness" a good conduit job cannot be excelled. The inherent trouble has been the unknown collection of water due to condensation. There are always chances for the entrance of water by reason of forgetfulness to replace the cover of some appliances. Such cases could not always be foreseen, but carefulness could avoid a large number of them. No care could stop or ingenuity prevent condensation, as the run of leads must pass from those spaces, like the boiler and engine rooms, which are warm to those spaces that are cold. The leads must come from the switchboard below to distribution panels above. This required the bending of the conduits and a resultant loop which in time would fill with the water of condensation. It was suggested that petcocks be installed at such loops and the water drained



Various types of "Shawmut" fittings for use on shipboard. Made by Chase-Shawmut Co., Newburyport, Mass., and marketed by the Condit Electrical Manufacturing Co., Boston, Mass.

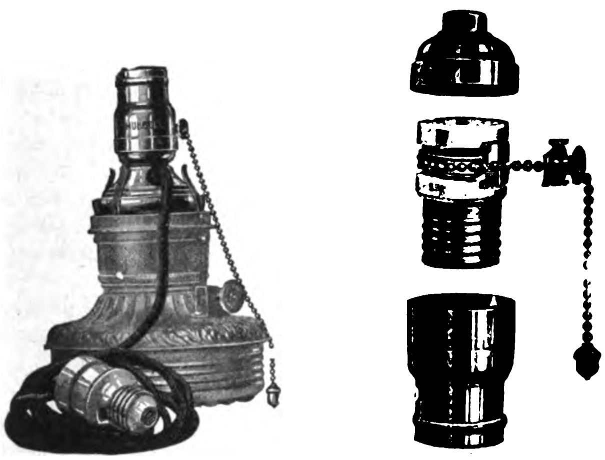
7-in. projector for use on shipboard. Lebby Engineering Co., 151 Meeting Street, Charleston, S. C.

off from time to time. There are installations where this has been done. As some owners discovered that every so many years they were forced to take down the conduits in the engine and boiler spaces or replace all the wire originally installed, other kinds of insulated wires were tried. Asbestos-covered wires were not found successful. In fact they proved worse. A rubber insulated lead-covered wire was tried in conduits. This method also proved a failure.

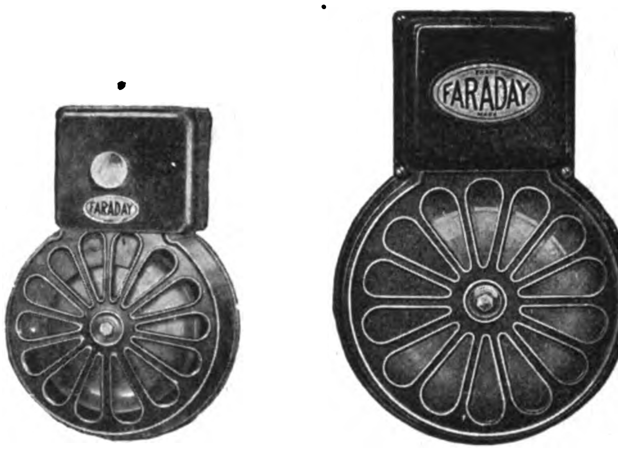
Foreign countries had discarded conduits for some years and were using a lead-covered, wire-armored cable. This type of cable had the steel armoring braided in long hanks.

About seven or eight years ago one of the electrical manufacturers of this country began the production of a lead-covered, steel-armored conductor after the pattern used by one of the foreign navies. The steel wire was braided on the conductor in a very close basket weave. In the design of the lead-covered type a tape was laid over the lead sheath before the galvanized steel wires were braided on. This type of electrical conductor furnishes a watertight and moisture proof protection to the wire and eliminates all questions of condensation or breakdowns due to grounds or short circuits in the conductor. It is a great safety factor. The objections seem to be based entirely on the high cost of the material and the increased cost of installation when compared with a conduit and molding equipment. The conduits are easily supported by the transverse beams in a ship, and therefore it is only necessary to drill holes in the beams and thread the conduits into them. Armored-cables have to be supported by a strap hanger every 12 to 14 inches, which necessitates hangers between the beams if they are so run. The strap hangers for armored cable require the drilling and threading of many small sized holes. If the armored cables cannot be run through the beams, or if there are any obstructions like bolts, rivet heads, reinforcing plates, then sheet iron pans are first installed as a backing for the cables. This method of construction all refers to the attachment of these cables to the steel structure, but, as has been noted previously, there are many spaces in a merchant ship where wood is used to conceal the steel. To these places the skilled man goes as quickly as possible when he lays out the plan of the vessel. The attachment of the armored-cable to wood is extremely simple, easy, and inexpensive. This is especially so if for some unforeseen reason the run has to be changed. The question of cost then resolves itself like many another into the ability of those who do the work. Such an installation can be made most expensive by locating the cables to a large extent on the steel work; it can be made most economical by seeking to lay the majority of the cables on those parts of the structure built of wood. The other advantages of armored conductors are seen at a glance—reduction in weight over conduit and a reduction in the space occuiped. A feature that appeals only to the electrical engineer but should influence every captain of a ship is that the entire wiring system is exposed to view and therefore is accessible for instant repair.

The above discussion leads easily to the deduction that for wooden vessels armored conductors would be the safest and undoubtedly the least expensive type of construction. Of course there would be no bushing of holes, as in the case of running through steel beams, and there would be no additional expense at bulkheads. It is believed that on a wooden vessel all fittings except at junction boxes could be eliminated, even to the kicking boxes when passing up through decks. Undoubtedly the appearance of the work after the painting was finished would be superior to a conduit installation.

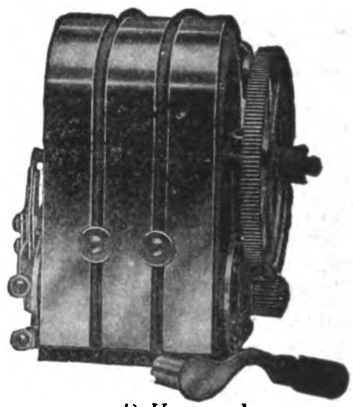


Two marine type fixtures made by Harvey Hubbell, Inc., Bridgeport, Conn.

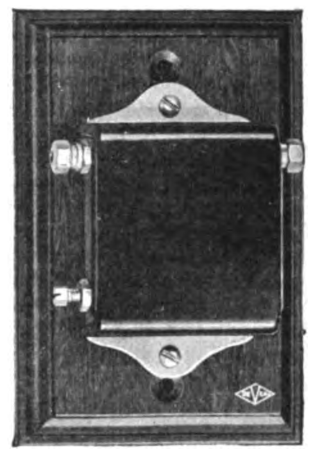


Two types of full-grid guarded and closed Faraday gongs.

DeVeau portable army or field outfit.



DeVeau 3-bar magneto generator.



DeVeau iron box buzzer.

Some of the fittings designed especially for use on shipboard and made by Stanley & Patterson, 23 Murray St., New York.

BUY LIBERTY BONDS WITH YOUR DOLLARS

LIBERTY LOAN THROUGHOUT THE LAND

By Albert Bushnell Hart, of Harvard University

"Proclaim liberty throughout all the land unto all the inhabitants thereof." So runs the legend on the Liberty Bell, which by a favorite tradition pealed out to the world the tidings of the birth of the United States of America on that famous July 4, 1776. We thought that message had gone out once for all; that freedom in the United States was a rock of Gibraltar that could not be scaled, nor penetrated nor moved. We have thought that the old days of national sacrifice and anxiety were forever passed. What so strong, so permanent, so vigorous, so dominant as government of the people in these United States?

If the American Revolution had been only bell ringing and the passage of resolutions, we should not now be the foremost republic of the world, nor any other kind of a republic. The Declaration of Independence was a bold statement of liberty which had still to be made good. The heroes of the Revolution knew how to watch as well as to pray, how to march as well as to resolve. The Declaration of Independence is a mighty force in the world because when the country called, soldiers sprang into the ranks. Liberty had to be spelled out by such big capital letters as Lexington, Saratoga, Monmouth, Illinois, Bennington, Eutaw, Rock Mount, Trenton and Yorktown. Liberty came not because men wished it but because they compelled it. Still a poor backwoods community, the three million Continentals defied, fought, and with the unforgettable aid of France, defeated a great world power with a square-headed, nearsighted German on the throne.

The hard fighting in the field won only half the battle. Our forefathers were able to "proclaim liberty throughout the land" because they found the sinews of war. It was one thing to raise the flag, another to raise the troops and still another to "raise the wind." There was not a bank in the United States till the Revolution was over, and few were the people who had money enough to lend to anybody, yet that three millions, of whom a fourth were slaves who could have no property, somehow induced the people of this country to turn to their small surplus of provisions, clothing and military supplies and take for it the obligations of the government, which toward the end of the dark period of the Revolution, seemed little likely ever to be paid. They furnished about $65,000,000 in taxes, contributions and supplies and at the end of the war the national debt and the state debts incurred in behalf of the Revolution were, including arrears of interest, $70,000,000, which was then about $20 a head on the population, man, woman and child, whites, Indians, and negroes, seamen, farmers, plantation slaves as they ran.

"Proclaim liberty throughout all the land unto all the inhabitants thereof." What those people did in their poverty and remoteness, we must do on a vaster scale or else forever sink beneath their patriotic level. We live in a time when every state and every country is rich in comparison with those national beginnings. Our land abounds in wealthy banks, corporations and individuals. A debt of $200 per capita for 100,000,000 people is only $20,000,000,000, which will be a lighter burden and more quickly extinguished than the Revolutionary debt.

It is not a specie that the government is demanding—few of us carry "fifteen dollars in my inside pocket" in the form of hard silver dollars or golden eagles. It asks us to share our credits, that is our power of commanding food and weapons and uniforms and aeroplanes and submarine and merchant ships and gas masks and all the numerous things that Uncle Sam must have. Make no mistake; this is not a question of whether we feel like subscribing to a loan any more than a question of whether we feel like receiving the news of a break on the war front and the capture or retreat of the American troops.

The nation is compelled to choose either to spend or to be spent. There is only one possible way to end the war to the honor and safety of the United States and that is to fight for it. Our sons fight in the army, our daughters fight in the Red Cross, we elders must fight in the safe deposit boxes and mortgage deeds and sheets of securities.

In the days when the French were in the habit of recruiting troops in Switzerland, there was a saying: "No money, no Swiss!" Nowadays it is "No money, no Yank!" for unless you subscribe to the loan your son cannot be trained or equipped, or fed or transported overseas, or carried to the front, or protected by a barrage of artillery fire, or put where he can attack the enemy.

The battle is going on from day to day in the national banks and the savings banks and the trust companies and the treasuries of the fraternities and the clubs and the churches and the restaurants, just as much as in northern France or Belgium. No one soldier can win at the front, nor a hundred thousand together. It would take a million, but if everyone of that million hangs back, there is no army, nor war—nothing but shame and misery for the nation. You cannot save your country all alone by your subscription to the Third Liberty Loan; but you can unite with a million others. Do your duty and expect and urge others to do theirs. That makes a victorious army of people pouring in their rattling dollars, as the boys at the front hurl hand-grenades.

"All the inhabitants thereof" that is what the Liberty Bell aroused. Not the soldier only, not merely the Red Cross, the Y. M. C. A., the Knights of Columbus, and the other noble co-workers and co-fighters with the troops. You banker, investor, manufacturer; you doctor, lawyer, teacher, scientific man, engineer; you farmer, business man, railroad man, mechanic, working man; you school boy, and school girl—listen to the Liberty Bell, subscribe to the Liberty Loan.

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BUY BONDS ELECTRICALLY

The Third Liberty Loan begins April 6. The Government is looking to the electrical industry to subscribe its share. These bonds should be bought through the electrical industry, in which a committee is already at work preparing for the sale of bonds to electrical men through electrical associations, electrical firms and companies, and electrical people generally. Give the electrical industry the benefit of your subscription

WITH YOUR LOOSE CHANGE BUY THRIFT STAMPS

FUEL SAVING IN HOUSEHOLD HEATING

During the winter just passed we have learned in the school of experience that coal is costly and hard to get. Profiting by this lesson, it behooves us to get next winter's supply at an early date, and to learn how to get the most heat out of it by studying the subject of combustion in household heating apparatus during the next six months. Household heating apparatus and how to manage it in an economical way is told in Edison Life by the assistant superintendent of the generating department of the Boston Edison Co. We reprint it here for the benefit of our readers who may not have seen it in that magazine.

The coal mines of the United States are at the present time producing about 597,500,000 tons of coal per year. It is estimated that about 15 percent. of the total production, or approximately 89,600,000 tons, is used for heating the dwellings of the people.

If by some means the average family could effect a saving of 10 percent. in the consumption of its coal, there would obviously be 8,960,000 tons of coal saved this coming year. At the prevailing price in Massachusetts during the present crisis that would mean a saving of $85,200,000.

From the dollar-and-cent basis it is difficult to analyze the coal question since the monetary figure is distorted by various conditions due to the times, such as the varying value of gold upon which our money is based. From the point of view of the economist, however, there would be released by such a saving the equivalent of 150 3000-ton ships available then for other uses; there would be released an army of 6000 miners who could then be transferred to other industrial or war employment.

This great economy can be accomplished. "Do your bit" has become the motto of the country. If each householder will apply this motto to the manner and way in which he handles his particular furnace, he may accomplish something for himself and for the country. It should not be understood that the object of this article is to advocate less heat in the home. How to obtain the maximum amount of heat from the minimum amount of coal becomes the "burning" question. To accomplish this end, the householder must put some study into the nature and characteristics of fuel and into the characteristics of his heating apparatus.

Some valuable investigations of this subject have been made by colleges and by the United States Government, and it is upon these investigations that the recommendations of this article are based.

Since very little new building is being carried on at the present time, the question of selecting the best type of heater will be passed over, confining the discussion to the operation of heaters already installed, with suggestions regarding the selection of fuel to use in them.

We are accustomed to think only of anthracite or hard coal in connection with the home heater, but if the present war conditions continue over an indefinite period, it may become necessary to make use of other fuels for the purpose. Wood, bituminous coals, peat, coke, fuel oil, gas, electricity—all may come under consideration by virtue of varying price values.

Table 1 shows the comparative advantages and disadvantages of various fuels for heating, but the value of this table has been somewhat affected by conditions prevailing since it was compiled. As an instance, gas and electricity are sold at the same price as before the war, but bituminous coal has advanced over 100 percent., and anthracite has advanced over 50 percent.

It should be noted from the table that electricity furnishes the ideal method for heating a house, but on account of the high cost as compared with the price of coal previous to the war it has been little used for this purpose.

Anthracite coal is the most desirable for household use. The amount of attention required by its use is much less than that by bituminous coal, and for this reason a higher price can be paid for the convenience. Considering the various sizes of coal, there is very little difference in the heating value of one size over another, and if some advantage is offered in price, that size should be used. The method of handling the different sizes, however, is different and requires judicious operation.

Bituminous or soft coal is not as desirable as anthracite for domestic purposes. Before the war the public was willing to pay 50 to 100 percent. more for hard coal than for soft on account of the convenience in handling; therefore, with both

Table I—Advantages and Disadvantages of Various Fuels and of Electricity

Fuel	Advantages	Disadvantages
Wood	(a) cleanliness, (b) cheerful fire, (c) quick increase of heat, (d) cheap in some localities.	(a) low fuel value, (b) large storage space necessary, (c) labor in preparation, (d) scarcity, (e) does not hold fire long, (f) unsteady heat.
Anthracite	(a) cleanliness, (b) easy control of fire, (c) easier to realize heat in coal than is the case with other coals, (d) steady heat.	(a) price high, (b) difficulty of obtaining, (c) slower response to change of drafts.
Bituminous Coal	(a) low price, (b) availability, (c) high heat value (in the best grades), (d) low percentage of inert matters (in the best grades).	(a) dirty, (b) smoke produced, (c) more attention to fire and furnace necessary than with anthracite.
Sub-Bituminous Coal and Lignite	(a) relatively low price, (b) availability (in some regions), (c) responds quickly to opening of drafts.	(a) slakes and deteriorates on exposure to air, (b) takes fire spontaneously in piles, (c) heat values generally low, (d) heat in fuel difficult to realize, (e) fires do not keep well, (f) gases generated over fire box sometimes burn in smoke pipe causing excessive heating.
Peat	(a) in general the same as wood.	(a) low heat value, (b) bulkiness.
Coke	(a) cleanliness, (b) responds quickly to opening of drafts, (c) fairly high heat value.	(a) bulkiness, (b) liability of fire going out if not properly handled, (c) fire requires rather frequent attention unless fire box is deep.
Oil	(a) high heat value, (b) immediate increase of heat, (c) cleanliness, (d) small storage space necessary.	(a) high price, (b) difficulty of safe storage.
Gas	(a) ease of control, (b) cleanliness, (c) convenience, (d) immediate increase of heat.	(a) high price in many places.
Electricity	(a) every advantage.	(a) high price.

coals at approximately the same price it is not probable that the public will resort to soft coal unless the hard coal supply is cut off. If it does become necessary to use soft coal, it will be found advantageous to use sized or screened bituminous coal for convenience in burning.

But there is another factor to consider in buying soft coal. The different grades of coal vary in heating value to a considerable extent, a factor not present in considering the size of hard coal.

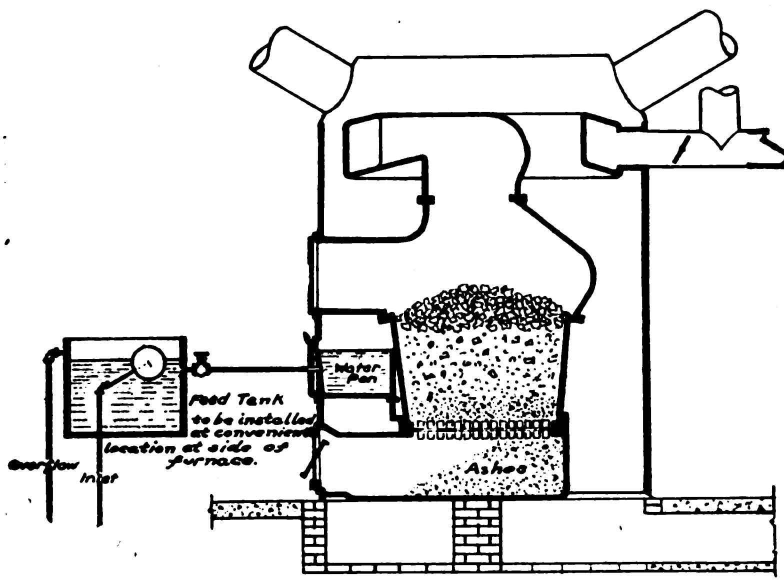

Fig. 1—Diagram showing convenient method of keeping water-pan filled, also condition of ashes which should not exist

The cost of wood as compared with coal must be small before its use would become an economy, since the heat available from one pound of wood is small.

Sub-bituminous coals, lignite, and peat are very little used in this country. The cost of preparing these fuels is high; but with the mounting cost of transportation there is a possibility that they may soon find a market in localities not far from those where they are produced.

Coke is considerably used at the present time for house heating. It is a by-product of the gas industry, and the demand for it has increased more than the increased use of gas. For this reason coke has increased in price at about the same rate as coal.

Fuel oil and coal gas have been very little used for domestic heating purposes and, even considering the increased cost of coal, it is doubtful whether it would be advantageous to install new apparatus for their use. In addition there would be no real economic saving to the country in the use of gas since it is a product of coal. However, the use of electricity, wood, kerosene, or coal gas for auxiliary heating, such as for individual rooms, fireplaces, bathrooms, etc., would be an economic saving under some conditions.

It is within our power to select the fuel we wish to use, but it must be selected for use in heaters now installed. The common types of heaters in prevalent use are the hot-air furnace, steam-heater, and hot-water heater.

The hot-air furnace costs less to install than any other heater, but its life is less than one-half that of the others. This heater conveys hot air to the rooms of a house by virtue of the fact that hot air is lighter than the cold outside air and rises. Air, therefore, must be freely supplied from the outside. Moisture must be supplied to the heated air since health requires it. Heated air has a greater capacity for holding moisture than has cold air; and unless moisture is supplied the hot air will absorb moisture from the skin and, since the process of evaporation cools the body, more heat will be required to produce the same sensation of warmth. Furthermore, furniture and woodwork will soon go to pieces if there is insufficient moisture.

The water-pan in a furnace is too often neglected. A convenient method of keeping this full is shown in Fig. 1.

The first cost of a steam or a hot-water system is much greater than that of a hot-air system. A hot-water system is more expensive than a steam system to install, but with regard to their relative economy, the reverse is true. Relatively the hot-water system is the most economical, the steam system the next, and the hot-air the poorest.

The reason that the hot-water system is more economical comes from the fact that water will circulate under wide variations in temperature. Heated air, on the other hand, must be hot in order to rise. Steam has a constant temperature at about 212 deg. F. for low pressure. For these reasons, hot water will give a heat more uniform than that supplied by the other systems.

If the heating system provides for ventilation from the outside, more coal must be used. This is true, not only for the furnace which draws air from the outside, but for the other systems where the air is changed in the rooms. The extra amount of coal required for this ventilation will depend upon the number of times per hour the air of the rooms is changed. Even at an additional expense it is advisable, from the standpoint of health, to have some means of ventilation.

With any fuel and any system of heating, the most important factor in economy is the method and care taken in operation. The one who pays the fuel bills will undoubtedly exercise the greatest care, so that naturally the man who attends his own heater obtains the best economy if his methods are correct.

Even regulation of heat is one of the principal methods of saving coal. Anticipate the cold periods of the day and open the drafts soon enough to gradually increase the heat, and check the draft before the house becomes overheated.

For complete control of the draft, the heater should be equipped with a damper to the ash pit, a check damper and a shut-off damper in the smoke-pipe. The damper to the ash pit allows air to reach the fire. The check damper allows the draft created in the chimney to draw air from the cellar instead of through the fire. The shut-off damper allows the fire to be shut off from the chimney. This damper should be arranged so that it is impossible to completely shut the fire box from the chimney, since otherwise explosions of coal gas may occur. When soft coal is burned, a lift damper on the fire door is also necessary to relieve gas explosions.

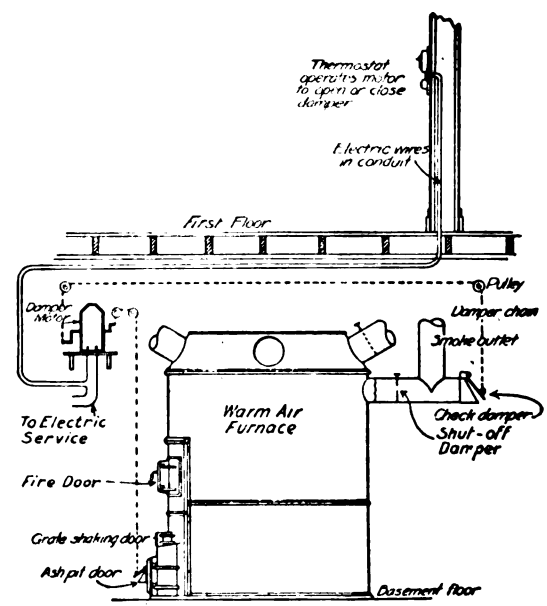

Fig. 2—An ingenious electrical device for maintaining an even temperature in the house.

The door over the fire should never be opened for cutting down the heat unless the house becomes uncómfortable. Opening this door reduces the heat delivered for the coal burned. The check damper should be opened instead.

If the heater does not burn enough coal to produce the necessary heat for the house when all drafts are open and check draft closed, an inspection should be made of all flue passages, the stack, and the chimney to see that they are clean and connections tight. The chimney should extend above all near-by obstructions. The area of a cross-section of the chimney should be at least one-eighth of the grate area. If these conditions are fulfilled the heater should supply enough heat unless it is too small for the work it has to do.

An ingenious device for maintaining an even temperature within the house is shown in Fig. 2. It consists of a thermostat and an electric motor for controlling the dampers so that very little personal attention is required.

Another essential feature in operating the heater for maximum efficiency is a method of uniformity in firing. If the heater is large enough, put the full supply of coal for 24 hours on at the banking period at night. This will cool the heater for the night and will allow a gradual ignition. If firing is required more than once a day, coal should be put on in the morning after the house is warm, but the quantity fired at this time should be as small as possible. The heavy firing should be done at night.

When firing is necessary in the daytime the live coals should be pushed back and the fresh supply filled in to an even height

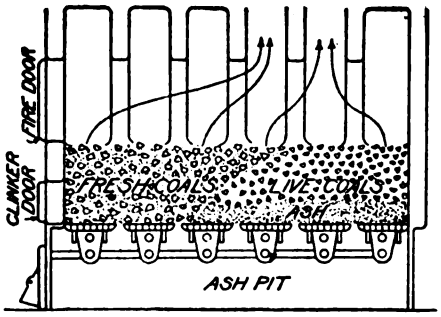

Fig 3—Method of firing coal to burn all coal gas.

in front. In this manner the live coals at the back will ignite the gases from the freshly fired coal and in addition the house will not cool off to so great a degree. Firing in this manner is absolutely necessary in soft-coal burning. Fig. 3 shows how this method is carried out.

If holes burn through the fire, cold air is admitted to the fire box. To prevent this a heavy fire should be kept.

If the heater has proved too small, its capacity for heating may be increased by using a large-sized coal. This allows a greater draft through the fire, causes a greater amount of coal to be burned, and more heat to be produced.

The grates should never be shaken at night. This should be done in the morning when the heat is required. It should be done with care, stopping when a small amount of light can be seen from the fuel bed. In mild weather, by allowing a layer of ashes to remain on the grate, the draft may be cut down and the heat kept low. Following these methods of shaking will cut down the loss of coal to the ash pit, and eliminate the disagreeable job of sifting ashes.

Ashes should never be allowed to accumulate under the grates, as they reflect the heat and tend to warp and burn the grates.

Of equal importance to the losses in the chimney and ash-pit are those due to radiation, and another loss which occurs from the decreasing capacity for heat absorption by the heater.

The radiation loss is often as high as fifteen percent. This figure can be cut to five or ten percent. by covering the pipes and conserving the heat for the rooms rather than for the cellar.

The loss due to the decreasing capacity for heat absorption by the heater is frequently large and receives little attention. Such heat as is not readily taken up by the heater passes on to the chimney. This heat may be turned into useful heat if the hot smoke flues are clean and all heat transferring surfaces free from soot. Soot is an almost perfect heat insulator, and a layer upon the heating surfaces will cut down heat delivered to the heating medium to a very large extent.

The foregoing recommendations pertain principally to the use of hard coal. Hard coal will undoubtedly remain the predominating fuel for household uses in this locality for some time to come.

It is not so much a question of shortage of coal as it is lack of transportation facilities, and one coal is as readily transported as another.

However, if the situation changes and soft coal comes into use, the householder will find it necessary to use new methods in handling his fire. Frequent firing becomes necessary. Means must be adopted to reduce the excess smoke and to consume the volatile gases. For this purpose air must be admitted over the fire after a fresh coaling so as to mix freely with the gases and burn them.

Coke requires about the same methods for burning as does hard coal, but with additional attention. It burns freely and burns out quickly. It should be well ignited before the drafts are closed, for otherwise it will go out.

Wood is very free burning and difficult to control. It also offers no chance for banking.

In conclusion, it may be noted that a considerable saving may be effected in the use of coal by a methodical procedure and a careful watchfulness for deteriorating influences. They may be summed up in a few suggestions. See that the firing is done at as infrequent periods as possible; that the grates are not shaken too often; that the temperature is kept uniform; that the radiation is small; and that the heating surfaces are clean.

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BIG SHIPS CUT IN TWO FOR PASSAGE VIA CANAL

A feat that is amazing to the layman is being performed on the Great Lakes, where mighty ore carriers that ply ordinarily between Duluth and the ports of Lake Erie are being cut in two so they may pass through the Welland Canal to the Atlantic and put into service in war trade. It is impossible for these vessels to be taken through the canal as they were built. Engineering science solved what would seem to the layman an insurmountable problem. These monster vessels are divided in the middle by an acytelene flame; the open end inclosed and half of the ship is taken through the canal. The other half follows and, in the St. Lawrence, the two are joined together again.

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HIGHER POWER RATE IN NEW JERSEY

The New Jersey Board of Public Utility Commissioners has authorized an increase in rates of the Public Service Electric Company, of New Jersey. The higher rates are designed to yield an increased revenue of approximately $1,000,000 a year.

In acting, the board emphasizes that the advance is solely a war emergency measure and does not affect the reasonableness of the proposed rates in normal times. It also reserves the right to abrogate or modify the new rates should conditions indicated by operating results warrant such action.

The decision allows a war addition to each bill of power consumers of 25 percent. There is also a surcharge for coal cost.

ELECTRICAL DEALERS ORGANIZING FOR THIRD LIBERTY LOAN

(Written exclusively for Electrical Engineering)

Manufacturers and dealers in every kind of electrical equipment are to-day organizing their forces for co-operative work in the Third Liberty Loan campaign which is scheduled to start April 6.

The electrical division will again be grouped with the Rainbow Division of trades in this city. Electrical men contributed $809,750 to the Second Liberty Loan last October. They are confident that this total will be bettered by several hundred thousand dollars during the coming drive.

Many of the larger firms already have started compaign work. Official Washington dispatches have placed the total amount to be raised this spring at $3,000,000,000. There has been no assignment of quotas.

In asking for redoubled activity on the part of committees to make the coming loan an overwhelming success, treasury heads point out that many trades and industries have made enormous profits through war contracts during the past year. Electrical men are among those whose business has been increased. For this reason, it is stated, men and women in this division should do everything in their power to insure an over subscription of the issue.

Banks have again signified their willingness to extend credit so that the new bonds may be purchased on the partial payment plan and employers have offered employees the privilege of subscribing to the loan on the instalment basis.

A recent announcement from the national capitol stated that the government expended but 2.8% of its estimated wealth of $250,000,000,000 during the first ten months of the war. Germany, on the other hand, has used up, according to figures received from reliable sources, 33 1/3% of her entire money power.

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WAR TRAINING FOR ELECTRICIANS

A war training course for electricians and telephone men needed for the United States Army has just been published by the Federal Board for Vocational Education. This course, it is planned, will be given to drafted men, enlisted and detailed on subsistence and pay to schools co-operating with the Federal Government in the preparation of mechanics and technicians for military service.

The course consists of 36 lectures and four class room, field, and shop units on electric wiring, testing, motors and generators, and telephone work. The instruction book is known as Bulletin No. 9, and may be had free on application to the Federal Board of Vocational Education, Ouray Building, Washington, D. C. Similar bulletins for training enlisted men in various trades have been prepared by the board and will be announced upon publication.

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COLLEGE-TRAINED ENGINEERS WANTED AS ARMY OFFICERS

The Engineering Bureau of the office of the Chief of Ordnance of the War Department desires to obtain a number of technical graduates who, if accepted, are to be given commissions in the United States Army. Highly skilled chemical and mechanical engineers capable of engaging in research work, in the preparation of chemical compounds, and in the designing of intricate mechanical devices, are needed. These men must be at least 25 years of age, must be graduates of universities or technical schools, must have an earning capacity of at least $1700 a year, must be physically sound, and must be in some other classification than 1-A under the Selective Service Law. Notification has been received in Chicago that a board of army officers will probably soon visit that city for the purpose of getting in touch with prospective candidates for these commissions. The work to be done promises to be very interesting to the kind of men qualified to undertake it. For preliminary interview, apply to the Military Training Camps Association, 624 Consumers Building, Chicago.

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CIVILIAN WORKERS WANTED FOR ORDNANCE DEPARTMENT

Men having a high school education, some shop training and the natural ability to adapt themselves to new work, may qualify for a Government appointment in which under Government instructors, they will receive the necessary training for the positions described below. Those who have the required technical training will be placed and advanced as quickly as their ability justifies.

Inspectors, powder and explosives.

Insepectors, cannon, forging operations.

Inspectors, gun fire control instruments.

Engineers and assistant engineers, for tests of ordnance materials.

Machinists, accustomed to work to 1000's of inch.

Send in your own application and urge your associates who may be qualified to do so. These positions are under civil service regulations, but applicants will not be required to report for examination at any place. Applicant will be rated in accordance with education and general experience. No applications will be accepted from persons already in the Government service unless accompanied by the written assent of the head of the concern by which the applicant is employed. Papers will be rated promptly and certification made with least possible delay. Apply or write for further information to, C. V. Meserole, Special Representative of the Ordnance Dept., U. S. A., Room 800, 79 Wall Street, New York City.

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POSTERS FOR MUNITION WORKERS

In order to install in the minds of the employes, particularly those engaged in munition work, the importance of exercising the utmost care in their work, the Westinghouse Electric Mfg. Co. has issued a series of colored posters which are said to have been unusually effective. These posters measure 18 x 21 in. The border and shells are in conventional red, white and blue, and the eagle is printed in a bronze tint. An illustration on one of them shows the disastrous results from the premature explosion of a defective shell which wrecked one of our allies' guns on a battlefield somewhere in France.

Other posters with the same border and a different illustration have been issued with the idea of speeding up production. One of these shows a view of the interior of one of the Westinghouse plants devoted to the manufacture of shells and bears the following wording:

BACK UP THE BOYS AT THE FRONT
They Need
All the Shells You Can Make
And They Need Them Quick.
Don't Forget
The More Shells You Can Make,
The Sooner the Boys Can Come Home
Remember
Good Shell Makers in This Shop
Are As Necessary As Soldiers
In The Trenches.

These posters have been the subject of considerable favorable comment from heads of industrial concerns and government officials, and it is believed that they have been very effective in accomplishing their object, as above stated, to instill a spirit of carefulness in the employe and to stimulate production.

POWER PLANT, LINE AND DISTRIBUTION PROBLEMS

A Record of Successful Practice and Actual Experiences of Practical Men

WINDINGS FOR POLYPHASE MOTORS

By T. Schutter

In the previous article the stator windings, of single-phase motors were discussed. The principles of these windings are no doubt still lodged in the mind of the reader. These same principles will also be employed in discussing the windings of polyphase motors.

All polyphase induction motors are self-starting. Any one phase or winding in a polyphase machine has the same characteristic as a single phase winding. By keeping this fact in mind, it will be readily understood that the placing of a number of single phase windings on a stator, windings which are displaced by the same angle as are the applied electromotive forces, will eventuate in a polyphase winding.

In this article the stator windings for two-phase and three-phase induction motors with squirrel cage rotors will be taken up. Wound rotors will be taken up later. Fig. 12 shows

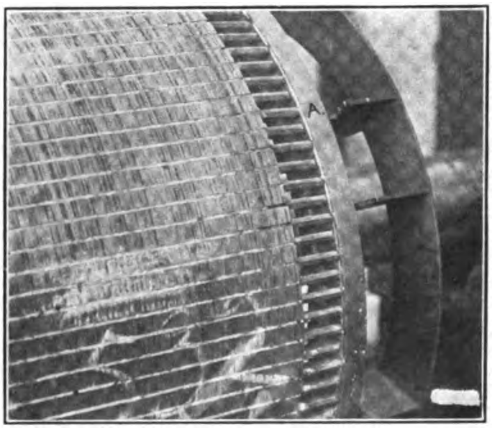


Fig. 12

a section of a squirrel-cage rotor (Westinghouse) with cast-on end ring A. Fig. 13 shows a squirrel cage rotor (Crocker-Wheeler) on which the end rings are built up in sections which are fitted over the bars. Fig. 14 shows a completed rotor (Crocker-Wheeler.)

The stator windings are divided into two classes: half-coil and whole-coil windings, and the following rules should be kept in mind when tracing the connections in the following winding diagrams.

Rule for half-coil windings:

When connecting a number of coils to form a group, connect the end of the first coil to the beginning of the second coil; follow this method until the group is completed. When connecting a number of groups to form a phase, connect the end of the first group to the beginning of the second group belonging to the same phase. Follow this method until each phase is completed.

Rule for whole-coil windngs:

The connections for coils forming a group are made the same as in half-coil windings; but when connecting up the groups to form a phase, connect the end of the last group to the end of the second group belonging to the same phase, and the beginning of the second group to the beginning of the third group belonging to the same phase, etc., until all connections are completed. The winding diagram as shown

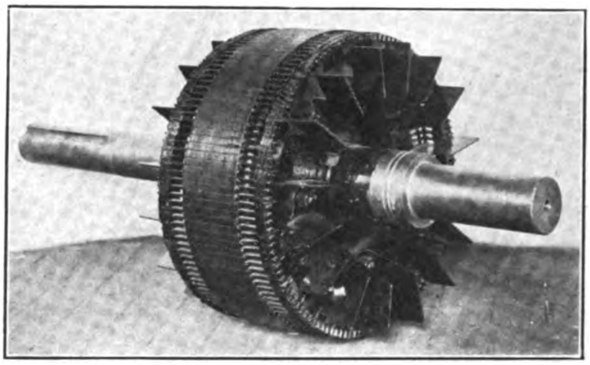


Fig. 13

in Fig. 15 is that of a two-phase, 4-pole one-half coil winding having 24 coils, 2 coils per slot.

A two-phase winding has the same characteristic as two single-phase windings placed in the same stator or field of an induction motor, or the armature of an alternator, only that they are displaced by the same angle as the applied or delivered voltage; that is, 90 electrical degrees.

The following are the symbols and their meanings as used in the various formulas for finding the coil pitch, and the number of coils per group:

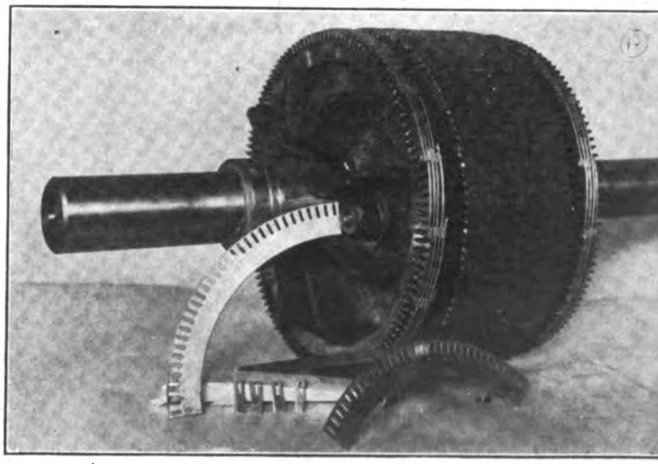


Fig. 14

C=Number of coils used in winding.
P=Number of poles.
Ph=Number of phases.
2=A constant.

The coil pitch as used in Fig. 15 is found as follows:

$$\frac{C \times 2}{P} = \frac{24 \times 2}{4} = \frac{48}{4} = 12$$

The reader will bear in mind that the coil pitch for a half-coil winding can result in either an odd or an even number, and that the number of coils used in the winding must fulfill two conditions; that is, the number of poles, and the number of poles times the number of phases, must be multiples of the number of coils used. These conditions are fulfilled in the above winding, and the placing of coils will be as follows:

Fig. 16 shows a typical diamond shaped coil as used in stator and armature winding by the Westinghouse Electric & Mfg. Co.

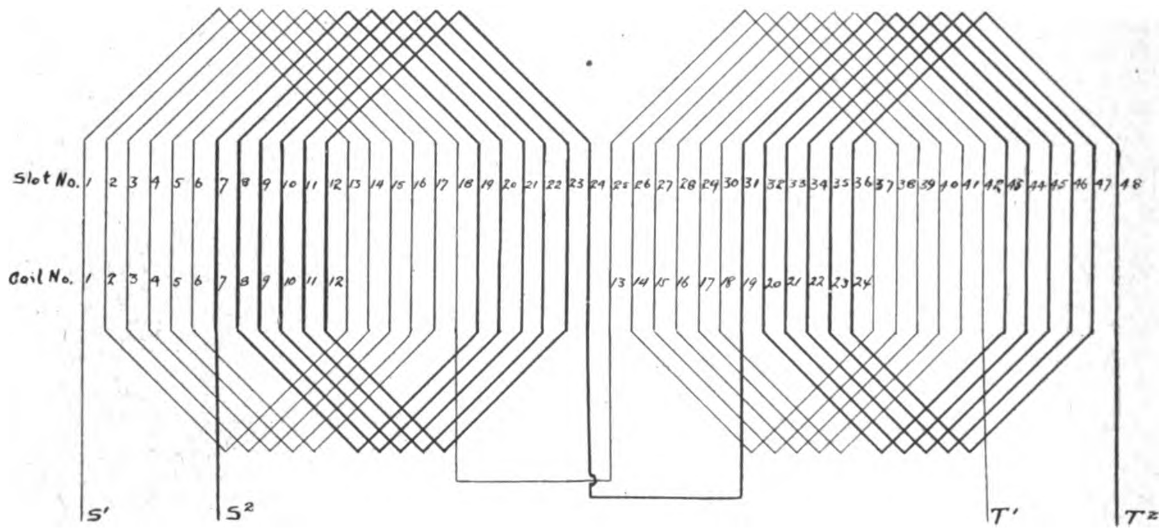


Fig. 15

Winding Table

Coil No.	Wound between Space No.	In slot No.
1	1 and 13	1 and 13
2	2 and 14	2 and 14
3	3 and 15	3 and 15
4	4 and 16	4 and 16
5	5 and 17	5 and 17
6	6 and 18	6 and 18
7	7 and 19	7 and 19
8	8 and 20	8 and 20
9	9 and 21	9 and 21
10	10 and 22	10 and 22
11	11 and 23	11 and 23
12	12 and 24	12 and 24
13	25 and 37	25 and 37
14	26 and 38	26 and 38
15	27 and 39	27 and 39
16	28 and 40	28 and 40
17	29 and 41	29 and 41
18	30 and 42	30 and 42
19	31 and 43	31 and 43
20	32 and 44	32 and 44
21	33 and 45	33 and 45
22	34 and 46	34 and 46
23	35 and 47	35 and 47
24	36 and 48	36 and 48

When all the coils have been placed they are then divided into groups. All coils belonging to the same group are connected in series, and the number of groups composing a phase will be equal to the number of pairs of poles. As this is a 4-pole machine, there will be two groups per phase. The following formula is used to find the number of coils per group:

$$\frac{C \times 2}{P \times Ph} = \frac{24 \times 2}{4 \times 2} = \frac{48}{8} = 6$$

By examining the diagram, Fig. 15, it will be seen that coils numbered 1 to 6, 7 to 12, 13 to 18, and 19 to 24, form the four groups (two groups per phase). The connections between the coils forming a group are made according to the rule stated above.

The two phases or windings in a two-phase machine are displaced by 90 electrical degrees, and for this reason the groups whose terminals are displaced by 90 electrical degrees will belong to phases 1 and 2 respectively.

From Fig. 15 it will be seen that groups 1 and 3 form phase number 1, and groups 2 and 4 form phase 2, and the connections are made as stated in the rule for one-half coil windings.

The terminals marked S^1, S^2, T^1 and T^2 are the beginnings (S) and the ends (T) of the phases. The numerals indicate the number of the phase to which they belong. A two-phase circuit can be either a 3-wire or a 4-wire circuit. If the winding in Fig. 15 is to be connected to a 4-wire circuit, the four terminals S^1, S^2, T^1, T^2, would be used as they are; but if

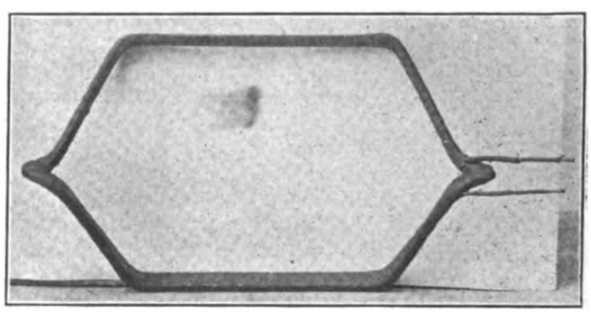
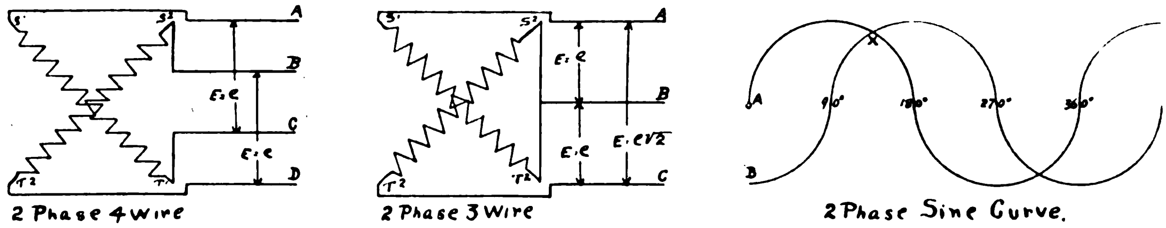


Fig. 16

they are to be connected to a 3-wire circuit, S^2 and T^1 would both be connected to the center wire of the line. Fig. 15A illustrates the 3-wire and 4-wire two-phase circuits.

The foregoing explanation as to the winding of a one-half coil two-phase winding can be applied to a winding of any size in regard to poles and coils.

Fig. 17 shows the winding diagram of a 4-pole, whole-coil, two-phase winding for either the field of an induction motor or the armature of a generator. By comparing the diagrams Figs. 15 and 17 it will be seen that the coils are placed somewhat differently, but the principles applied to



2 Phase 4 Wire 2 Phase 3 Wire 2 Phase Sine Curve.

Fig. 15a

both windings are practically the same. In Fig. 15 there is one coil per slot, while in Fig. 17 there are two coils per slot. The reader will notice that all the odd numbered winding spaces represent the beginnings of the coils, and the even numbered winding spaces are the ends of the coils. Both Figs. represent 4-pole windings. In Fig. 15 there are two groups of coils per phase, while in Fig. 17 there are four groups of coils per phase. The following rule may be helpful in defining half-coil and whole-coil windings:

In the half-coil winding there will be as many groups of coils per phase as there are pairs of poles, while in a whole-coil winding there will be as many groups of coils as there are poles.

The spread of a coil in Fig. 17, in which there are 24 coils and 4 poles, will be found as follows:

$$\frac{C \times 2}{P} = \frac{24 \times 2}{4} = \frac{48}{4} = 12 \text{ winding spaces.}$$

This being an even number it must be made odd by plus or minus 1; then $12 \pm 1 = 13$ or 11. In this winding the spread of a coil will be 11 winding spaces. The following table gives the numbers of the coils, also the winding spaces and slot numbers in which they are placed.

Coil No.	Wound between Space No.	In slot No.
1	1 and 12	1 and 6
2	3 and 14	2 and 7
3	5 and 16	3 and 8
4	7 and 18	4 and 9
5	9 and 20	5 and 10
6	11 and 22	6 and 11
7	13 and 24	7 and 12
8	15 and 26	8 and 13
9	17 and 28	9 and 14
10	19 and 30	10 and 15
11	21 and 32	11 and 16
12	23 and 34	12 and 17
13	25 and 36	13 and 18
14	27 and 38	14 and 19
15	29 and 40	15 and 20
16	31 and 42	16 and 21
17	33 and 44	17 and 22
18	35 and 46	18 and 23
19	37 and 48	19 and 24
20	39 and 2	20 and 1
21	41 and 4	21 and 2
22	43 and 6	22 and 3
23	45 and 8	23 and 4
24	47 and 10	24 and 5

When all coils have been placed they are then divided into groups, and all coils belonging to the same group are connected in series as in the rule governing whole-coil windings. To find the number of coils per group use the following formula:

$$\frac{C \times 2}{P \times Ph \times 2} = \frac{24 \times 2}{4 \times 2 \times 2} = \frac{48}{16} = 3 \text{ coils per group}$$

Then Group No. 1 consists of coils Nos. 1, 2, 3
Group No. 2 consists of coils Nos. 4, 5, 6
Group No. 3 consists of coils Nos. 7, 8, 9
Group No. 4 consists of coils Nos. 10, 11, 12
Group No. 5 consists of coils Nos. 13, 14, 15
Group No. 6 consists of coils Nos. 16, 17, 18
Group No. 7 consists of coils Nos. 19, 20, 21
Group No. 8 consists of coils Nos. 22, 23, 24

The next step is to determine which groups belong to the same phase. As previously explained, the phase displacement in a two-phase machine is 90 electrical degrees. A simple rule for finding how many coil sides must be advanced from any point to equal 90 electrical degrees is as follows:

Each pole in any machine is equal to 180 electrical degrees; then in a 4-pole field there will be 4×180 or 720 electrical degrees. In the case of Fig. 17, there are $24 \times 2 = 48$ coil

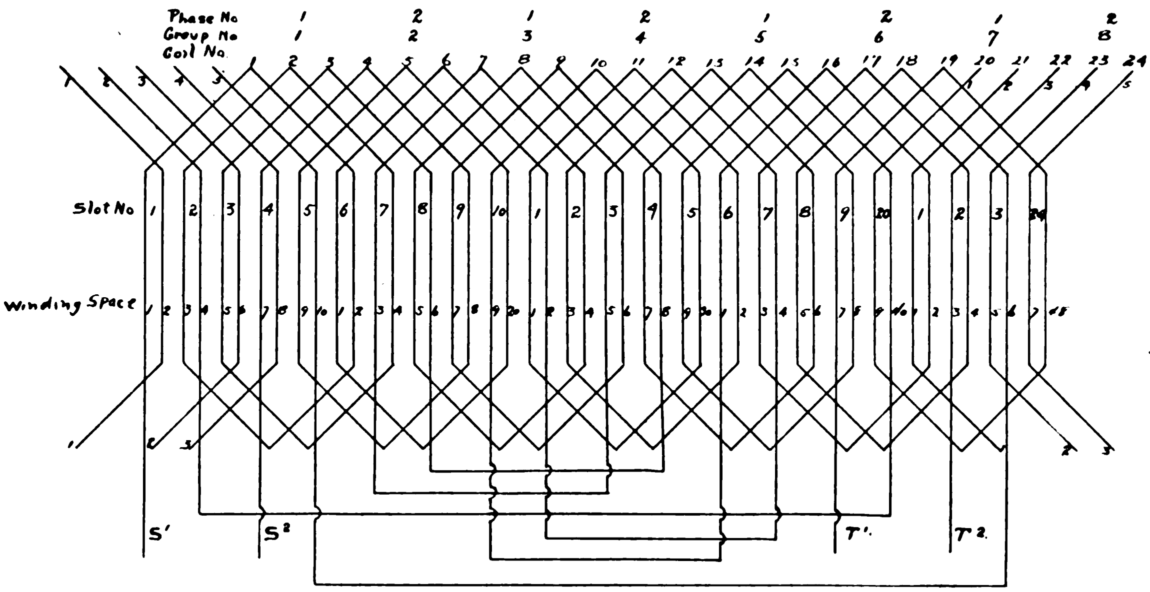


Fig 17

sides, and to find the number of coil sides that will be equal to 90 electrical degrees apply the following formula:

$$\frac{\text{Coil Sides}}{\text{No. of Poles} \times 2} = \frac{48}{4 \times 2} = 6 \text{ coil sides}$$

Then by assuming that coil side No. 1 which is in winding space No. 1 is the beginning of phase No. 1, the sixth coil side from this point, or No. 7 will be the beginning of phase No. 2. As shown in Fig. 17, S^1 and S^2 are the beginnings of coils 1 and 4 which are also the beginnings of groups 1 and 2. From this it will be seen that alternate groups belong to the same phase; that is, groups numbers 1, 3, 5, and 7 will form phase No. 1, and groups 2, 4, 6, and 8 form phase No. 2.

The interconnection between the groups which form a phase are made as stated in the rule which governs whole-coil windings. The four final terminals S^1, S^2, T^1 and T^2 can be formed in a 3-wire or a 4-wire circuit, as shown in Fig. 15A. As shown in Fig. 15A, between leads A and C on the 3-wire two-phase circuit a higher voltage is obtained. This is caused by both windings being connected in series, but it should be remembered that neither winding is producing its maximum pressure (E) at the same time. As shown in the two-phase sine curve at point X, both windings are producing an average pressure (E), and for this reason the line pressure will be the sum of both, which will be equal to $E \times \sqrt{2}$ as the pressure across the terminals A and C, while the pressure across A and B, also B and C, will be equal to the pressure per winding (E=e).

In a three-phase winding the same principles are followed as in a two-phase winding; that is, the winding when complete will have the same characteristic as if three single-phase windings were placed on the same stator. These windings are displaced by 120 electrical degrees from one another, which is the angle by which the applied electromotive forces in a three-phase circuit are displaced.

When winding a three-phase one-half coil stator the coils will be placed in groups and these groups will be displaced by 120 electrical degrees. Fig. 18 shows a three-phase, one-half coil, 4-pole winding having 24 coils, one coil per slot. The spread of the coils is found by the following formula:

$$\frac{C \times 2}{P} = \frac{24 \times 2}{4} = \frac{48}{4} = 12$$

Then coil No. 1 will be placed between slots Nos. 1 and 13. The number of coils per group is found by the formula:

$$\frac{C \times 2}{P \times Ph} = \frac{24 \times 2}{4 \times 3} = \frac{48}{12} = 4 \text{ coils per group.}$$

To find the number of coil sides to be advanced to equal 120 electrical degrees—bearing in mind that in this winding there is one coil side per slot—proceed as follows: The number of electrical degrees in a 4-pole circumference is 180 degrees per pole × 4 poles = 720 electrical degrees. There are 24 × 2 = 48 coil sides, then 24 coil sides equal 360 electrical degrees, and 8 coil sides equal 120 electrical degrees, which will be the distance between the phases and the groups as they are being placed.

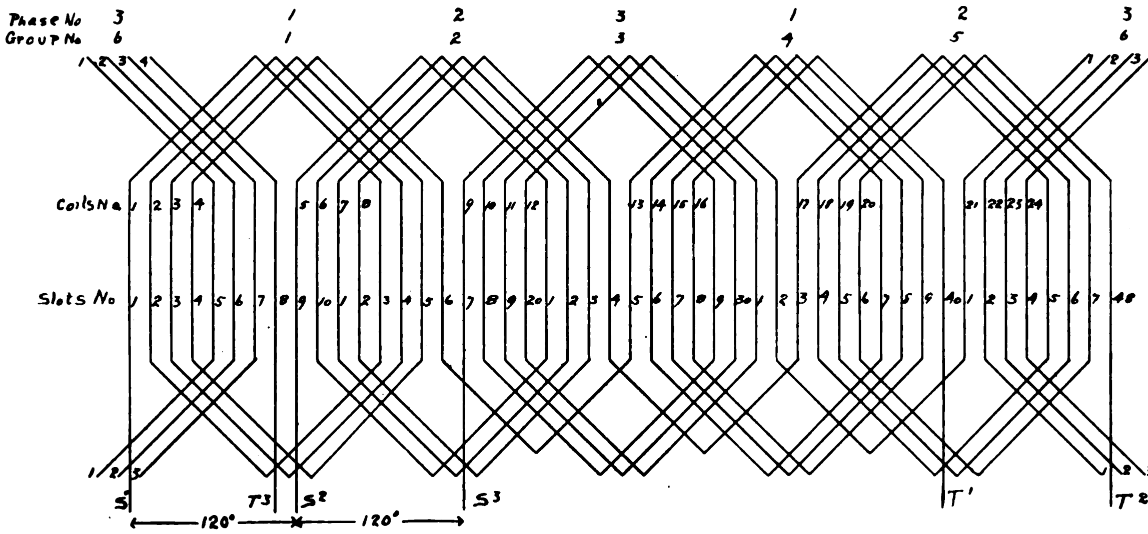


Fig. 18

The following table will give the number of the coil and slots in which they are placed:

Coil No.	Wound between slots Nos.
1	1 and 13
2	2 and 14
3	3 and 15
4	4 and 16
5	9 and 21
6	10 and 22
7	11 and 23
8	12 and 24
9	17 and 29
10	18 and 30
11	19 and 31
12	20 and 32
13	25 and 37
14	26 and 38
15	27 and 39
16	28 and 40
17	33 and 45
18	34 and 46
19	35 and 47
20	36 and 48
21	41 and 5
22	42 and 6
23	43 and 7
24	44 and 8

When all the coils (24) have been placed in groups of 4 coils each (which are 120 electrical degrees apart), all coils belonging to the same group are then connected in series. Assuming that group No. 1 is a part of phase No. 1, then group number which is 120 electrical degrees away is a part of phase No. 2. Group No. 3 being 120 electrical degrees from group No. 2 will be part of phase No. 3. From this it will be seen that groups Nos. 4, 5, and 6 will then belong to phases Nos. 1, 2, and 3 respectively; then:

Groups Nos. 1 and 4 form phase No. 1.

Groups Nos. 2 and 5 form phase No. 2.

Groups Nos. 3 and 6 form phase No. 3.

By following the rule for the inter-connection of groups belonging to the same phase it will be found that there will

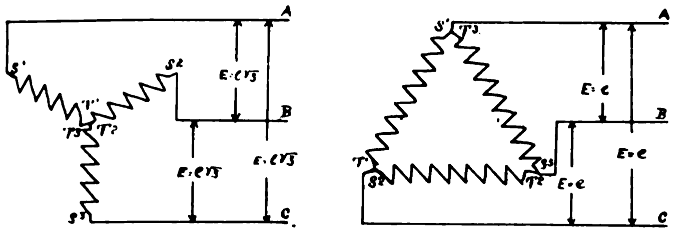


Fig. 18a

be six terminals S^1, S^2, S^3, T^1, T^2, and T^3. A three-phase machine can be connected in two ways, star and delta, and by interconnecting the six terminals as illustrated in Fig. 18A.

Fig. 19 shows the winding diagram of a three-phase, whole-coil, 4-pole winding having 24 coils with 2 coils per slot. In this style of winding it is not necessary to place the coils in groups which will be spaced 120 electrical degrees apart, because when all coils have been placed and paired in groups such groups as are 120 electrical degrees apart will be connected up as a phase.

To find the spread of a coil in the above problem the following formula is used:

$$\frac{C \times 2}{P} = \frac{24 \times 2}{4} = \frac{48}{4} = 12 \pm 1 = 13 \text{ or } 11.$$

The following table shows the number of the coil, the numbers of the winding spaces, and slots into which the coils are wound.

Coil No.	Wound between Space No.	In slot No.
1	1 and 12	1 and 6
2	3 and 14	2 and 7
3	5 and 16	3 and 8
4	7 and 18	4 and 9
5	9 and 20	5 and 10
6	11 and 22	6 and 11
7	13 and 24	7 and 12
8	15 and 26	8 and 13
9	17 and 28	9 and 14
10	19 and 30	10 and 15
11	21 and 32	11 and 16
12	23 and 34	12 and 17
13	25 and 36	13 and 18
14	27 and 38	14 and 19
15	29 and 40	15 and 20
16	31 and 42	16 and 21
17	33 and 44	17 and 22
18	35 and 46	18 and 23
19	37 and 48	19 and 24
20	39 and 2	20 and 1
21	41 and 4	21 and 2
22	43 and 6	22 and 3
23	45 and 8	23 and 4
24	47 and 10	24 and 5

When all coils have been placed they are then paired into groups; by:

$$\frac{C \times 2}{P \times Ph \times 2} = \frac{24 \times 2}{4 \times 3 \times 2} = \frac{48}{24} = 2 \text{ coils per group}$$

Then when coils Nos. 1 and 2 have been connected in series, and the same with each pair of two coils, the winding will result in 12 groups of 2 coils each.

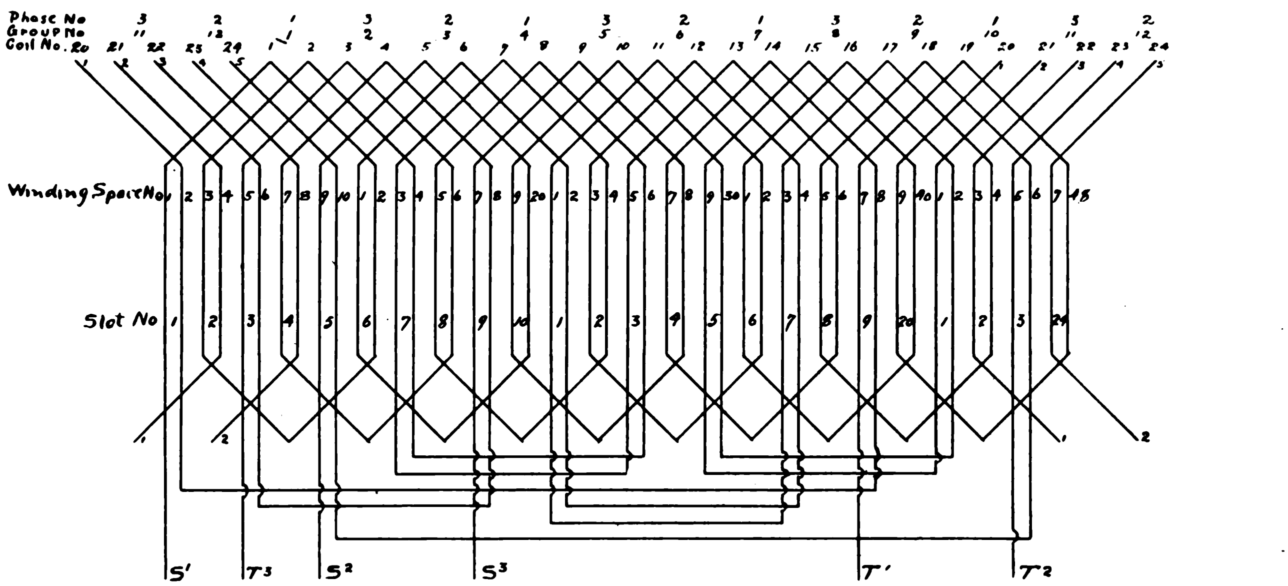


Fig. 19

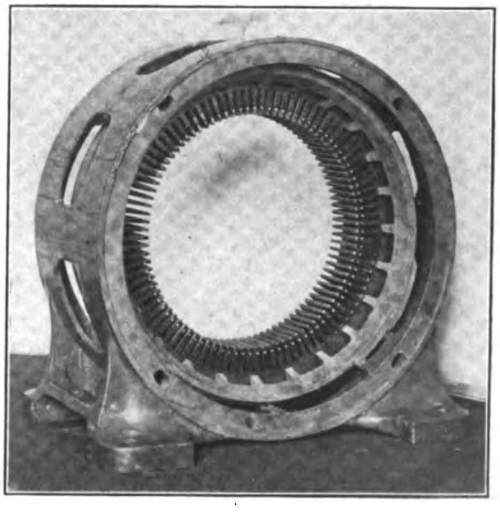


Fig. 20

Next the number of coil sides which are equal to 120 electrical degrees are to be determined. As previously explained, that each pole is equal to 180 electrical degrees; then four poles will equal 720; since 48 coil sides are placed around this distance the following method can be used:

48 coil sides = 720 electrical degrees
24 coil sides = 360 electrical degrees
8 coil sides = 120 electrical degrees

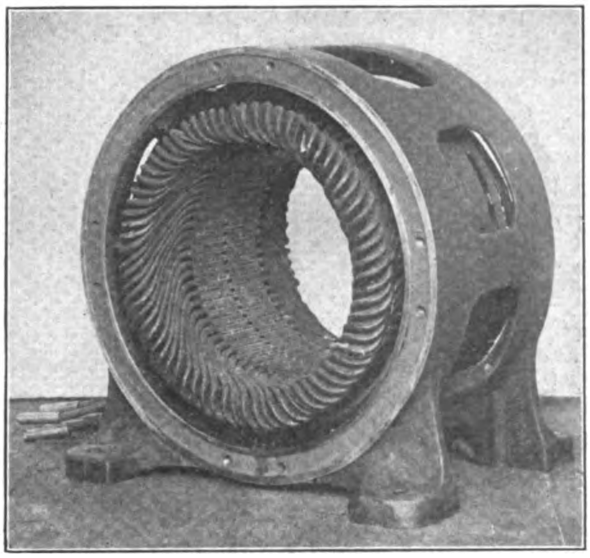


Fig. 21

Then if coil side No. 1 is considered as the beginning of Phase No. 1 (S^1) the eight-coil side away or No. 9 will be the beginning of phase No. 2 (S^2) etc. By following the rule which gives the connecting methods for interconnecting whole coil windings, the connections shown in Fig. 19 can be readily traced out.

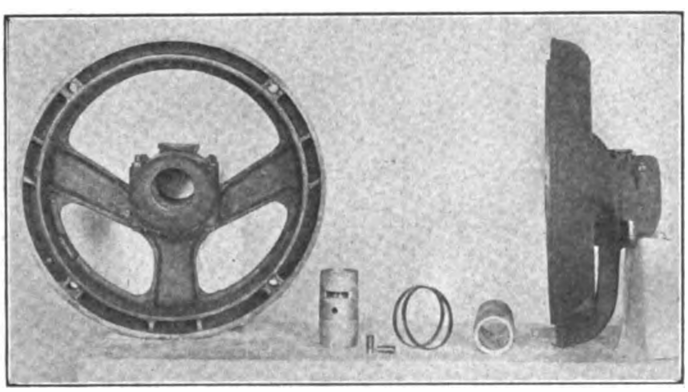


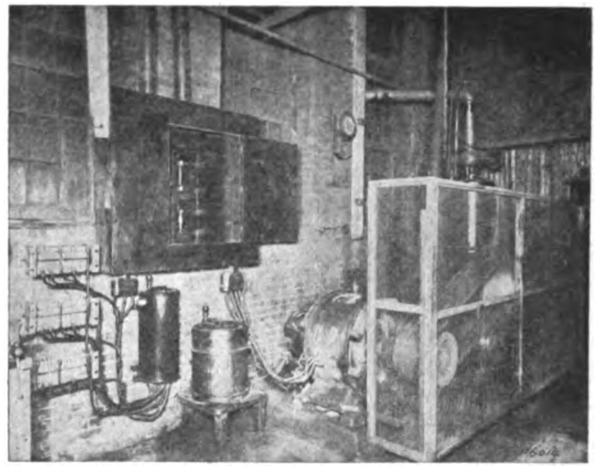
Fig. 22

Fig. 20 shows a stator or field of an induction motor (Crocker-Wheeler) ready for winding. In Fig. 21 the coils of a three-phase winding have been placed, using the style of coil as shown in Fig. 16. Fig. 22 shows the end shields and bearings for the rotor. The rotor itself is shown in Figs. 13 and 14.

✦ ✦ ✦

ELECTRIC DRIVE SAVES 30 PER CENT.

A saving of 30 percent. in power cost is the report from Taylor & Company after replacing a steam engine in their foundry in Greenpoint, Brooklyn, N. Y., by 150 h.p. in Westinghouse motors. The motor shown in the illustration is a 50 h.p. machine and drives a 12 in. by 12 in. Curtis air compressor. This motor is of the wound-rotor type, desirable for compressor service because its sheld is adjustable. At the left of the compressor motor is seen its controller;



Electric drive saves 30 percent. of operating cost.

that for another motor; and above, Krantz safety-type switches for each motor. These are so arranged that it is impossible to get at any part of the circuit while it is alive. The fuse-compartment cannot be unlocked until the switch is open.

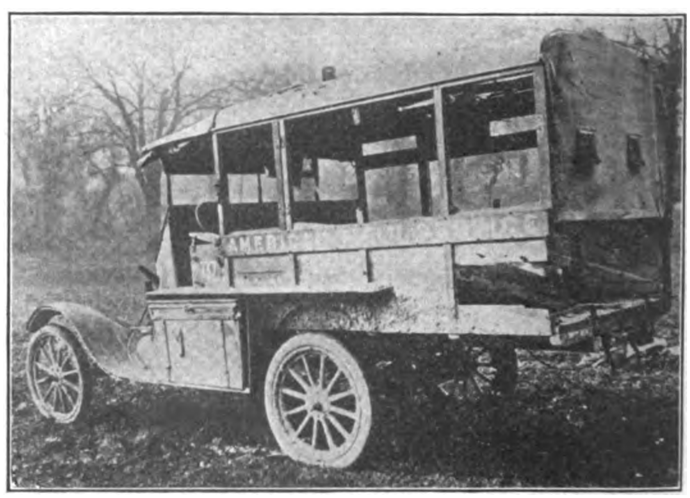
In addition to the saving in power-cost, the management finds the power-supply of central-station lines to be more steady and satisfactory than that of their own power-plant. This leaves all their energies free for the main job—turning out sound castings on schedule time and at a minimum cost. Power for this installation is furnished by the Edison Electric Illuminating Company, of Brooklyn.

✦ ✦ ✦

BYLLESBY EMPLOYEE'S AMBULANCE DAMAGED IN SERVICE

Word has just been received that the ambulance furnished by the Byllesby employes to the American Field Service in France was damaged in action recently but will be repaired and again placed in service. A letter from Stephen Galatin, dated the fifth of February, concerning the Byllesby ambulance is reproduced:

"I am enclosing a photograph of Car No. 737 which you gave to the service. This photograph was taken after the car had been sent in from the front and shows the damage done



H. M. Byllesby Amercian Field Service ambulance in France partly wrecked by German shell.

to it by a shell. The ambulance was, as you know, in Section 29 which was working in the region of Hill 344, a particularly dangerous sector. It had just gone to the Poste de Secours and the driver was waiting there for wounded when a 210 shell landed near it, but fortunately no one was injured. The car had to be towed back and was then shipped to Paris.

"I felt sure that you would like to have this evidence of the kind of work your car had done and that it might give you a clearer realization of the work that the service, to which you contributed, had been performing for the past three years in France.

"I take this opportunity to again thank you for your generous gift."

◆ ◆ ◆

COST IN COAL OF AVOIDABLE BELT SLIP

One of the simplest losses to overcome and at small expense, is belt slip. To show the extent of the loss of money through slipping of the main belt alone a chart, supplied by the Cling-Surface Company, Buffalo, N. Y., is shown herewith, upon which this is easily ascertained. By glancing up and down

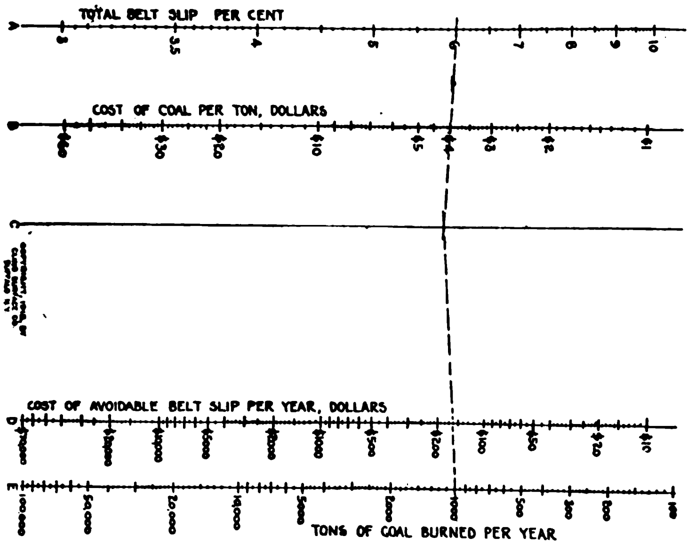


Diagram showing method of computing cost of avoidable belt slip per year.

column D of this chart it is evident that the cost of avoidable belt slip per year in dollars may vary from the smallest sums to thousands of dollars.

To give a clear idea as to the meaning of total belt slip percent. let us take an example. It is found by means of a revolution counter that a driven pulley is rotating only 940 times per minute. You figure that without slip it should rotate 1000 times per minute; 60 revolutions per minute, therefore, are lost. Dividing this 60 by the revolutions per minute that pulley should make you get 0.060 or 6 percent. which is the total belt slip. After having made this determination it is a simple matter to apply it to the chart as has been done and find what is the money loss per year due to such slip.

◆ ◆ ◆

WASHINGTON AND PUBLIC UTILITIES

The threatening situation in the public utility field due to wartime conditions has been brought to the attention of the Federal authorities at Washington by a committee representing the National Electric Light Association, the American Electric Railway Association, American Gas Institute, and National Commercial Gas Association. This committee says if the utilities are to remain solvent that:

1. Rates must be increased sufficiently to absorb the increased costs of producing the service.
2. The utilities must be relieved during the period of the war of all non-essential and unproductive requirements, such as paving, undergrounding of wires, duplication and unnecessary extension.
3. Some way must be found to enable the utilities to take care of obligations maturing while the war lasts.
4. Assistance must be provided to enable the companies to finance the unavoidable extensions of service made necessary by the nation's war program.

Realizing the seriousness of the situation, Secretary McAdoo took the matter to President Wilson, saying that "it is obvious that every part of our industrial and economic life should be maintained at its maximum strength in order that each may contribute in the fullest measure to the vigorous prosecution of the war. Our local public utilities must not be permitted to become weakened.

"Our public service utilities are closely connected and are an essential part of our preparations for and successful prosecution of the war."

Replying to the secretary's letter the President said: "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. I hope that state and local authorities, where they have not already done so. will when the facts are properly laid before them, respond promptly to the necessary of the situation."

◆ ◆ ◆

ELECTRICITY AS PLUMBING SUBSTITUTE

Seventy-five frozen water services were thawed out by electricity during February by the Danbury & Bethel (Conn.) Gas & Electric Light Company. This total included two schoolhouses and one factory. The company had ten other calls for similar service that could not be handled as they were either on cement water mains or located off its lines. There was no question but that the public appreciated this service as it was impossible to secure plumbers.

◆ ◆ ◆

The growing menace of the freight transportation situation has induced the Associated Business Papers, Inc., New York, through their executive committee, to formulate a plan for definite, practical co-operation by shippers to relieve terminal congestion and keep freight moving. This plan is explained in detail in a printed report issued by the above mentioned organization late last month. A copy of it can be had by writing Jesse H. Neal, executive secretary, 500 Candler Bldg., 220 West 42nd St., New York, N. Y.

◆ ◆ ◆

The use of bagasse, or megasse, as it is sometimes called, as a source of fuel, dates from the earliest periods of cane-sugar manufacture, according to E. C. Freeland, in a paper read before the recent annual meeting of the American Society of Mechanical Engineers. One pound of bagasse will evaporate from 2 to 3½ lb. of water "from and at 212 fahr." Assuming coal and fuel oil to have, respectively, calorific values of 14,000 and 19,000 B.t.u. per lb., then from 4 to 6 lb. of bagasse are equivalent to 1 lb. of coal and from 43 to 65 lb. equivalent to 1 gal (about 7.6 lb.) of oil.

◆ ◆ ◆

During the last few years production has endeavored to keep pace with the remarkable growth of demand. Extraordinary and effective work has been done at mines and refineries. The capacity to produce largely is now the greatest in the history of the copper industry provided sufficient and efficient labor is kept on the job. There has been recent tangible evidence, however, that the full capacity of American plants has not been utilized. Severe winter weather, difficult transportation, and scarcity of labor have hindered mining activities recently. But with more favorable conditions a decided expansion in total output is expected. Maximum production is the imperative need. The near future should see a monthly output of at least 200,000,000 pounds of refined copper if the actual requirements of international demand are to be met.

PRACTICAL ALTERNATING CURRENT ENGINEERING PROBLEMS

By W. R. Bowker

The extensive use of rotary converters, particularly in connection with electric lighting and industrial power plants, frequently necessitates a variable ratio between the alternating and direct voltages, for charging storage batteries and compensating for line drop as well as for numerous other special requirements.

The variation of conversion ratio has generally been effected by means of auxiliary apparatus such as induction regulators or voltage varying dial switches connected to taps in the transformer windings. These devices, however, require attention and involve complications and expense in cable connections.

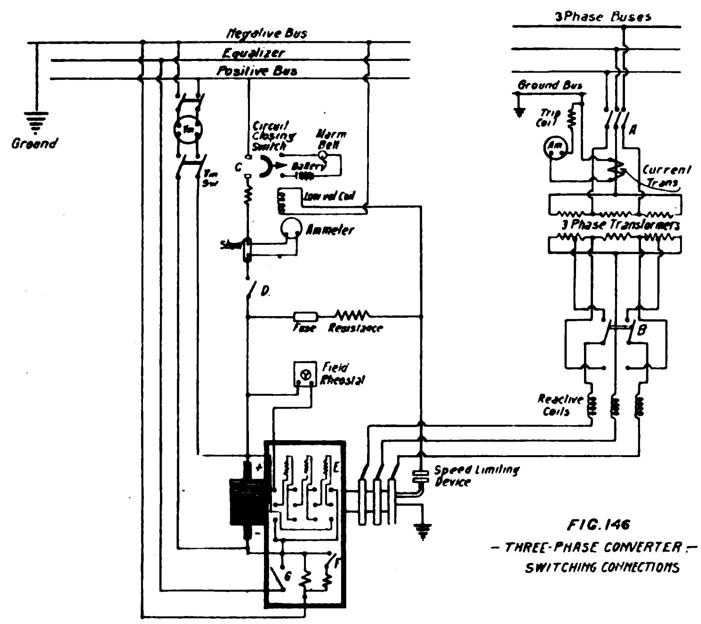


Fig. 146
Diagram showing switching connections for three-phase converter.

With the object of simplyfying the wiring arrangements and reducing the cost of auxiliary devices, the regulating pole rotary converter has been developed.

In this machine the field structure is divided into two parts; namely, a main pole and an auxiliary regulating pole.

The ratio between the voltages on the direct current and alternating current sides may be varied by varying the excitation of the regulating poles, the only auxiliary apparatus required being a field rheostat for controlling the exciting current.

Where automatic regulation is required machines may be provided with compound windings, or automatic field regulators may be used responsive to either voltage or current.

Standard rotary converters have been developed for 25 and 60 cycles. Standard railway machines are compound wound, the series field being usually designed for a compounding of 600 volts at no load and full load when supplied from a source of constant potential with not more than 10 percent. resistance drop, and with 20 to 30 percent. reactance in the circuit.

A well-known firm supplies 200-kw. and 300-kw. 25-cycle converters and the 100-kw. and 200-kw. 60-cycle converters wound for three-phase operation. Whilst all the larger capacity machines are wound for 6-phase, 25 cycles in the standard adopted for railway work.

The ratio of conversion between the alternating and direct voltages varies slightly in different machines, due to differences in design. The best operating conditions exist when the desired direct voltage is obtained with unity power factor at the converter terminals when loaded.

Six-phase machines may be supplied from transformers with double delta secondaries, or if a direct current neutral is desired for three-wire service, diametrical connections may be used, provided the transformer primaries are star connected. Diametrical secondaries with delta primaries should not be used. Three-phase regulating pole converters can use the same options of transformer connections as fixed ratio converters.

The three-phase and six-phase machines require different voltages from the transformers on account of the use of the diametrical connection instead of the double delta for six phases.

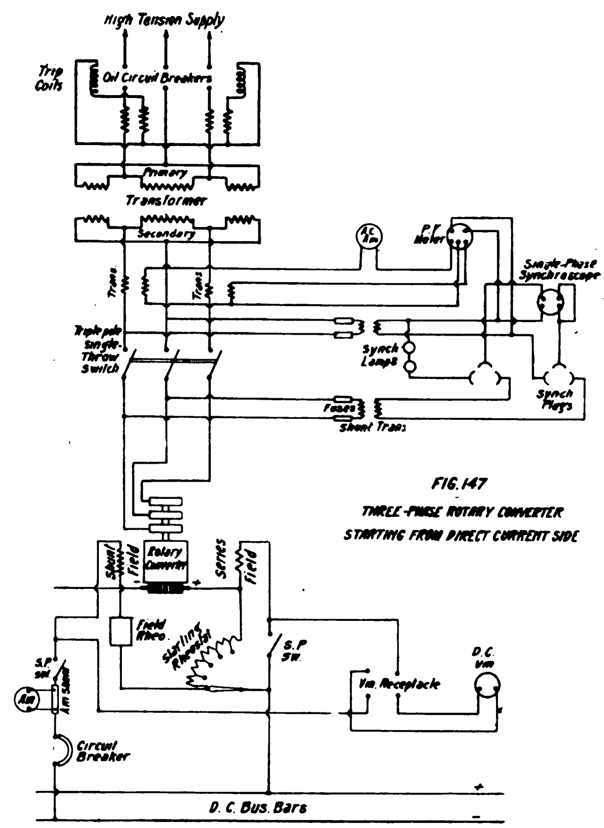


Fig. 147
Diagram of connections showing three-phase rotary converter starting from direct current side.

The no-load alternating voltages delivered from the transformers best adapted to compound converters designed to give 600 volts direct current with a variable load are 370 for three-phase converters and 430 for six phases. This gives a lagging current at no load, a leading current on overloads, and unity power factor at about average load.

The three-phase converters start at approximately full load current from the line when connected to fractional voltage taps on the transformer secondaries, and six-phase converters started from one-third voltage taps take about three-quarters to full load line current.

Delta-connected transformer primaries have been customarily used to permit operation with two transformers in case of trouble with the third. It has not usually been appreciated that with the primary windings star connected with the neutral solidly grounded, and with the high tension neutral of the generating system also grounded, three-phase or six-phase converters may be started and successfully operated with two transformers per converter, in case of trouble with the third one.

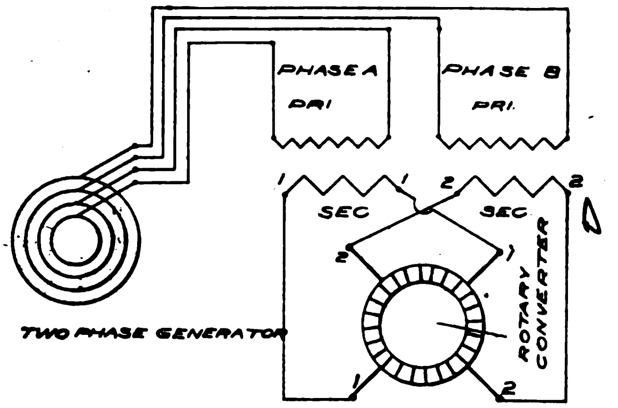


Fig. 148—Rotary converter and transformer, polyphase connections, two phase diametrical.

The output in either of the above emergency cases is, of course, limited to that of the transformers in use. With the grounded star connections, the service may be maintained in case of trouble on one phase of the transmission line, the other two wires and ground serving as the circuit.

If three-phase shell type of transformers are installed with high tension delta or grounded star connections, two phases

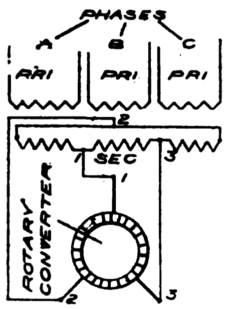


Fig. 149

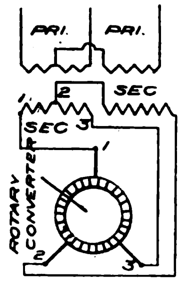


Fig. 150

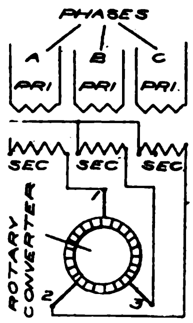


Fig. 151

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.

may be likewise operated, provided both windings of the third phase are disconnected and short circuited. The output of the unit is limited by the capacity of the two transformers or phases instead of the three. Transformers for higher pressures than 20,000 volts should be designed for star connection with the primary neutral grounded, but may be operated delta at 57 percent. of their rated star voltage, if initially lower voltages are needed than those for which they are designed.

For railway work a primary voltage of 13,200 is frequently used.

For 11,000 volts the transformers are delta connected; and for 33,000 and 66,000 volts the transformers are star connected.

Synchronous or rotary converters are seldom built for direct voltages higher than 750 volts, so that the alternating side pressure is not often greater than 535 volts.

In some central and power stations the equipment will permit of the rotary being started either from the direct current side, or the alternating current side, and when started up as a direct current motor, the direct current may be obtained from a storage battery, from another converter, or a motor-generator set may be installed for this purpose. A device for automatically tripping or breaking the direct current circuit breaker upon closing the alternating current switch, is a convenient and invaluable auxiliary to the equipment for starting converters by this method.

Fig. 146 illustrates the diagram of connections of a three-phase converter, compound wound as employed in railway service.

Previous to starting, all the switches should be open, and the machine should be connected to the voltmeter of the direct current switchboard by means of the voltmeter switch.

To start: close the high tension triple pole switch, A; close the double-pole, double-throw switch, B, on to the upper contacts. The machine should then run up to speed and synchronize, this condition being indicated by the voltmeter.

Close the equalizer switch, G, and series shunt switch, F; close the field dividing and reversing switch, E, on to the top contacts.

Quickly switch over the switch, B, from the top to bottom contacts. Now adjust the direct current voltage to equal approximately that of the bus bars. Adjust the low voltage release of circuit breaker and close circuit breaker, C. Close main switch, D. If more than one machine is in service, adjust the load between the machines by means of the regulating field rheostats.

To stop the rotary converter, open the circuit breaker, C, and pull the alarm bell auxiliary circuit closing switch. Open main switch, D; open the triple-pole main switch, A; slow down the speed of the machine until the voltage drops to about 100 volts

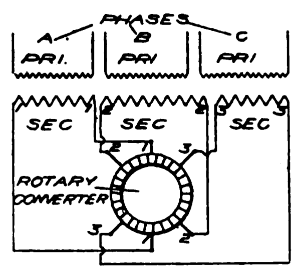


Fig. 152

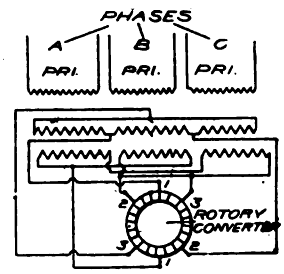


Fig. 153

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

before opening the field switch, E, or the starting switch, B. Open the field switch, E, equalizer switch, G, series shunt switch, F, and starting switch, B.

Be careful not to open the field switch, E, until the machine voltage has been lowered, otherwise "arcs" may result or the field winding insulation may be punctured, due to disruptive discharges induced by high voltage self inductive effects; and do not open the starting switches until the machine voltage has been reduced to zero. Do not open the triple-pole, oil-break switch when the converter is on the starting taps of the transformers, and the field circuit closed.

Do not parallel the machines on the direct-current side unless you close the equalizer switch.

The circuit breaker switch, C, must be closed before the main switch, D.

Do not start the converter with the field switch, E, closed in either the upper or lower contact positions or with the series shunt switch, F, closed.

All switches must be switched into contact quickly, and should also be opened quickly.

In Fig. 147 is shown a diagram of connections for a three-phase rotary converter starting from the direct-current side. This represents practically a complete wiring diagram and switchboard connections and instruments necessary for its operation, including synchronizing apparatus and indicating instruments qualified in the drawing. The method of starting and stopping the rotary converter is explained in other parts of this article.

A rotary converter supplied with constant voltage alternating current tends always to produce a constant voltage on the direct-current side. The terminal voltage decreases, however, as the load is increased due to the resistance drop in the armature.

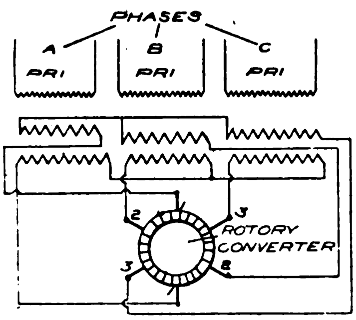


Fig. 154

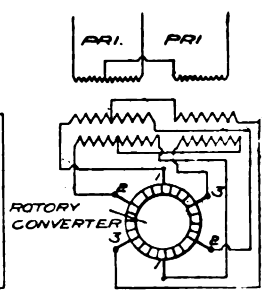


Fig. 155

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

For a three-phase converter the effective resistance for unity power factor is 58.5 percent. of the true armature resistance; hence the IR or resistance drop is 58.5 percent. of the apparent drop in volts.

To obtain practical operating results in the voltage regulation of compound wound rotary converters, an approximation of the combined effects of ohmic resistance, reactance, and armature reaction is necessary. The proper way to operate a compound wound rotary converter to obtain a flat or slightly rising voltage characteristic is to adjust the shunt-field rheostat so that a lagging current is produced at no load; and to adjust the series-field turns so that sufficient series ampere-turns are produced as the load comes on to make the sum of these ampere-turns and the constant shunt-field ampere-turns produce unity power-factor at the average load.

The field may be adjusted so that unity power factor will occur at half-load or full-load or any desired point on the load curve. For normal operating conditions and with the fields properly adjusted, the power factors will be approximately unity over a considerable range of load. To predetermine the voltage characteristic of a compound wound rotary, it is necessary to know the total amount of reactance and resistance in the converter circuit, and also the ratio of the series-field ampere-turns to the armature ampere-turns. With this information the voltages and power-factors of a converter for a definite adjustment of the field rheostat can be closely approximated. A total reactance of 15 percent. may be generally assumed to be the maximum required in the converter circuit to obtain an approximately flat voltage characteristic. Allowing a reactance of 5 percent. in the converter itself, it thus requires approximately 10 percent. additional reactance in the transformers and choke coils to fulfill this requirement, and for that reason there has been established the standard practice of allowing for 10 percent. reactance in the transformers, thereby doing away with the utilization of choke coils, thus saving the expense and space required if they were installed.

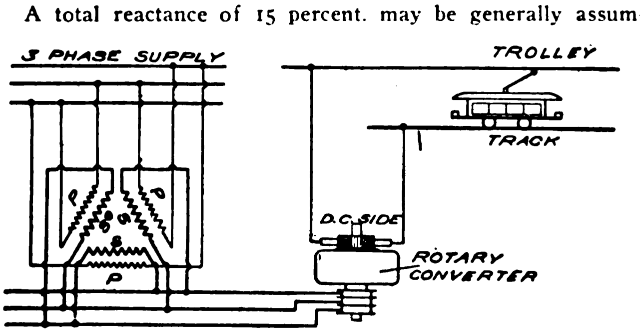


Fig. 156—*Three-phase transformer delta connected supplying three-phase current to rotary converter, direct current side connected for street railway service.*

TEMPERATURE SENSITIVE PAINTS

Writing in a recent issue of the *General Electric Review*, W. S. Andrews, of the consulting engineering department of the General Electric Co., says that this name has been applied to chemical compounds that are subject to color changes at a comparatively small rise in temperature. These paints are occasionally used for indicating a dangerous rise in the temperature of machine bearings, electric generators and other apparatus where excessive heating has to be avoided. The two compounds described below are easy to make and reliable in operation.

Double Iodide of Mercury and Copper

This compound is normally red but turns black at about 87 deg. C, becoming red again when the temperature falls.

To prepare it make separate solutions of copper sulphate and potassium iodide in distilled water. Add the latter to the former with cornstarch stirring until the precipitate which is first formed is re-dissolved. Then add a strong solution of mercuric chloride (corrosive sublimate) and the red double iodide of mercury and copper will be precipitated. Wash and dry this precipitate on filter paper. The red powder may be mixed with a weak solution of gum arabic in water and used as a paint.

Double Iodide of Mercury and Silver

This compound is normally of a light primrose yellow, but turns to a dark orange or brick red at about 45 deg. C. It becomes yellow again on cooling—and it may be heated and cooled an unlimited number of times without losing its curious property, providing it is not overheated.

To prepare this make separate solutions of silver nitrate and potassium iodide in distilled water. Add the latter to the former with constant stirring until the original precipitate is dissolved. Then add a strong solution of mercuric chloride (corrosive sublimate) which will produce a precipitate of the double iodide of mercury and silver of a bright yellow color. Wash and dry the precipitate on filter paper. It can be used as a paint by mixing with a weak solution of gum arabic in water.

METAL SAWS WITHOUT TEETH

According to *Automotive Engineering*, smooth steel discs revolving at high speeds are now being used for cutting metals in Germany, with results equally good and sometimes better than those obtained by toothed saws. The actual cutting is not effected, as was formerly understood, by removing the metal, but by the heat generated by the friction between the rapidly revolving disc and the metal. That heat is so great that the metal is melted at the point of contact. The disc has consequently only to discard the molten metal, and by doing so clears the dividing groove. Naturally the steel disc also becomes heated in the operation, but as the greater part of its circumference is always out of contact, and continuously being cooled by air, and as the friction for each point of the disc circumference only lasts for a minute fraction of a second, its own heat remains always below melting point. When that fact was realized, toothless saws were soon constructed which were able to cut through all metals, even the strongest joints, in a minimum of time. The advantages over the toothed metal saws are that the discs do not wear out so quickly as saws, and there are no teeth.

EDITORIAL

THEORY AND PRACTICE

We have it on the authority of a so-called practical man that the theorist is a dreamer without whom the world would be able to get along very well indeed. Maybe that's so and again maybe it isn't. 'Twas ever thus; those who labor by rule of thumb are wont to jeer at those who reason by logic and analogy. Probing a bit into chemistry and physics, we frequently find ourselves wondering where the theory leaves off and the practice begins. More often than not in these sciences, and the arts which are based upon them, theory and practice are as interdependent as the two blades of a scissors. Of what use is one blade without the other? Of what use is both blades without the rivet or fulcrum on which to turn them? Where would the chemical industries be to-day were it not for the atomic theory? Take the case of the electric motor, for example. Can the so-called practical man—we refer specificially to the self-satisfied man who boasts of his ignorance of theoretical electricity—can he tell whether or not a direct current motor will run on an alternating current circuit, or an alternating current motor on a direct current circuit? If it will run or won't run, can he tell why? And if he can't tell why, how is he to get along if confronted by these problems, as he might be at any time? Take another case, the saving of transmission line investment and overhead by the simple expedient of properly connecting transformer coils so as to change three phase to two phase energy at the point of distribution. Did a so-called practical man first make that experiment and then turn it over to a so-called theorist for analysis? No; on the authority of the theoretical man who conceived it, it was tried out in the laboratory after having been thought out in the study, and it owes its being to common sense and plane geometry.

We could multiply examples to prove our contention that the so-called practical man has no monopoly on wisdom, but one more will suffice perhaps to show how practice without theory can sometimes cause trouble and expense in matters electrical. Our practical man has in the cellar of his home a big gas engine for pumping water from an artesian well into a tank in the attic. Wearied of buying dry cells for ignition purposes at forty cents apiece, he thought he would connect the primary of a bell-ringing transformer to the lighting circuit (single phase, 60 cycles, 110 volts) and the secondary (6 volts) to his spark plug and run the engine that way. Scoffing at sine waves of electromotive force and things of that sort, he cranked his engine and, lo, it ran! The house wasn't big enough to hold him, so out he sprinted to tell the neighbors what a wonderful Little Jack Horner they had in their midst. When the neighbors arrived the engine had stopped. No amount of cranking would start it again, not even with the secondary connected for twelve volts, for eighteen volts. He tinkered with it for a week, but there was nothing doing. Calling in a man who knew something about the theory of alternating currents, he was shown that the first run was purely a matter of accidental good luck—all of which he could have found out before he scrapped his dry cells and invested in a bell-ringing transformer had he had less contempt for theory. We hold no brief for the so-called theorist, but he has his place in engineering economy just as much as the chemist has his in domestic and industrial economy.

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SAVING DAYLIGHT

One does not have to submerge in the deeps of the dismal science to learn the art of being thrifty. Though political economy touches on thrift, and its high priest, Adam Smith, tells us that parsimony is the foundation of all great fortunes, nevertheless thrift is not learned in schools of science but in the open, where men strive for a living and struggle for existence. Some few are born thrifty, no doubt, but most men who get and keep, either acquire thrift or have it thrust upon them. In this respect it is like its prototype, greatness. If the travail, horrors, and sacrifices of this war thrust thrift upon us and teach us to acquire it, the war will not have been in vain. Like the dunghill that fosters the rose, the flower of thrift that follows in the wake of combat and crowds out the weed of extravagance will compensate in a small way for the wanton destruction that produced it. No longer is it good form for the improvident to point the finger of scorn at the thrifty and dub him "tightwad." Rather it is become fashionable for the thrifty to remind the careless—who invariably have to be helped along in time of emergency by the scorned savers—that a fool and his money are soon parted. As with his money, so with his time, albeit we seem to have been somewhat tardy in applying thrift to time as well as to money, however given to parroting that time is money. But now we are half awake as to time thrift, and maybe the other half of us will awake later. Tardily on the last day of March we effected a reform

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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?

suggested by Ben. Franklin one hundred and thirty-five years ago. On that day we turned our time pieces ahead one hour, thereby paying a long deferred compliment to our late countryman, for he it was who wrote in 1784: "In a walk through the Strand and Fleet street one morning at seven o'clock I observed that there was not one shop open, although it had been daylight and the sun up above three hours, the inhabitants of London choosing voluntarily to live by candle light and sleep by sunshine; and yet often complaining a little absurdly of the duty on candles and the high price of tallow." Perhaps Franklin's observation might still be resting undisturbed by vulgar activity had not our resourceful and practical enemies and our allies turned it to good account in the effort to win this war. Three long years after Germany saw fit to live one hour longer by daylight and one hour less by candle, gas, oil, and electric light in order to save tallow, oil, and coal, we discover what an infinitude of wisdom and common sense Ben Franklin possessed! Truly, as three of the Evangelists have it, a prophet is not without honor save in his own country. Born of the travail of war, plus the adaptability of our practical and single-minded enemies, comes this belated honor to our frugal Poor Richard. At rest in that quiet little graveyard in Philadelphia, let him know that the electrical industry, which he helped to found, will aid the cause during the next seven months by contributing the equivalent of over two hundred hours of lighting in every place in the land where electrical energy is consumed in lamps from dusk until it's time to go to bed.

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YOUTH VERSUS DOLLARS

Ask any man who is past middle age what is the one thing in life worth having. He will tell you, youth. Then ask him what he would give in exchange for youth, in exchange for the time when all the fields are green, every goose a swan, lad, and every lass a queen. Unless he be a miser he will answer: "All I have and all I hope to have." Thus highly do men value that which throughout the ages has been the theme of the poet, the musician, the painter, the sculptor—of all the gifted ones who are designed by nature to catch such fleet footed half-phantoms and transfix them in type, song, paint, and marble. Literature, music, art—all are vibrant with the song of youth. Even the calamitous Ecclesiastes bids the young man rejoice in his youth, while the sun, or the light, or the moon, or the stars, be not darkened. Since time began man has sought industriously to find the fountain of youth, but all in vain. Try as hard and as dextrously as he may, the crowsfeet will come, the step falter, the arteries harden, and the hair grow white. By way of recompense—if recompense there can be for such an irreparable loss—there is acquired experience, caution, control of the emotions, and, perhaps, wealth in varying degree. This wealth cannot be exchanged for the man's own lost youth, charlatans and fakirs to the contrary notwithstanding, but in the present crisis it can be employed in saving this priceless possession all over the world, including the misguided youth in those lands whose masters now seek world dominion. Of all the crimes committed by those who brought on this war, that of maiming, debauching, and killing youth is the worst. These varlets seem bent on sweeping out of the world all the song and story and music now in the making, leaving nothing but old men and women to tell the tale of the glory of youth butchered to make a Teuton holiday. The way to save this priceless possession from complete destruction is to bring an end to the war, and the only way to end the war is for this country to smite the enemy hip and thigh; to beat him to his knees. To beat him so his own mother won't know him we must call upon and sacrifice some of our own youth—that is unfortunate but inevitable in the circumstances. These youths must be trained, equipped, shipped overseas, and supplied with all that makes for overpowering fighters. This means that all those who have youth ahead of them, as well as those who would give all they possess to get it back again, must aid the government in every way possible. Our children who are too young to work for wages are selling Thrift Stamps. That is their task just now, and right nobly are they doing it. Their elders with incomes in the shape of wages, profits, dividends, and inheritances must do the rest. Every dollar they can spare from their savings must be invested in the Liberty Bonds which are about to be offered. Those who have but little ready cash must consecrate their future labors to this imperatively worthy cause by subscribing for these bonds and taxing themselves to the maximum every week until the debt is cancelled. Our boys are going "over there" to fight for us, and as Coningsby Dawson says:

"Of all the lads who've gone out to play
There's some'll return and some who'll stay;
There's some will be back 'most any day—
But some won't wake up in the morning."

How trival is our sacrifice compared with theirs. Their life is ahead of them; ours is largely behind us. All they ask for is our moral and our financial support. Let us resolve to give both without stint; for unlike the lads who marched out in the morning, all our poor dollars will be back 'most any day, all will return and none will stay to sleep 'neath the poppies of Flanders.

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THAT INCOME TAX

There is just enough space left on this page to allow us briefly to pay our respects to the authors of that remarkable document known as the Corporation Excess Profits Tax Return. The art of taxing, says a French savant, consists in getting the most feathers out of a goose with the least amount of squawking. Another French savant, Talleyrand, says that language was intended to disguise thought. Experience in making out our own report last month, added to that of every business and professional man with whom we have compared notes, prompts us to observe that the persuasive spirit of Talleyrand must have hovered nearby when the committee compiled Form 1103. As for the other tenet of the French school of political economy, we hope for the sake of the national treasury that the feathers plucked in this way will measure up with the squawks that come from those whose unhappy and bewildering task it was to interpret that document. Never have we seen the beat of it for obscurity and obfuscaty.

REDUCING ELECTROLYSIS IN OMAHA

A menace to the maintenance in sound condition of water pipes and other underground metallic structures has been found to exist where electric railways utilize the track, and hence also the ground, for a return conductor, at least where care is not taken to avoid trouble. This is due to the electrolytic corrosion which takes place wherever stray currents of electricity leave gas or water pipes or cable sheaths to traverse the soil. If such electrolysis is to be avoided careful control of conditions must be maintained and measures promptly adopted to mitigate influences which will encourage electrolytic corrosion.

In order to avoid unfavorable conditions and to find out just how matters stood, the officials of the various public utilities in Omaha decided in 1916 that a survey of their city should be made. It is the underground pipes and cables utilized for utility service that are endangered by a situation favoring electrolysis and it is the electric street railway which usually has the duty of relieving such conditions.

In Omaha the water supply is furnished by the Metropolitan Water District, a municipal organization, while the gas, railway, telephone, and electric light service is furnished by a number of corporations. Representatives of these interests met, arranged for meeting the expenses of a survey, and asked the National Bureau of Standards to conduct it. This invitation was accepted and in October, 1916, the work began. R. A. Lenssler, assistant manager of the Omaha and Council Bluffs Street Railway Company, was chairman of the committee representing the utilities, and Burton McCullum, electrical engineer of the Bureau of Standards, directed the work. The railway, water, gas, and telephone utilities each furnished a technical assistant to the supervising engineer, as well as furnishing labor, transportation, and such facilities as it had for furthering the work.

During the course of the survey, measurements were made not only on the properties of the four utilities just mentioned, but also upon the cables of the electric light company, the Western Union Telegraph Company, the Postal Telegraph-Cable Company, and the pipes of the Council Bluffs City Water Works all of which furnished information and men to assist in making measurements upon its own lines.

The Omaha and Council Bluffs Street Railway comprises approximately 160 miles of single track, 30 miles of which is in Council Bluffs. The area covered in Omaha is about 10 miles in each direction. Power is supplied from a steam plant and distributed through two substations, as well as directly. One of these substations is in the southern part of the city and is known as the South Omaha substation. The other is in the north and is known as the Lake Street substation. The cars in Council Bluffs were at that time fed from the main power station.

The survey consisted chiefly in obtaining the following series of measurements and observations: (1) Load curves over a 24-hour period on all trolley section feeders and on the three stations; (2) over-all track potentials, or the drop in voltage between outlying points on the track and the tracks near the power station; (3) track potential-gradients, including gradients through earth between tracks as well as gradients on continuous sections of track; (4) potential-difference measurements between the various underground piping and cable systems, and between these and the railway tracks and negative return feeders; (5) current flow in gas and water pipes at numerous points; (6) current flow in drainage cables connecting the various underground structures and the railway return circuits; (7) inspection of pipes and cables at locations where electrolysis has been experienced or where conditions seemed particularly to favor it; (8) measurements of earth resistance at a number of points in both Omaha and Council Bluffs.

Load Curves

From the standpoint of electrolysis it is usually desirable to know the all-day-average values of potential differences and currents rather than momentary or peak values; and in order to know the relation between observed values taken at various times of the day and the corresponding all-day-average values, it is necessary to know the shape of the daily load curve of the particular circuit concerned. For this purpose, and also for use in making calculations relative to possible changes in the feeding circuits, load curves were taken for each of the trolley feeding sections on the entire system. This was accomplished by connecting a recording millivoltmeter across the ammeter shunt of each feeder circuit at the power station and plotting the recorded current for the 24-hour period. Each of these curves was analyzed, and the all-day-average value calculated. A study of the several load curves revealed the fact that although different circuits differed somewhat, the all-day-average values were in general approximately the same as the normal day-load values between the hours of 8:30 a.m. and 5:00 p.m.

Typical station and feeder curves are shown in Figs. 1 and 2. As the potential-difference measurements were made during the day period (8:30 a.m. to 5:00 p.m.) it was thought better to use actual observed values rather than to attempt corrections depending upon the instantaneous load.

Overall Potential Measurements

In making these measurements, use was made of spare telephone wires, which were usually available. An idle pair of wires was selected at some convenient cable terminal, and a twisted pair used to extend these wires to a pole butt opposite the desired point of attachment to the track. A No. 6 copper wire was then welded to the rail by means of the oxy-acetylene torch, and brought out to the curb line and connected to the spare pair. Various means were employed to protect the wire where crossing the street, depending on the character of the pave-

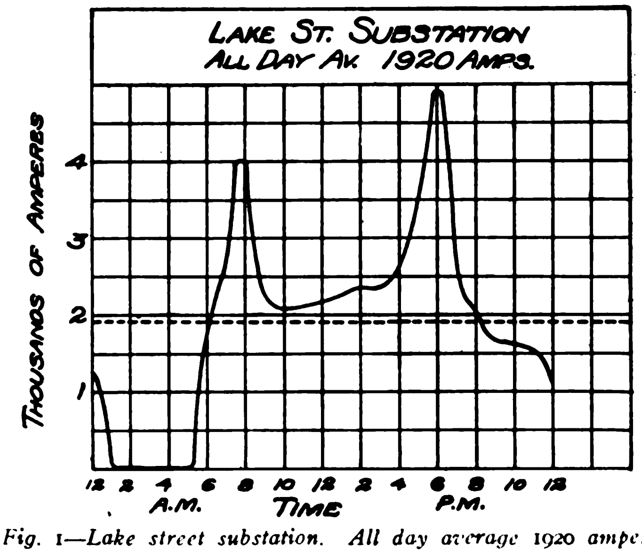


Fig. 1—Lake street substation. All day average 1920 amperes

ment, but it was usually found possible to bury it in the pavement or between stones or bricks in such manner as to insure a permanent connection for a period of a few days during which these tests were in progress. Sixty-four such taps were made to the track network and the pairs brought to a terminal board in the Douglas Street telephone exchange. In most cases, this

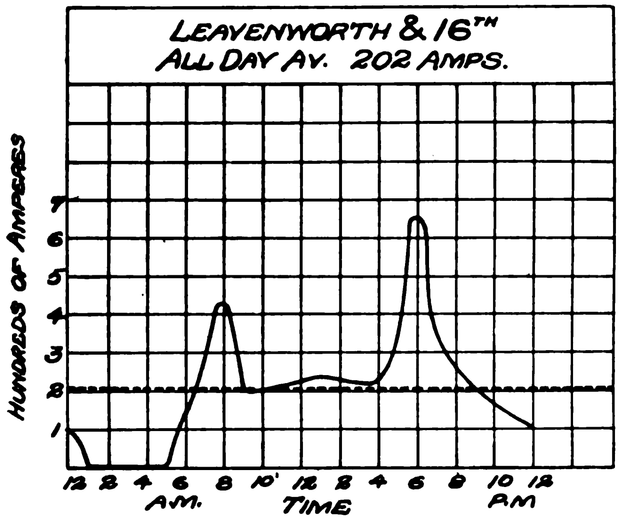


Fig. 2—Leavenworth and Sixteenth street, all day average 202 amperes.

necessitated trunking through one or more exchanges and could not have been accomplished without the large reserve plant maintained by the telephone company.

In order to insure accuracy and facilitate the making of connections for the many measurements desired as well as to give a visual conception of the nature and relation of the observations, these wires were connected to binding posts installed on a city map, the location of each binding post corresponding exactly to the actual point of connection of its wire to the rail. In this way a miniature of the entire railway system was reproduced on the map and observations could be quickly and easily made between any two desired points.

Loop resistance measurements were made on all of the pairs of wires before connecting them to the terminal board in order that corrections for the resistance of the leads might be made to the observed voltages.

One-hour records were taken on Bristol recording voltmeters, and a direct-reading voltmeter was frequently used to check the recorded values. These one-hour records were analyzed by means of a polar planimeter and the average value recorded after making the necessary correction for the resistance of the potential wires.

Potential Gradient Measurements

These measurements were made in the same manner as for overall potentials. They are useful in locating high-resistance and overloaded sections of track, and give a general idea of the potential distribution over the entire system. They also indicate points at which leakage from the rails may be excessive. Gradients of 0.3 to 1.0 volt per 1000 ft., depending upon conditions, have been considered dangerous from the standpoint of electrolysis. Some of the conditions affecting the limiting safe gradient are: (1) conductivity of soil; (2) character of roadbed; (3) distance over which gradient extends; (4) proximity to underground structures. These factors are usually so uncertain that in general no definite limits to gradients can be set to insure satisfactory conditions.

Potential Difference Measurements

Measurements of potential difference between water pipes and rails were made at about 170 locations in Omaha and Council Bluffs, one-hour records on Bristol recording voltmeters being taken in nearly every case These measurements indicate more accurately than similar measurements to lead cable sheaths the tendency of the rails to discharge or pick up current from the earth. This is due to the fact that water pipes are, as a rule—particularly where carrying little or no current—at about earth potential, owing to the extent of the system and the intimate contact which they make with the earth. Cables, on the contrary, are run in ducts which insulate them in a greater or less degree from the earth, and as they frequently carry currents to drainage feeders they are often at a potential quite different from that of the surrounding earth. Potential measurements to water pipes, therefore, not only give an indication of the condition of the pipes themselves, but reveal the positive and negative areas of the earth relative to the return circuit.

Potential-difference measurements alone are by no means sufficient to determine the degree of danger existing to any piping system. The resistance of the circuit upon which the measured potential is impressed will determine the amount of current flow and as this resistance is dependent upon a number of factors such as the character of the roadbed, the conductivity of the earth, and the resistance of the pipe joints, it is unwise to attach undue importance to such measurements. However, when considered with other data they are valuable in determining conditions in general, and are indispensable in any thorough electrolysis survey.

Measurements between electric cables and other structures were made with a Weston voltmeter, readings being averaged over a period of 2 to 5 minutes.

Currents in Pipes

Twenty-two current-measurement stations were established on the water mains in Omaha and twelve in Council Bluffs. Twenty-three stations were also established on the gas mains in Omaha. In many instances, it was necessary to excavate in paved streets at a considerable expense to expose the mains, and in order to provide for future measurements permanent connections were made to the pipes and wires brought out to stopboxes at the curb line. In all cases connections were made 6 ft. apart on the mains with no joints between. The size of the pipe and the exact location were recorded in each instance and made a part of the permanent records of the pipe-owning companies. Connections were made by tapping the water mains and installing ½-in. corporation cocks to which No. 10 stranded, rubber-covered wires were soldered. Solid brass plugs were used on the gas mains instead of corporation cocks.

Measurements were made by observing the voltage drop between the two taps and calculating the current from this and the estimated resistance of the pipe. Where the drop was sufficiently great it was measured with a Bristol recorder over a 15-minute period, but where very small it was necessary to use an indicating voltmeter having a range of 2.0 millivolts.

Drainage Currents

Current in all pipe-drainage taps known to exist was measured, but it is believed that there are other connections whose locations are not known, principally drainage taps to the water pipes in the central district.

Inspection of Pipes

In connection with the establishment of current-flow stations on gas and water mains, a number of pipes were carefully examined as to their surface condition. With but one exception, those so examined were found to be in good condition and free from any marked corrosion. The exception was on Lake Street near 20th Street in a positive district where a large main was found to be slightly pitted but by no means in a serious condition.

A general study of the data collected during the survey seemed to indicate that at least one source of immediate danger might be looked for at points of intersection of different underground structures where they exhibited a considerable difference of potential. Local corrosion on gas and water service pipes has been experienced in various locations from time to time, and usually attributed to leakage in some nearby structure. One gas service in particular, at 24th and Leavenworth Streets, which passed very close to an electric light service conduit, had corroded so rapidly as to require frequent replacement. At present it is protected by a metal screen which was recently installed.

In order to determine the degree of danger which exists at such locations and to ascertain the extent of damage being done, a number of excavations were made at points of intersection of gas and water pipes with cable systems at a lower potential. It was assumed that the points of greatest hazard were those where mains or service pipes crossed under or over metal conduits carrying lead-covered cables, and the records were studied to determine the location of a number of such intersections. It developed that the telephone company had discontinued the use of metal conduits some 15 years previous and has since been using vitrified tile with cement joints. Metal pipes for service connections were to be found in only a small downtown district, and as the potential differences in this locality were small, no attempt was made to unearth them.

It was found that the practice of the electric light company was to use both iron and fiber ducts for service extensions, and a number of points of intersection where the former existed were examined. Examinations were also made at points of intersection of gas and water mains with the main conduits of the three principal cable systems.

These observations seem to indicate that under moderately dry soil conditions, little leakage can take place between water or gas mains and lead cables, unless the latter are encased in metal ducts, and even then the metal casing tends to take the potential of the surrounding earth rather than that of the enclosed cable. There appears to be a very high contact resistance between lead cables and metal ducts enclosing them, which is evidently due to the presence of iron rust. Single cables in vitrified sewer tile with cement joints appear to present little hazard to adjacent structures under dry soil conditions.

Earth Resistance

The Bureau of Standard has made an exhaustive study of methods of grounding electrical circuits, and of ground resistances, and has measured the resistance of some 500 ground connections of various types including buried plates, driven pipes, and patent grounding devices. The territory thus covered includes 32 cities on the Atlantic seaboard, the middle west and northwest. Omaha was included and measurements on 33 earth connections including transformer and lighting-arrester grounds were made there and in Council Bluffs.

The soil of Omaha and Council Bluffs is a fine clay of uniform texture and very deep, no gravel or rock outcrops occurring. The resistances of the ground connections were found to be of about the same magnitude as those in other localities having the same character of soil, and very low as compared with those in cities where the soil is of a less uniform texture.

The average resistance of 33 ground connections in the two cities was 23.3 ohms. The Bureau of Standards has made similar measurements in many other cities, and the average in clay soil is close to this figure, while the average in gravel and sandy soils is 447 ohms. The soil in Omaha may therefore be classed among those of very low resistivity.

General Rules of the Survey

Maps were provided upon which the results of measurements were recorded, thus giving an opportunity for comparing and checking results, and presenting them in a comprehensive form.

It was found that the greatest overall potentials were those between the tracks in Council Bluffs and the main power station. A large portion of the track system in that city was at a potential considerably higher than the tracks in Omaha, thus providing ideal conditions for leakage between the two systems. No very large potentials were found around South Omaha substation, but on a number of the longer lines fed from the other stations the potenial drops were large enough to demand attention.

Half of the potential gradients measured were found to be in excess of 0.4 volt per 1000 ft., and in view of the low resistance of the soil this value was regarded as the limit for safety. One-quarter of the gradients were in excess of one volt per 1000 ft. The latter were mostly around the main station and the Lake Street substation. With the exception of one track, no track passes nearer than 1600 ft. to the main power station, and the concentration of the return current to this single track and the bare copper cables which parallel it produces high gradients and a consequent hazard to adjacent structures near the power house. The currents in the single track and in the return feeders were calculated. The current returning from Council Bluffs was found to be not over 300 amperes. The current supplied to that city was about 600 amperes, showing that about half of it was leaking from the tracks in Council Bluffs and returning through the earth to the Omaha side of the river.

Measurements of potential differences between water pipes and rails showed a strongly positive area in the vicinity of the main power station, and a similar area of much larger extent surrounding the Lake Street substation. A positive area of considerable extent also surrounded the South Omaha substation, but the potentials were comparatively small and not of great consequence.

The entire system in Council Bluffs was negative to the tracks. This should be expected, owing to the remoteness of this system from the power house and the discontinuity of the two water systems. It was found that in all the outlying portions of Council Bluffs the water pipes were discharging current into the earth, so that in these regions a certain amount of electrolysis was in progress.

The telephone cables were found, with few exceptions, to be negative to adjacent structures and to the earth. One positive region was found in Council Bluffs. While in most locations the telephone cables were in satisfactory condition, due to current drainage, they presented a hazard to other structures, such as gas and water pipes, which were positive to them at points of close proximity. This is a condition which exists wherever competitive drainage is resorted to. It emphasizes the desirability of unified drainage where several systems of pipes and cables are concerned, and where conditions warrant drainage as an auxiliary means of mitigating electrolysis.

Electric light cables were found at most points to be strongly negative to water pipes and to earth, and usually negative to telephone cables also, due to their being drained to the railway return circuit. The power plant from which these cables are distributed is directly south of the main railway power station. At this point the cables had been strongly drained and were returning nearly 700 amperes to the railway power house. Like the telephone cables, these cables also presented a hazard to adjacent pipes and in certain locations had caused pronounced electrolysis in gas service pipes, necessitating renewals.

The street railway cable sheaths were found to be extremely negative to other structures throughout their course, the differences running up to 6 and 8 volts. These cables were laid in vitrified clay ducts, which offered good insulation from earth during the dry season in which the tests were made. They also were drained at the power house and at the substations.

The Western Union Telegraph cables were found to be positive to other structures at many points. As they are run in metal ducts, however, they were shielded from danger. The Postal company's cables in Omaha were negative; in Council Bluffs they were positive, owing to lack of drainage.

The water mains in Omaha were found to be conducting current into the positive areas. The drainage taps into the Lake Street substation carried 368 amperes. In Council Bluffs there was one drainage tap to which neighboring currents were directed. At other points the current was found to be flowing away from the tracks and was evidently discharging through remote laterals to earth. With one or two exceptions, currents on the gas mains were absent or negligibly small. This may be due to the large number of cement joints in the pipes, or to the metallic connections to water pipes through gas water heaters.

Recommendations

Injury in progress was set down to two general causes: (1) high voltage gradients in the negative return of the electric railway due to the long feeding distances; (2) the existing cable and water-pipe drainage, improperly employed. Each utility drained its system independently and endeavored to keep it lower in potential than surrounding structures, thus producing large drainage currents.

The engineers of the Bureau of Standards consequently recommened three methods for reducing potential gradients: (1) the use of additional substations; (2) the use of insulated negative return feeders; (3) the use of a three-wire system of distribution. In the three-wire system of distribution the negative bus remains connected to the track and becomes a neutral bus, while some of the generators are changed so as to have their positive terminals connected to it. This can be simply accomplished by reversing their polarity. They can no longer be run in parallel with the positive generators, but have their negative terminals connected to a third bus which supplies certain sections of the line with negative curent. Current in the positive sections flows through the car motors from trolley wire to track, but in the negative sections it flows from track to trolley wire, as shown in Fig. 3.

An additional substation was considered necessary in Council Bluffs and eventually, perhaps, one also in the western portion of Omaha. Insulated negative return feeders were considered necessary to replace the bare return conductors in the area surrounding the main power station. One additional insulated return feeder was found necessary also at the Lake Street sub-

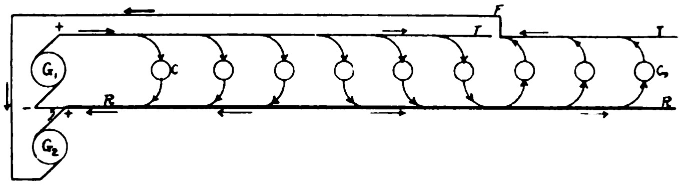


Fig. 3—Three-wire principle applied to railway system. G1—Normal generator. G2—Reversed generator. C1 to C9—Trolley cars. T—Trolley. F—Trolley feeder. R—Rail. Arrows show direction of current flow.

station and it was recommended that four outlying sections of track be supplied from one rotary converter with its polarity reversed. If found satisfactory, three-wire operation should be extended to the central district.

It was also recommended that the pipe and cable drainage be overhauled. In each power district the drainage from a system of pipes or cables should be made at a single point, and should be controlled by having a rheostat and ammeter connected in the drainage cable. The potential of the tracks adjacent to the Lake Street substation should be raised 4.6 volts by inserting resistance between the tracks and the negative station bus.

No changes at the substation in South Omaha were found necessary.

Results of the Changes

These recommendations were carried out early in 1917. A temporary portable substation, with a capacity of 400 kilowatts, was established in Council Bluffs, and all the lines in that city were supplied from this substation except that between the river and the main business section. At peak hours, morning and evening, the substation was operated in parallel with the main station, adjustable resistance being inserted to prevent overloading the substation.

At the Lake Street substation not only were the four outlying sections fed with negative current, but one city section was similarly fed except at times of peak load. All of these sections were connected through double-throw switches, so that they could be fed with either positive or negative current, but normally negative. The switch connection was provided to prevent overloading the negative rotary.

A supplementary survey was carried out in June, 1917, and conditions were found very much better. The loading conditions at the Lake Street substation are illustrated in Fig. 4. Curve 3 shows the total station load, which formerly would have to be returned to the station through the track. Curve 1 shows the positive load and Curve 2 the negative load. The difference between Curves 1 and 2 is given by Curve 4, which shows the current returning to the neutral bus. This is to be contrasted with Curve 3, which was the load returning to this bus under the old conditions. The integrated current is now only about 38 percent. of the previous value.

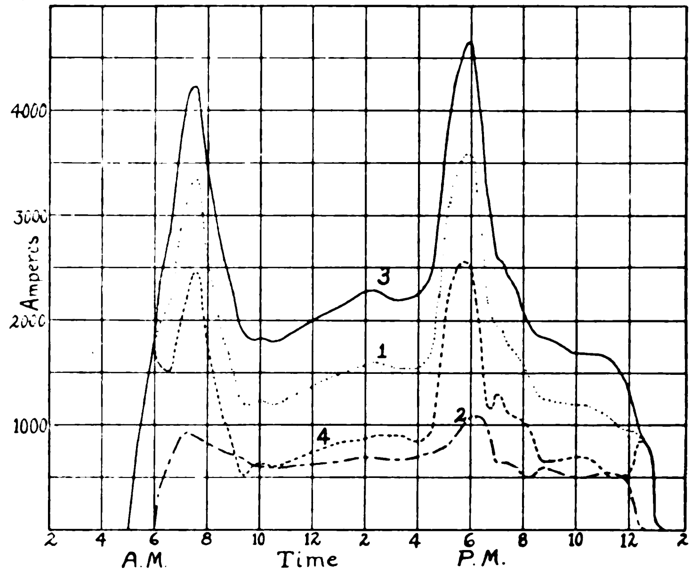


Fig. 4—Load curves. Lake street substation, Omaha, June, 1917. 1—Positive load. 2—Negative load 3—Total substation load. 4—Current return to neutral bus.

A marked contrast was found in overall potentials and potential gradients as compared with 1916 values. The overall potentials were reduced from magnitudes of 10 to 14 volts to the order of 1 and 2 volts. The gradients were of course very much reduced, especially near the station, owing to the greatly reduced track currents. Owing to the low potential which exists on all of the outlying sections of track, a positive area was found on both water mains and telephone cables. This suggested the use of drainage taps in these districts, with the current limited to values which will reduce the potential difference between pipes and rails to about 0.4 volt.

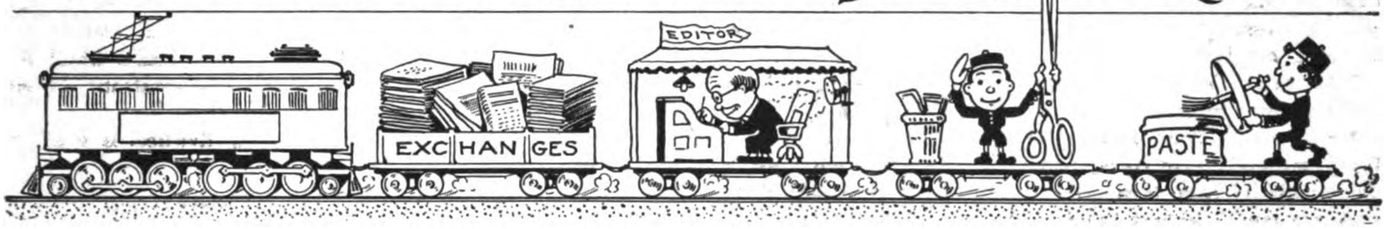
In Council Bluffs it was found that current was returning to the substation from all sections of the city, including that supplied from the main power station in Omaha. This indicated that current was still leaking from the ends of the lines and finding its way to Omaha. It should be corrected by installing sufficient capacity in the substation to supply the entire city of Council Bluffs, which would eliminate leakage across the river.

The very high positive potential difference which formerly existed between water pipes and negative returns near the river in Omaha were found to have disappeared, and the water and gas mains in the central district were no longer in danger.

In order to reduce the high gradients which still existed on some sections of the track in the central power district, it was recommended that three-wire distribution be installed in this district. In lieu of three-wire operation, equally good conditions could be secured by the installation of a substation in the western portion of the city.

Electrolysis measurements should be periodically and regularly made, especially following any important extensions or changes in the railway system or any of the other underground utility systems. These will show where insulated negative return feeders should be installed or where pipe drainage should be modified or limited. Tests should be carried out at least annually, as the failure of rail bonds or drainage cables may seriously modify conditions.

VIA THE SHEARS AND PASTE-POT ROUTE



Items of Interest Gleaned From Various Sources

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.

CARE OF DRY CELLS

There are a few rules regarding the care of dry cells—most of which are self-evident—which should be observed if the best results are to be attained, says a writer in the current issue of *Telephony*.

Care should be exercised with dry cells to keep the cells, whether actually in use or in storage, in a place not subject to extremes of temperature, as freezing and exposure to heat and vibration loosen the seal of the cell and cause the moisture in the cell to evaporate.

In renewing dry cells a greater number should never be put in series than was originally required to do the work. The additional cells increase the voltage beyond that required, causing more current than is necessary to flow through the circuit which is attached to the cell and this increased current flow shortens the life of the battery.

In connecting dry cells in places where they are subject to vibration, heavy solid copper wire should be used, as it is likely to develop a loose connection with the binding post.

Water should not be allowed to come in contact with the paper covers of the cells because these covers form the insulation of the cell. Hence when moist, current will leak across from one cell to another, resulting in running down the battery.

In testing dry cells with an ammeter, care should be taken to take the readings as quickly as possible, for the ammeter being of a low resistance, acts as a short circuit on the cell.

A voltmeter is not used in testing cells as while the cells are not giving out current, their voltage remains practically constant and a cell that is really very weak might show a high voltage.

In a battery of cells it is always wise to test all of the cells with an ammeter and remove and replace any cell whose amperage is considerably lower than that of the balance of the cells in the battery.

Care should be taken that the pasteboard covering of the cell is continuous and unbroken and that it projects above the top edge of the zinc.

In connecting a battery of cells it is always wise to tighten the nuts by means of a pair of pliers.

Cells in which the pitch or seal at the top is badly cracked should never be put in use, as it is merely a question of a short lapse of time until the moisture within the cell will all evaporate.

Dry cells that have been exposed to a low temperature in cold weather or in storage will always, when tested with an ammeter show a low reading until their temperature regains normal.

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While greater production and sales of power resulted in an increase of $162,279 in the gross of the Niagara Falls Power Company for 1917 this was more than offset by higher operating costs and taxes. The balance sheet shows that taxes alone more than quadrupled. There was added to surplus, after all charges, $1,200,065, compared with $1,362,116 in 1916, a decrease of $162,052.

Niagara Falls Power Company, the pioneer in the production of hydroelectric energy, was one of the three power plants at Niagara Falls whose output was requisitioned by the Government last December. Under the terms of the order, some of the company's customers of long standing were deprived of power, while others doing war work received a larger amount to meet increased demands. Throughout the past year the demands for power were far in excess of the capacity of plants, according to officials of the company, and a power famine now exists at the Falls.

✦ ✦ ✦

People possess imagination in varying degrees; some have too much and some too little. There are those to-day who appear to think that the end of all things is at hand. There are an infinitely greater number who seem to have no real comprehension of the situation confronting this nation. No harm need be apprehended from the fears of the former. The torpidity of the latter is a great menace.

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The life of a concrete vessel is from 10 to 15 years longer than a wooden one. Concrete vessels are also said to possess superiority over both wood and steel vessels under gun fire or submarine attack.

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The Hog Island yard contains about 900 acres, and will have 50 shipways in five groups of 10 each, a fitting-out basin containing 7 piers each 1,000 ft. long with a capacity of 4 ships per pier. There is not in Philadelphia to-day a single pier of this length and not many in the country. The classification, storage, holding yards and distributing tracks for material entering into the construction of the 120 ships require 75 miles of standard gauge railway track. The covered buildings, such as plate and angle shops, blacksmith shops, and machine shops, with office buildings, mess halls, fire stations, police headquarters, and living quarters will include more than 25 acres under roof; 75,000,000 ft. of lumber will be used, about 500,000 tons of steel and nearly 30,000 men will be required as a maximum, a larger force than has ever been organized for shipbuilding in any previous yard.

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O. B. Wilcox writing in *The Annalist* of New York, emphasizes the great part which the public utilities of the country are taking in meeting the national crisis. The article contains the following paragraphs:

"Time and labor and money saving machinery in the United States must offset the high cost of labor, materials and fuel. Machinery will win the war—time and labor-saving machinery;

the same machinery, and nothing else, can protect our trade balances and our gold reserves against tremendous and destructive losses when the strength of all the world will enviously reach out for our accumulated capital.

"Our public utility systems save more time, labor, and fuel, and therefore more money, than any machinery in this or any other country. These savings mean more rapid production and lower manufacturing costs; that is why the demands upon the public utilities have been greater than ever before, and that is why we are dependent upon them for speed and success in preparing for and prosecuting the war."

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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.

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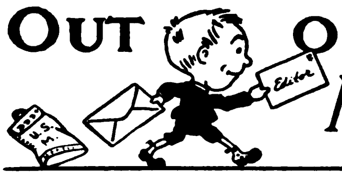
George Washington's recipe for keeping warm was to: "Take a billet of wood of a competent size, sling it out of the garret window into the yard, run down the stairs as hard as you can drive; and when you have got it run up again with it at the same measure of speed; and thus keep throwing down, and fetching up, until the exercise shall renew as often as occasion may require."

OUT OF THE MAIL BAG



FROM OUR CONTRIBUTING EDITORS

FLYWHEEL CALCULATIONS

In the January number of Electrical Engineering, in a interesting article "A Simple Friction Test," W. F. Schaphorst discussed the saving which may be effected by keeping bearings, shafting, and belting of a transmission system in good working order. For installations where an engine flywheel is used he gives a formula for calculating the yearly cost of excessive friction, viz.

Yearly cost of excessive friction

$$= \frac{W V^2 C N D (Tg - Tb)}{17{,}700\ Tg\ Tb}, \text{ where}$$

W = Weight of engine flywheel, in pounds.
V = Velocity of flywheel periphery, in feet per second.
C = Average cost of power per horse power hour, in dollars.
N = Number of hours run per day.
D = Number of days run per year.
Tg = Time, in seconds, required for flywheel to come to rest after transmission has been improved.
Tg = Time, in seconds, required for flywheel to come to rest before transmission was improved.

The writer believes that this expression for the cost of excessive friction is incorrect, and that it gives results which are about three times too large. The following demonstration shows how this conclusion was reached.

The kinetic energy stored in a rotating flywheel is equal to

$$E = \frac{W V_R^2}{2 \times 32.16} \text{ ft. lb., where}$$

VR = Velocity of extremity of the radius of gyration, in feet per second.

The radius of gyration of a flywheel is usually equal to eight-tenths of its outside radius. From this it follows that the last equation may be written

$$E = \frac{0.64\ W V^2}{2 \times 32.16} \text{ ft. lb., or}$$

$$E = \frac{W V^2}{100} \text{ ft. lb. approximately}$$

To simplify calculations it will be assumed that this energy is dissipated at a constant rate in Tb seconds in one case and in Tg seconds in the other case, then the power given up by the flywheel rim, the greater will be the accuracy of the results.

$$\frac{E}{Tb} = \frac{W V^2}{100 Tb} \text{ ft. lb. per second,}$$

$$\text{and } \frac{E}{Tg} = \frac{W V^2}{100 Tg} \text{ ft. lb. per second.}$$

The saving of power effected by improving the transmission is therefore expressed by

$$\frac{E}{Tb} - \frac{E}{Tg} = \frac{W V^2}{100 Tb} - \frac{W V^2}{100 Tg} \text{ ft. lb. per second.}$$

$$= \frac{W V^2 (Tg - Tb)}{100\ (Tg\ \ Tb)} \text{ ft. lb. per second.}$$

$$= \frac{W V^2 (Tg - Tb)}{55{,}000\ (Tg\ \ Tb)} \text{ horsepower}$$

Multiplying this last equation by C, N, and D the cost of excessive friction per year is found to be equal to

$$\frac{C N D W V^2 (Tg - Tb)}{55{,}000\ \ (Tg\ \ Tb)} \text{ dollars.}$$

The results obtained from this formula may still be greater than the actual cost of excessive friction, because the assumption upon which it is based is not strictly correct, due to the presence of windage friction. The smaller the velocity of the flywheel rim, the greater will be the accuracy of the results.

As an example, for the application of the formula we will use the same values which Mr. Schaphorst used to apply his formula.

Let W = 4000 lb.; V = 80 ft. per second; C = $0.01; N = 9 hr.; D = 300 days; Tg = 55 seconds; Tb = 40 seconds, then

Yearly cost of excessive friction

$$= \frac{0.01 \times 9 \times 300 \times 4000 \times 6400}{55{,}000} \times \frac{(55 - 40)}{55 \times 40} = \$85.70$$

It will be noticed that this result is about one-third of the amount obtained from Mr. Schaphorst's formula.

H. H. Metzenheim, Ampere, N. J.

THE TRADE IN PRINT

What The Industry is Doing in a Literary Way

Pass & Seymour, Solvay, N. Y., have issued loose-leaf circular 42-A containing data and prices on porcelain Shurlok key and keyless sockets and receptacles.

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Lighting for Production and Safety is the subject of a 20-page booklet just issued by the Cooper Hewitt Electric Co., of Hoboken, N. J.

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Automatic Reclosing Circuit Breakers and Relays are described and illustrated in Bulletin 130 just issued by The Automatic Reclosing Circuit Breaker Co., of Columbus, Ohio.

✦ ✦ ✦

Delta-Star Electric Co., of Chicago, is distributing a new edition of Bulletin 31 entitled, "High Tension Indoor Universal Unit Type Bus Bar Supports." It contains 48 pages of data and illustrations.

✦ ✦ ✦

Important Changes is the running head on Bulletin 11-A-1 issued by Pass & Seymour, Inc., of Solvay, N. Y. It gives present prices on a number of P. & S. fittings.

✦ ✦ ✦

"Electrifying the Rockies" is the title of an illustrated monograph on the electrification of the Chicago, Milwaukee, & St. Paul Railway issued by the Champion Coated Paper Co., of New York.

✦ ✦ ✦

Electrical Equipment in the Woodworking Industry is the title of a new circular just issued by the Westinghouse Electric & Mfg. Co. The publication is profusely illustrated by views of motor driven woodworking machinery, both alone and as installed in representative woodworking plants.

✦ ✦ ✦

The Reflectolyte Co., St. Louis, Mo., has just issued Catalogue No. 4. It contains 32 pages of cuts and descriptions of the different types of "Reflectolytes" now being offered to the trade. Ceiling-Bright units will be found on pages 8 and 9. Pages 22-31 show a line of multiple units, both in metal and compo with brackets to match.

✦ ✦ ✦

Fundamentals of Illumination Design, a booklet of 68 pages, has been prepared by the engineering department of the National Lamp Works of General Electric Co. It is intended for the use of all who are interested in the principles and practice of illuminating engineering. In compiling this booklet the needs of the practical man engaged in illumination work have been kept constantly in mind.

✦ ✦ ✦

Revised Catalogue on Lighting Arresters has been issued by the Westinghouse Electric & Mfg. Co. It contains a brief treatment of lightning in general and ground connections. Direct-current lightning arresters are considered at some length. Outline drawings with approximate dimensions of Type AK arresters in various settings complete the book, which is of much interest to electrical men having to do with transmission lines for power and railway purposes.

✦ ✦ ✦

Simplex Electric Heating Devices is the title of a bound set of bulletins with revised list and index recently issued by the Simplex Electric Heating Co., of Cambridge, Mass. It contains descriptions and illustrations of Simplex soldering irons, household devices, glue pots, baking ovens, circulation water heaters, hotel appliances,immersion coils, disc stoves, heavy-duty, two-oven and household ranges; water, coffee and chocolate urns; hot closets, laundry and tailor equipment, sterilizers, sadirons, table appliances, curling irons, and radiators.

✦ ✦ ✦

Dixon's Graphite Brushes is a booklet that tells the story of how graphite brushes came into being and further describes the advantages of graphite brushes over carbon. The various conditions of service are also described and recommendations made as to where graphite brushes may be used to the best advantage. The two center pages are devoted to an arrangement of prices and sizes so that the cost of any size brush may be found in a minute. There are also rules as to how to order graphite brushes. Other graphite electrical specialties such as resistance rods and lubricating rods are shown and described. Graphite, unlike carbon, brushes will not cut or scratch the commutator. They prevent sparking and wear of the commutator and have a very long life if properly adjusted.

✦ ✦ ✦

Electrical Heating Publication.—Of interest to everybody connected with the heating of baking, drying and japanning ovens is a reprint just issued by the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa. This includes an article "Electrically Heated Japanning Ovens," by C. F. Hirshfield, reprinted from the *N. E. L. A. Bulletin* and "Heat Calculation for Baking and Drying Ovens" by W. S. Scott, reprinted from the *Electrical Journal.* Thus there are grouped under a single cover an article giving general considerations in favor of electrical heating for this purpose and an article giving the detailed method of calculation for the amount of heat required to raise the temperature of the work, of the supporting and carrying parts such as trucks and of the ventilating air. How to compute the losses from the external surface of the oven, and the heat required to raise the temperature of the oven walls, are also given. Copies will be furnished on application to any Westinghouse Electric branch office for Reprint 66.

NUTS FOR THE KNOWING ONES

QUERIES AND ANSWERS IN TECHNICS

Will you kindly give me the following data for making a transformer, input 120 volts, 60 cycles, and output at secondary, at the following steps:

15 amperes, 8 volts.
12 amperes, 19 volts.
10 amperes, 12 volts.
8½ amperes, 14 volts.
7½ amperes, 16 volts.
6½ amperes, 18 volts.

Kindly give me the size of the core that is necessary, also the size of primary, and secondary wires, stating how I can get the various outputs as above explained.

J. Louis Lange, Jersey City, N. J.

✤ ✤ ✤

The desired output will require a transformer core of iron strips having the following dimensions: Longer strips to be 7½ in. long and 1 in. wide; shorter strips to be 3¼ in. long and 1 in. wide. Sufficient of these strips should be provided to build up a core 1 in. in thickness. That is, the core will consist of laminated strips arranged as shown in Fig. 1 built up to make a core cross-section of 1 sq. in. The thinner the strips the more will be required to make the core. Each strip should be carefully varnished with shellac varnish and allowed to dry thoroughly before assembling.

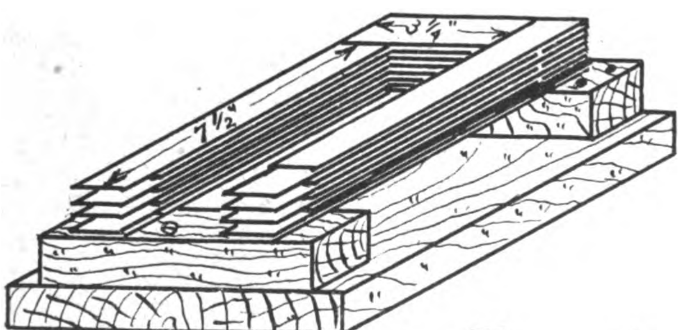


Fig. 1.

Fig 1—Details of transformer construction.

The primary and secondary may be wound on spools or forms, as indicated in Fig. 2; the primary being wound on first in even turns and layers.

The primary on each form should consist of 280 turns of No. 25 B. & S. gauge, double cotton covered copper magnet wire, wound in two layers.

The total turns in the primary is 560 turns.

The secondary should consist of No. 14 B. & S. gauge double cotton covered copper magnet wire, wound as follows:

80 turns for 8 volts; 100 turns for 10 volts. Connecting these two coils in series will give a terminal pressure of 18 volts.

Two coils of 60 turns each to give 6 volts. Connecting these two coils together in series will give 12 volts, or one of them in series with the 10-volt coil will give 16 volts, or one in series with the 8-volt coil will give 14 volts.

Thus four secondary coils will give all the pressures desired by properly connecting coils together in series.

If the 10-volt coil and the 8-volt coil should be connected together in opposition the resulting pressure would be 2 volts.

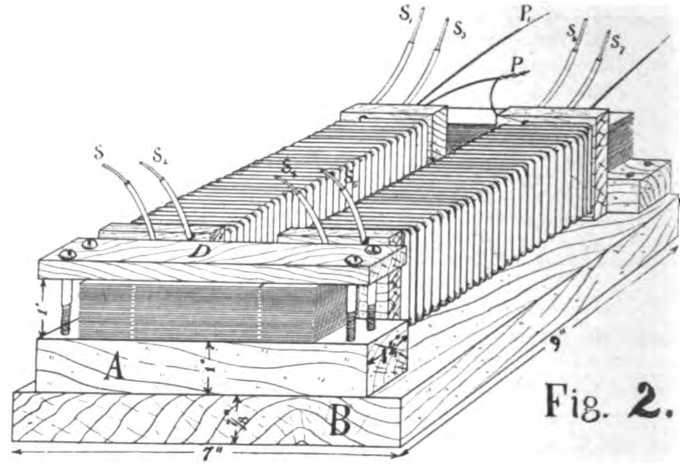


Fig. 2.

Fig. 2—Further details of transformer construction.

If the 10-volt coil and one of the 6-volt coils should be connected together in opposition, the resulting pressure would be 4 volts.

The forms for the coils may be made of cardboard with wooden ends held in place with glue.

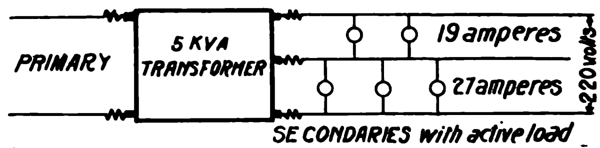
F. E. Austin, Hanover, N. H.

✤ ✤ ✤

Question 1—Will a modern potential, pole type, oil-cooled transformer, 2200 volts primary 60 cycles, single phase, 220 and 110 volts secondary three-wire distribution 5 kva. capacity, handle a load that has 35% more amperes on one leg than on the other and keep the voltage the same on both circuits?

The way it is handled now is as follows: There is one 10-kva. transformer handling 23 kva. connected load. The voltage on one leg is 90 volts; on the other it is 130 volts on Saturday night peak load. When there is no peak load the high voltage is on the opposite side. This transformer is 10 years old.

I am thinking of putting in to replace this a modern transformer of 5 kva. to handle 11.3 kva. connected load, and divid-



ing the other 11.7 kva. (which is wired on the two-wire system) to a two-wire distribution that is within reach. But these changes leave an unbalanced load of 35% which cannot be changed without tearing the building to pieces to get to the connections.

The sketch shows secondaries with 19 amperes on one side and 27 amperes on the other. (This is what the active load is approximately.) The voltage is 220 on the outside wires. What will the voltage be between the outer and center wires?

Question 2—In figuring load factor. Do you take for maximum load the capacity of the generator, or the maximum load carried at the peak load?

E. Barnott, Fort Saskatchewan, Alberta, Canada.

✤ ✤ ✤

Reply to question No. 1.—It is doubtful if a commercial transformer, without some modification, will keep a balance in pressure if the load varies on the two legs.

The pressure between the outer and the center wires may be balanced at say half load, but unbalance will obtain at no load or full load. The ordinary commercial transformer may be adapted to meet variations in load conditions, acting as an auto-transformer, by special windings.

Reply to question No. 2.—Load factor should mean the ratio of the useful output load, to the total possible output of the generator or plant. F. E. Austin, Hanover, N. H.

✦ ✦ ✦

The 10-kva transformer is overloaded more than 100% if it has 23 kva. corrected load and that if a 5-kva transformer is substituted for the 10-kva. the 5 will burn, being overloaded more than 400 %.

Referring back to the 10-kva. transformer, would suggest that if he gets 90 volts on one side and 130 volts on the other side during the peak load, his trouble lies in the neutral or middle wire being open circuited between the transformer and the load, probably the first connection between the transformer and the neutral-line wire.

Referring to his sketch and the 5-kva. transformer with 27 amperes on one side and 19 amperes on the other side: this transformer will have a full oad on the 27-ampere side and will also have 110 volts. The other side will have 110 volts but not a full load, and the only effects this unbalanced load will have is that the neutral wire will be carrying the difference in amperes between 27 and 19 which is 8 amperes. That is what the neutral is for, to take care of any unbalancing that may exist.

If both sides of the circuit had the same amount of amperes on each, the circuit would be balanced and the neutral wire would not have to return all the way back to the transformer.

Again, if the load is unequally divided, and the neutral wire does not return to the transformer, he will have as a result a high voltage on the side with the least load in amperes and a low voltage on the side with the heavy load in amperes.

This is exactly the trouble with his 10-kva. transformer, the neutral wire is open, or has a bad joint in it somewhere.

F. P. Miller, Lafayette, La.

✦ ✦ ✦

Will a direct-current motor operate on an alternating-current circuit? E. H. Towne, Peoria, Ill.

In a direct-current circuit the current always flows in the same direction. It starts from zero value and after reaching its maximum value remains at that until the generators is shut down. An alternating current circuit, on the contrary, is continually changing in direction, also in value; that is, starting from zero the value increases until maximum is reached, when it begins to drop back to zero again. Then it goes up to maximum again, but in the opposite direction.

In Fig. 1 are shown the connections of a direct current series motor, the resistance of the armature and the resistance of the field coils being practically equal. In order to reverse the direction of rotation of the armature, the direction of flow of current must be reversed in either the armature or the field circuits. The direction of flow of current is as indicated by the arrows in Fig. 1, and the direction of rotation of the armature is shown by the arrow in the center. In Fig. 2 the armature current has been reversed, the current through the field coils remaining as before, and the direction of rotation of the armature has been reversed. If both the armature and field circuits are reversed, which would be the same as transposing the feeders from + to —' and — to +', then the direction of rotation of the armature would not be reversed, see Fig. 1.

This is exactly what happens in a motor operating on an alternating current circuit. At one instant a wire will be negative and the next it will be positive; the number of changes per second is always equal to $\frac{\text{poles} \times \text{speed}}{60} =$ alternations per second.

As stated above, as the resistance of the armature and that of the field coil in a direct-current series motor are nearly equal, and as they are connected in series, see Fig. 1, there will be but one circuit, and it makes no differnce how often the current is reversed in direction—the armature will continue to turn in the same direction as at first. For this reason, if we connect a series direct current motor on a single-phase alternating current circuit, it will run.

A series direct-current motor to be run on an alternating current circuit must have laminated pole pieces, or better still an entire laminated frame. The laminations help to keep the eddy current losses down to their lowest value, and thus also keep down the heating.

In a shunt wound direct-current motor the resistance of the field winding is many times the resistance of the armature winding, and the field winding is in parallel or shunt with the armature. This gives a shunt motor two circuits—one of high resistance, the field; and one of low resistance, the armature. If a shunt motor were connected to a single-phase alternating circuit as shown in Fig. 3, the high resistance in the field winding would cause a very high reactance; this would result in a lag in the field current. The armature being of very low resistance, would allow a large current to flow through th ebrushes and armature coils. This would probably cause flashing across the brushes, blowing the circuit breaker or the fuses. For these reasons it is impossible to run a direct-current shunt motor on an alternating current circuit. T. Schutter.

✦ ✦ ✦

Will an alternating current motor run on a direct-current circuit? E. H. Towne, Peoria, Ill.

As explained in the preceding article, series direct current motors will run on alternating current single-phase circuits; consequently, if such a motor were originally installed on an alternating current circuit it would also run on a direct current circuit. Most machines, however, when designed are intended to operate on either an alternating or a direct current circuit. Most machines, however, when designed, are

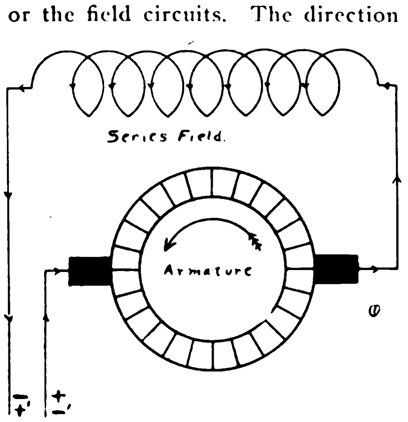


Fig. 1

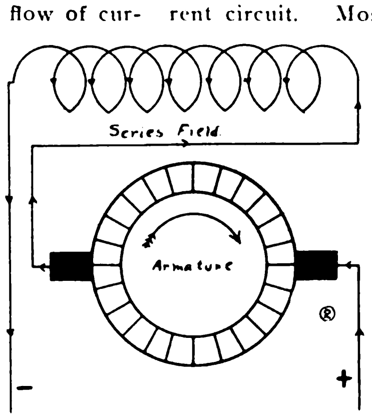


Fig. 2

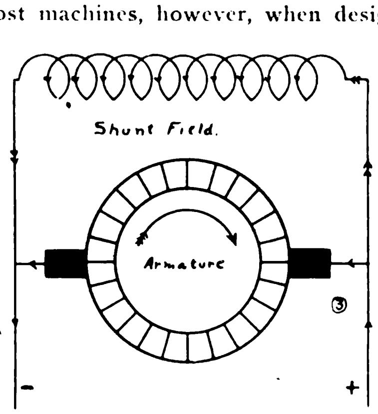


Fig. 3

intended to operate on eithr an alternating or a direct current circuit. An exception to this rule is a small motor used for stirring soda fountain products, also hand vibrators. These are called universal motors and are stamped d.c. and a.c.

As noted in the March issue of ELECTRICAL ENGINEERING, in the writer's article on single-phase alternating current windings, alternating current motors have as a rule no windings on the rotating element, which is called the rotor. It would be impossible, for this reason, to run such a motor on a direct current circuit, because in all direct-current motors a commutator and a winding on the armature are necessary, also brushes to keep a definite relation between the field and armature windings.

I would add that any motor wound especially to be operated on an alternating current circuit will not operate on a direct current circuit, as all direct current windings are of the closed circuit or re-entrant type, while alternating current windings are of the open circuit, or non-re-entrant type.

T. Schutter.

✦ ✦ ✦

We have one light upstairs and one light downstairs to be controlled by one switch upstairs and one switch downstairs. We want the switches to control the lights, upstair light on by itself, and downstair light on, then off, and both on, then both off, the lights to be controlled the same way from both switches.

Can it be done, and if so, what kind of switches can be used? And of course the lights are to be turned on by the upstair's switch, and turned off from the downstair's switch, or vice versa. W. J. Cameron, Dayton, Fla.

✦ ✦ ✦

By connecting two 2-circuit electrolier switches as shown you can operate either one lamp or both lamps from either switch. Use adjustable single-pole electrolier-push switches.

Howard B. Stevens, Waltham, Mass.

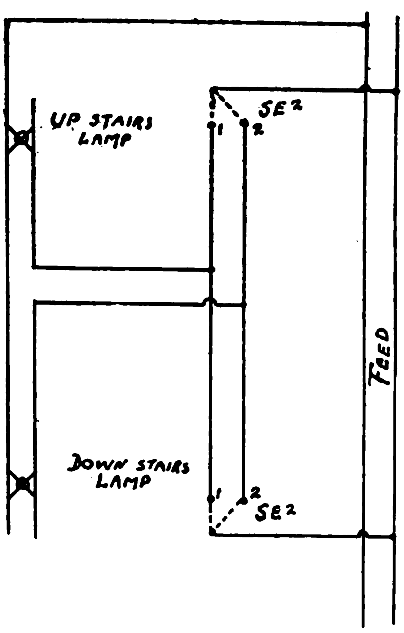


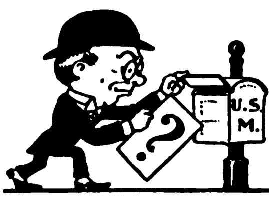
Diagram for controlling lamps upstairs and downstairs by means of two switches.

✦ ✦ ✦

NOT METERED

"Maxie," queried the teacher of the juvenile class, "what is the difference between electricity and lightning?"

"You don't have to pay nothing for lightning," answered Maxie.—*Chicago News.*



I WANT TO KNOW

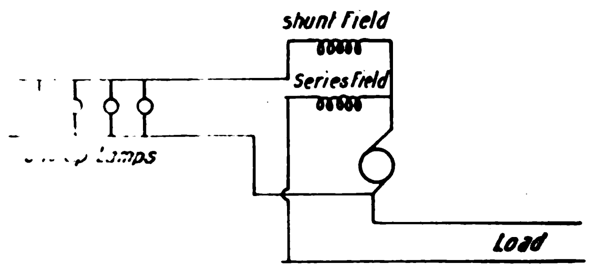
WE INVITE ANSWERS TO THESE QUERIES

I have a 110-volt, compound wound, ⅛ hp. direct current motor that I wish to change to a converter, whose output is to be 10 to 12 volts, 10 amperes direct current. The armature of the motor has 15 slots, and the commutator has 30 segments. The speed of this motor is 1200 rev. per min. Will you kindly furnish me with the necessary data for changing this motor to a converter, as above specified.

J. Louis Lange, Jersey City, N. J.

✦ ✦ ✦

I wish to know if there is any way of using a bank of lamps for a field rheostat on a 15-kw. generator which is self-excited? I connected five 16-cp. 110-volt lamps in multiple and then this group in series with the shunt field. The generator refused to build up, and showed only 2 or 3 volts across the armature



terminals. I later connected two 2-gal. jars of salt water in series and also in series with the shunt field. The generator generated 140-volts with the plates close together in the rheostat. With the plates as far apart as possible it only reduced the voltage about 5 volts and I required 120 volts. Please state if it is possible to operate a water rheostat as a field rheostat on a generator. A. K. Bowles, Hornell, N. Y.

DID YOU KNOW THAT—

BITS OF GOSSIP FROM THE TRADE

Westinghouse Electric & Mfg. Co. has leased for a period of years, the Baxter Stove Company, Mansfield, Ohio, with the intention of consolidating at this plant the manufacture of its heating appliances now being carried on at some of the other Westinghouse plants.

✦ ✦ ✦

Having Discontinued the manufacture of the ornamental types of ceiling fans offered for the past two seasons with chain suspensions, The Emerson Elec. Mfg. Co., of St. Louis, Mo., offers a limited number of these fans remaining in stock at especially attractive prices, subject to prior sale.

✦ ✦ ✦

Lux Lamps.—New York City and Chicago have awarded their respective 1918 municipal contracts on Lux lamps, this being the first year that the same brand of lamps has been chosen by both cities. New York has shown her preference for Lux lamps three times during the past four years, through contract awards.

✦ ✦ ✦

Pittsburgh Service Department of the Westinghouse Electric & Mfg. Co. has moved from its former location on Amberson Avenue, to new quarters at 6905 Susquehanna Street, in the Homewood district of Pittsburgh. Express and freight should be consigned to East Liberty, Pa. via. P. R. R. The Automobile Equipment Service Department has also moved to the new location.

✦ ✦ ✦

Western Electric Company has issued its report for the year ended December 31, showing a balance of $2,851,716 for dividends, after all expenses and charges, an increase of $527,100 over 1916. After dividends on the preferred stock, the balance of earnings applicable to the 150,000 shares of common stock of no par value, was equal to approximately $10 a share, compared with $9.49 a share earned in the previous year.

✦ ✦ ✦

Robbins & Myers, of Springfield, Ohio, draw on practically all parts of the United States for supplies, although the bulk of the metal products comes from Pittsburgh, Pa., and Middletown, Ohio. Purchases of imported supplies, including shellac from India and mica from India and Canada, are made through American importing firms. Fifty carloads of raw material each month enter into the construction of R. & M. motors.

✦ ✦ ✦

Hurley Machine Co. is occupying its new factory at 28 East Jackson Boulevard, Chicago. In this building, in addition to a full equipment of labor saving devices, much has been done to safeguard the welfare of the employees. There is a hospital department in charge of a skilled surgeon, this surgeon being at the disposal of all employees for free examination and medical advice. The main office building houses the private offices, sales, credit, and accounting departments, also a rest room for employees. A model restaurant on the third floor serves luncheon to employees at actual cost. For use in summer, there is a roof garden on the roof of the front end of the factory building.

✦ ✦ ✦

The Annual Report of the American Telephone and Telegraph Company, comprising the entire Bell system, for the year ended December 31, 1917, showing earnings of $8.83 a share, is one of the most interesting documents ever issued by that company. This is because, as President Theodore N. Vail points out, the telephone has come to be a vitally important factor in all defence operations, for the Bell system, with connecting companies, shows now a total of 3,500,000 miles of toll wire, bringing together in one system all cities and towns and most rural communities of the country. The traffic last year broke all records, the daily average of toll connections being 1,000,000 and of exchange connections 30,845,000. This means an average of about 100 calls a year for every man, woman and child in the United States.

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PURELY PERSONAL

Terrell Croft has become connected with the Luminous Unit Co., of St. Louis, Mo., as chief electrical engineer.

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F. G. Keyes, formerly chief engineer of the Cooper Hewitt Electric Co., Hoboken, N. J., has received a commission as captain in the chemical section of the National Army.

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F. B. Duncan has been appointed manager of the Chicago office of the Packard Electric Co., of Warren, Ohio. This office is in the Lees Building.

W. F. Durand, professor of mechanical engineering at Leland Stanford Junior University, has arrived safely in France, after a voyage of 18 days, according to word recently received by his friends at Palo Alto.

✦ ✦ ✦

Harris J. Ryan, professor of electrical engineering at Stanfor University, is busily engaged in investigating the controlling factors in the durability of suspension-type insulators.

✦ ✦ ✦

L. A. Osborne, vice-president of the Westinghouse Electric & Mfg. Co., has been appointed by the Secretary of Labor as a member of a committee on industrial peace during the war.

✦ ✦ ✦

Frank B. Jewett, chief of the Western Electric Co., who received the commission of major last spring, has been promoted to the rank of lieutenant-colonel.

✦ ✦ ✦

Peter Junkersfield, assistant to the vice-president of the Commonwealth Edison Co., Chicago, who was in charge of the electrical construction of the cantonments, has been promoted to the rank of lieutenant-colonel.

✦ ✦ ✦

W. W. Briggs, formerly general agent for the Great Western Power Company, has left San Francisco for New York, where he has accepted an executive position with the Westinghouse Lamp Company.

✦ ✦ ✦

J. G. Sandidge, who has been in the Chicago office of the Cooper Hewitt Electric Co., of Hoboken, N. J., as district salesman for the last few years is now located at 1011 Majestic Building, Milwaukee, Wis. He will look after Cooper Hewitt matters in that vicinity.

✦ ✦ ✦

Edward F. Perot, for thirty-five years president of the National Conduit and Cable Company, has retired. George J. Jackson, who had been one of the vice-presidents, has been elected president, and Morton A. Howard will fill the place made vacant by the appointment of Mr. Jackson.

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Samuel Insull, chairman of the Illinois State Council of Defense and president of the Commonwealth Edison Company, Chicago, has retired from the presidencies of the West Penn. Railways Company and the Western Power Company, Pittsburgh, Pa. He has been succeeded by A. M. Linn, one of the officers of the American Water Works Company.

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George H. Wilmarth, formerly manager of the Sapulpa Electric Company, has been appointed manager of the Muskogee Gas & Electric Co., Muskogee, Okla., suceeding J. E. Owens, who has been promoted to higher duties. R. C. Coffy, formerly manager of the Puget Sound Gas Company, Everett, Wash., will succeed Mr. Wilmarth as manager of the Sapulpa Electric Company.

✦ ✦ ✦

W. E. Quillan, new business manager of the Lorain County Electric Company, at Lorain, O., has discovered a profitable way of helping to sell electric lamps. Silk lamp shades appeal to the decorative tastes of most women, but the expense often balks them. Mr. Quillin solved this by instructing the women in the art of making their own silk shades. He obtained a young woman of Lorain with needlework abilities and sent her to a needle school in Cleveland. When she returned he opened a department of instruction for home silk shade manufacture. The company laid in a line of wire frames, silks and braids, so the pupils could buy the materials at the place of instruction, and success was immediate. There are now as many as thirty women in the Lorain County company's office in one afternoon buying material and working on shades. Purchases of lamps to fit the shades have been numerous. The instructor makes shades for the company during her spare time, and the profits on these more than pays her salary.

✦ ✦ ✦

Harry W. Alexander, director of publicity, The Society for Electrical Development, New York, has resigned to become assistant to president on sales, American Writing Paper Co., New York and Holyoke, Mass. Mr. Alexander is succeeded by Roy B. Woolley, now in the Society's publicity and sales department, but late of the American Ambulance Field Service, Verdun sector, France. Mr. Woolley was formerly sales manager, Standard Electric Stove Co., Toledo, and one time associated with the MacManus-Kelley Co., Toledo and The F. Bissell Co., of Toledo.

✦ ✦ ✦

E. Kilburn Scott, consulting engineer, of London, England, lectured on "Nitrogen from Air for Explosives" at a meeting of the Yale Branch of the American Institute of Electrical Engineers at New Haven onMarch 8. Mr. Scott talked about the quantity and kinds of explosives required in the war, in shells, mines and torpedoes: importance of nitrogen; sources of nitrogen; and risk in dependence on Chili nitrates; methods of fixation of nitrogen from air; electrical processes; ideal method of manufacturing nitrates, employing gas power and air from coke ovens and producers.

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C. H. Van Hooven, claim agent of the Manila (P. I.) Electric Railroad & Light Company, who has been visiting the United States on a vacation for the purpose of consulting with officers of The J. G. White Management Corporation, New York, N. Y., the operating managers of the Manila Company, is returning to the Philippines by way of Hawaii and Japan. While in the United States, Mr. Van Hooven also devoted considerable time to inspecting the claim methods of electric railways in a number of large cities. He has been connected with the Manila Railroad & Light Company for the past ten years. Mr. Van Hooven was recently admitted to the Philippine bar, having successfully completed the law course at the Manila University.

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OBITUARY

Edward K. Patton, for the last 18 years western manager of the Bryant Electric Co., died at his home in Chicago on March 23rd. Mr. Patton, who was born in Chillicothe, Ohio, about 58 years ago, first became associated with the electric supply business in 1888, when he was appointed western manager of the Perkins Electric Switch Mfg. Co. When, in 1900, that company passed into the control of the Bryant Electric Co., he was continued in a similar capacity.

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E. W. Stevenson, one of the best known cable engineers in this country, was lost with the steamship "Florizel," which was recently wrecked while en route from Halifax to New York. He was on a trip to Newfoundland in connection with British government business, being engaged in supplying that government with insulated wire and cable and storage batteries. Born in England, he came to this country about 1886 and was associated from that time until 1899 with various cable manufacturing and operating companies. In 1899 he went with the Hazard Manufacturing Co., of Wilkes-Barre, Pa., and remained with them until 1913, when he resigned to become agent for Messrs. Smith & Nicolls, wax manufacturers. Mr. Stevenson's tragic and untimely death is genuinely regretted by all who had the good fortune to know him intimately. In spite of great pressure of work and responsibilities of a trying nature, he was always ready to speak a kind word to a fellow-worker and unselfishly to help him in any way that he could. In his death the electrical industry loses a gentle, kindly, and sincere man.

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ASSOCIATION NEWS

American Institute of Electrical Engineers will hold its annual convention at Atlantic City, N. J., on June 26-28.

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American Society of Heating and Ventilating Engineers will meet at 29 West 39th Street, New York, on April 15 at 8 p. m. Meeting devoted to fuel conservation.

✦ ✦ ✦

John Fritz Medal will be presented to J. Waldo Smith at 8.30 p. m. on April 17, in the auditorium of the Engineering Societies Bldg., New York.

✦ ✦ ✦

Natonal Association of Electrical Contractors and Dealers has removed its offices from Utica N,. Y., to 110 West 40th Street, New York. In future *The National Electrical Contractor* will be published in New York.

✦ ✦ ✦

American Institute of Electrical Engineers will hold a meeting at 29 West 39th St., New York, on April 12, at 8.15 p. m. Papers will be presented by B. G. Lamme on "A Physical Conception of the Operation of the Single Phase Induction Motor" and by R. E. Hellmund on "No-load Conditions of Single-phase Induction Motors and Phase Converters."

✦ ✦ ✦

Gear Standardization will be the principle subject of discussion at the second annual convention of the American Gear Manufacturers' Association, to be held at Green Brier Hotel, White Sulphur Springs, W. Va., on April 18, 19 and 20. An address by a representative of the United States Chamber of Commerce, of which the association has just become a member, will also bring matters of timely interest before the association. Among the papers will be one by C. R. Poole, on "Hardening and Heat Treating of Gears."

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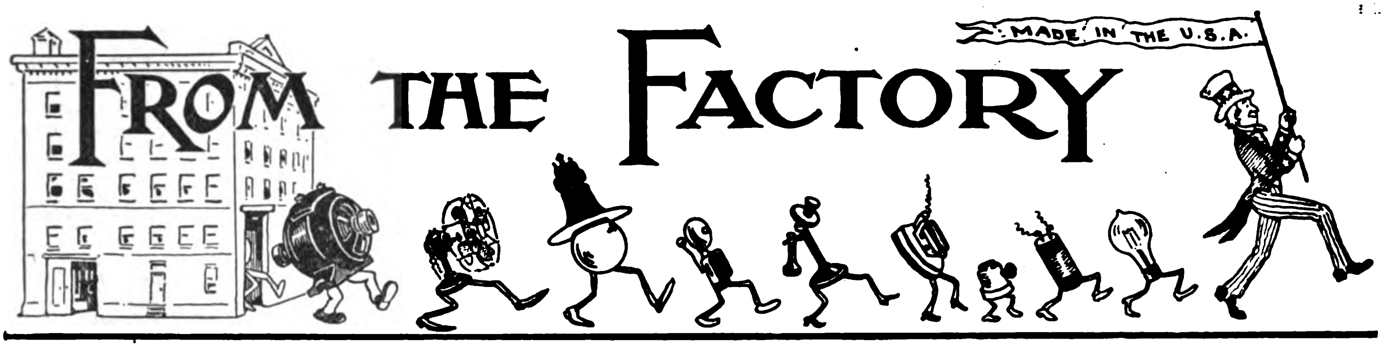
New York Section A. S. M. E. and Metropolitan Student Branches will hold a joint afternoon and evening meeting on Tuesday, April 9, at the Engineering Societies Building, 29 West 39th Street. The afternoon session will begin at 4 p. m. and will hear well-known engineers tell how the engineering profession is helping to win the war on land and sea and in the air. There will be a buffet supper, smoker and entertainment at 6.30 p. m. In the evening there will be several addresses, followed by a lecture and motion pictures on "The War in the Air" by G. D. Wardrop, editor of *Aerial Age*.

From the Factory

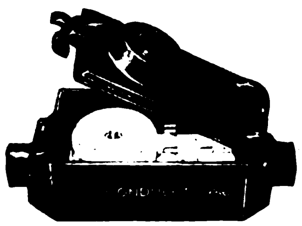


Short Stories About Electrical Goods Offered By Manufacturers

SWITCH CONDULETS

Two new switch condulets of the ZY series—the latest additions to the large family of conduit fittings manufactured by the Crouse-Hinds Company, of Syracuse, N. Y., are shown in the accompanying cuts. It is claimed for them that they protect from shock the switch operator and the person renewing fuses. They cannot be operated by accident; they withstand the roughest usage; water will not drain into them, and it is impossible for lint or other inflammable particles to lodge upon the current-carrying parts and thus create a fire hazard.

Both the body of the condulet and its cover are cast iron. Inside is a combined 20-ampere snap switch and fuse block. The



Small motor switches. Crouse-Hinds Co., Syracuse, N. Y.

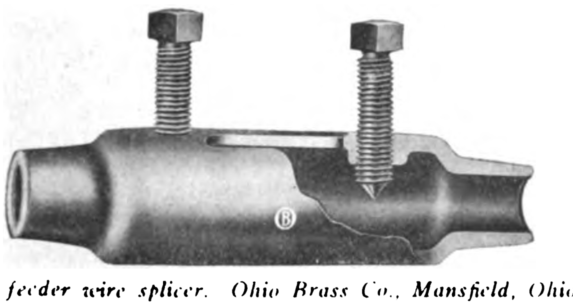
switch is externally operated, and its handle interlocks with the latch of the door in such a way that the latter cannot be opened when the switch is in the "on" position. As a result of this arrangement, the circuit is dead when the door is open, and fuses can be replaced without danger of shock or short circuit.

The manufacturers list ZY condulets in one and two-gang forms and in sizes and arrangements of threaded conduit hubs to meet various conduit wiring arrangements.

✦ ✦ ✦

O-B FEEDER WIRE SPLICER

The desirable characteristics to be possessed by a successful feeder wire splicer are all said to be embodied in the O-B design, manufactured by the Ohio Brass Co., Mansfield, Ohio. They may be enumerated as follows: (1) Must develop full tensile



O-B feeder wire splicer. Ohio Brass Co., Mansfield, Ohio.

strength of the cable. (2) Must show full conductivity; that is, its resistance must not be greater than an equal length of unbroken cable. (3) Light weight. (4) Must be installed with tools found in lineman's belt; i. e., connectors, pliers, screwdriver and monkey-wrench (or S wrench) excepting of course solder pot, ladle and solder. (5) Must be non-fouling so that when taped it can be pulled in over cross-arms or over foreign wires without catching or fouling. (6) Freedom from corrosion due to uncombined salts in soldering flux used. (7) Must be designed to permit easy removal and re-use. (8) Must employ a positive means of spreading or fanning out the strands in the splicer body and this means should be visible so as to permit an inspector to tell at a glance whether strand has been fanned out or not. (9) Must not make it necessary to shorten the conductor.

In case it is necessary to remove the splicer, cut off cable up to end of splicer and melt out cable ends and solder in a furnace. The splicer may then be used again.

These splicers are made in sizes to include from 4-0 to 1,000,000 c. m. cable and ranging in length from 5½ to 7 in.

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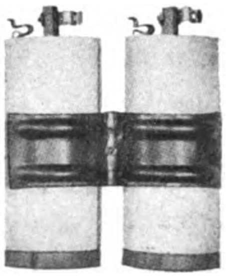
BATTERY SUPPORT CLAMP

There is shown in the annexed cut a new battery support clamp which is simple and inexpensive but provides good support for dry batteries when used in pairs such as in telephone service.



Battery support clamp, Leich Electric Co., Genoa, Ill.

Such a clamp has often been asked for, and it comes at a time when it is badly needed. It is manufactured by the Leich Electric Co. of Genoa, Illinois.

✦ ✦ ✦

FOUR IN-ONE CARTRIDGE FUSE

A four-in-one catridge fuse, known as the Atlas fuse, has been placed on the market by the Atlas Selling Agency of New York City.

From the outside this type of fuse looks the same as the standard type of cartridge fuse, and it can be used anywhere that standard fuses are used. However, instead of one single chamber, as in the ordinary type of cartridge fuse, the inside of the shell is divided into four compartments by four pieces of fiber.

If a fuse blows, all that is necessary is to remove the cartridge from the clips, pull the cap out about ¼ in. and give it a quarter turn, push back the cap, and another fuse element is in circuit. Replace the cartridge in the clips, and the circuit is again ready for service.

MORE LAMPS PER CIRCUIT

In mill work it is frequently helpful to take advantage of the opportunity to place a larger number of lamps per circuit than the Code permits for general wiring. In order to provide a keyless socket for pendant drop lights wired with No. 14 portable cord, the Bryant Electric Company, of Bridgeport, Conn.,

Keyless socket for pendent drop lights. Bryant Electric Co., Bridgeport, Conn.

has added to its line of "New Wrinkle" socket caps one having a strain relief porcelain bushing with ½ in. hole. The catalogue designaton of this socket cap is CB, and when used in connection with Bryant No. 13 New Wrinkle keyless socket body, provides a device that meets the conditions specified in National Electrical Code, second paragraph, Rule No. 23.

PACKARD BELL-RINGING TRANSFORMER

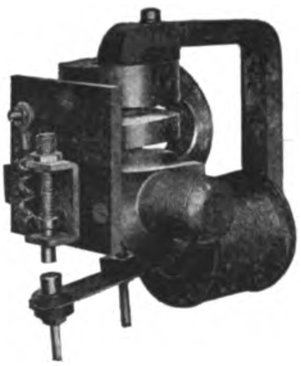
A new form of transformer for use in connecting house signal bells with the lighting circuit has recently been developed by the Packard Electric Co., Warren, Ohio. It is illustrated in the accompanying illustration. Like other de-

Bell ringing transformer. Packard Electric Co., Warren, Ohio.

vices of like nature, it reduces the lighting voltage to a pressure where it can be utilized to operate the bells at maximum efficiency and minimum expense. It replaces dry batteries for this purpose, and is always in circuit.

REVERSE CURRENT RELAY

The new form of reverse current relay developed by The Automatic Reclosing Circuit Breaker Co., of Columbus, Ohio, is pictured herewith. These relays are of the circuit opening type and are so designed that the relay will open either upon reversal of current, or with zero current at normally low voltage.



Reverse current relay 400-800 amperes.

Reverse current relay 1200-2000 amperes.

Two types of reverse current relays made by the Automatic Reclosing Circuit Breaker Co., Columbus, Ohio.

The relay is closed and held closed by a shunt polarizing coil. A high resistance is connected in series with this coil. To close the relay a push button switch is provided which temporarily short circuits the high resistance. The high resistance limits the current in the shunt winding to just sufficient value to hold the relay closed. A reversal of current or failure of voltage will thus cause relay to open.

These relays are designed for mounting on rear of circuit breaker panel. The 1200-ampere and 2000-ampere size has a magnetic yoke which surrounds the upper stud of breaker. The 400-ampere and 800-ampere size relay is provided with a series winding one terminal of which is connected directly to the upper stud on the rear of the panel.

HOME MOVING PICTURE MACHINE

A new type of moving picture machine for commercial, educational, and home use has just been brought out by the Pathescope Co. of America, New York. Its special features are motor drive, by a motor that can be used on both direct and alternating currents; high illumination; and a feed mechanism that gives satisfactory results. It is driven by a Westinghouse Sew-Motor, which operates at practically the same speed with either kind of current.

Illumination is provided by a 14-volt, 2-ampere, argon-filled lamp, which is sufficiently brilliant for throws as long as 100 ft., and for pitcures up to 12 ft. wide. The 110-volt current received from the lighting circuit is reduced to low voltage for the use of the lamp, by means of a rheostat; this rheostat is adjustable so that the degree of illumination can be varied to suit conditions. The machine weighs 23 lb.

SHOP MAIL BY TRICYCLE

The Westinghouse Electric & Mfg. Company has departed from the old and slow method of delivering mail through its East Pittsburgh Works by means of a boy on foot, which required from three to four times longer than the newly adopted method to deliver a piece of mail from the central mailing department to one of the outlying buildings.

The first improvement in this direction was that of the storage battery truck fitted up with racks similar to those used in a post office. This truck made trips throughout the works, collecting mail and sorting it while the truck was on its grounds.

This was found to be a considerable improvement over the old method but on account of the trucks being large a great deal of time was lost in waiting to get through aisles where material was being loaded and unloaded. The truck required the services of two men, one for the sorting of the mail and one for operation.

The new tricycle which is 11½ in. narrower, costs considerably less; in fact eight tricycles can be purchased for the cost of one storage battery truck and it requires the services of but one boy to handle the mail and tricycle.

At the present time there are four of these tricycles in use and an extra is held in reserve for emergencies. Each tricycle will cover approximately three-quarters of a mile per trip, and the time will be between 30 and 60 minutes per trip.

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TRIUMPH ELECTRIC SEWING MACHINE

A new portable electric sewing machine is announced by the Triumph Specialty Co., 235 Canal Street, New York. It consists of a sewing machine head, a motor, a speed regulator, and a cover. The whole outfit can be packed inside the cover, and is so light that it can be easily carried, and so compact that it can be put away in a closet. The machine, which can be used on any table, is always ready for operation when connected to any lamp socket.

It operates on the lock-stitch principle, and is provided with a full set of attachments for tucking, ruching, and other operations. Power is supplied by a Westinghouse Sew-Motor, which can be operated on direct current circuits of 115 volts, and on alternating current circuits of 110 volts, of any frequency up to 70 cycles.

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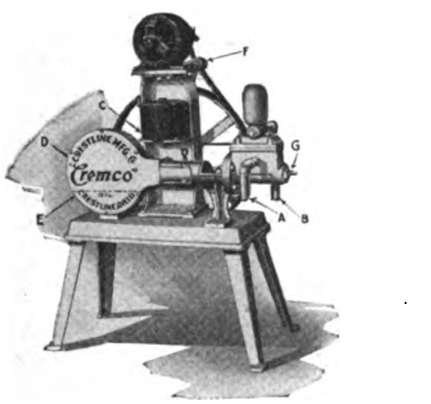
ELECTRICALLY OPERATED HOUSE PUMP

A new small capacity electric-driven pump has been developed by The Crestline Mfg. Co., Crestline, Ohio, which is especially suited to replace the common water lift to pump rain water for soft water in residences. It can also be used for general water supply in homes when city water supply service is not available and the pump can be placed so the suction lift will not be over 25 ft.



Electric pump driven by Robbins & Myers motor.

The outfit is made in two capacities—Model A, single cylinder with a capacity of 125 gal. per hour, and Model B, with a capacity of 250 gal. per hour. Both will operate against a pressure of 50 lb. per sq. in.

An automatic controller switch is connected with the discharge and is set to operate between pressures of 40 lb. maximum and 20 lb. minimum. It can be adjusted, however, to any desired pressure.

The cylinders are brass lined, have a 1½ in. bore, 3-in. stroke, and are self-primed. An air valve provides sufficient air for pneumatic pressure tank system. The valves are bronze and rest in bronze seats.

The pump and motor are mounted on a cast iron base. The pump is a slow speed type which is connected to the motor by bolt with idler pulley attachment. Pressure tanks are also supplied when ordered.

Model A is fitted with a 1/6 hp. and Model B with a 1/4 hp. Robbins & Myers motor.

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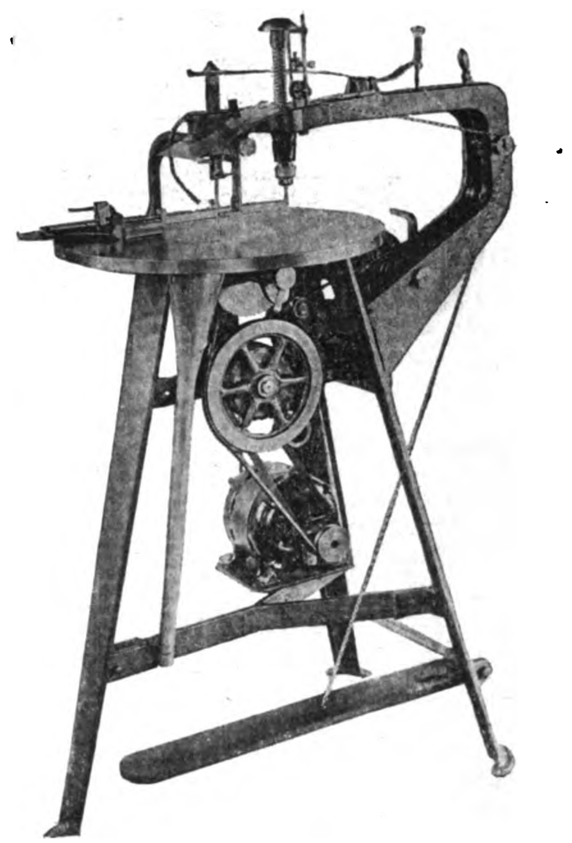
CUT FINISHING MACHINE

The J. E. Richards Co., of Kalamazoo, Michigan, has developed a motor operated machine for standardizing print shop, composing room operations. The same machine buzz saws, jig saws, drills, touts, broaches, notches, undercuts and mortises,



Richards multiform saw driven by General Electric motor.

electros, halftones, etchings, bases, "boiler plate," and linotype slugs.

A swinging jig saw arm is provided, permitting this part to be swung at right angles with the circular saw to allow material of any length being run through the machine.

This machine is belt driven from a General Electric fractional horsepower motor. Current is obtained from the lamp socket.

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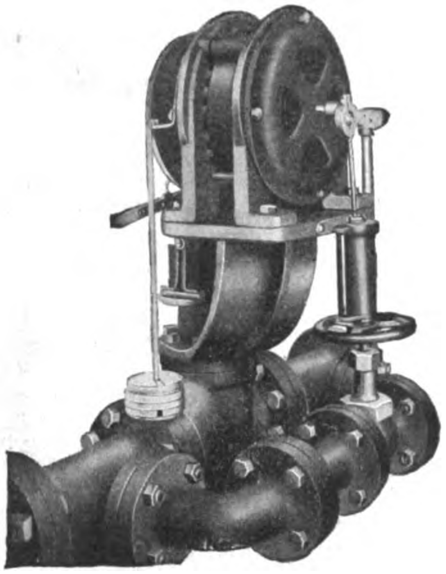
GRINDER REGULATOR

To maintain a steady maximum from electrically driven grinders in pulps mills, the General Electric Co., Schenectady, N. Y., has developed a regulator which maintains a practically constant load on the grinder motors. It is in practical operation.

The regulator consists of a small induction motor which is connected through series current transformers to the feeder lines of the grinder motor. The rotor of the regulator motor rotates through a small angle and actuates the throttle valve of the main water supply to the grinder, automatically reducing the water pressure when the load on the grinder motor starts to increase, and opening the throttle valve and increasing the water pressure to compensate for a falling load.

Service tests show that with a single three-pocket grinder, with instantaneous changes in load as great as 33 1/3 percent., the fluctuations on the driving motor feeder circuit did not exceed 2 percent



Grinder regulator for use with paper making machinery. General Electric Co., Schenectady, N. Y.

While the results achieved by the regulator on the electrical system are excellent, the most important effect of its use is the considerable increase in production secured. Without the regulator the grinder must operate for varying periods at reduced output when the pockets are being filled, whereas with the regulator in operation such reductions in load are instantly corrected by the changes in water pressure, so that the motor-driven grinder set, when provided with this regulator, is always operating at its maximum rate of production.

THE ATTRACTOGRAPH

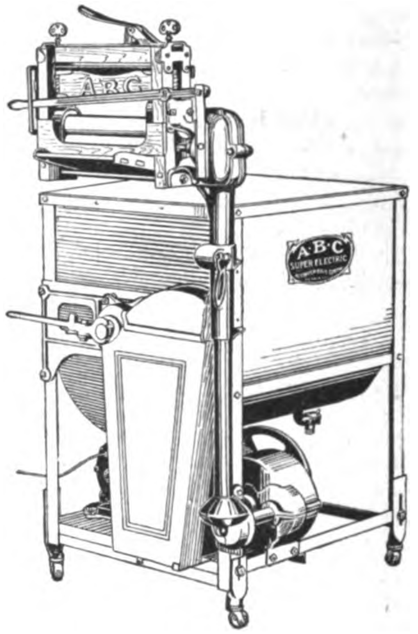
A new type of moving picture machine for office, convention and show window has been brought out by the Attractograph Company, 220 West Forty-second street, New York City. This machine displays pictures which can be readily seen in broad daylight as well as by night. Its operation is entirely automatic in all its functions. After the reel is projected it is automatically rewound and then displayed again, so that after the machine is arranged and started it will continuously operate for an indefinite period, without any further attention.

The outfit consists of two separate parts, the moving picture machine and miniature theatre, in which the pictures are displayed. The moving picture machine will operate on either direct or alternating current. Two horizontal discs carry the film, which passes in one direction for projection and in the opposite direction for rewinding.

ELECTRIC WASHER

A new washer of the revolving cylinder type has been developed by Altorfer Bros. Co., Peoria, Ill. This washer, known as the A. B. C. Super-Electric, is made of metal throughout with the exception of the wringer frame and the revolving cylinders.

The cylinder is built of 2-in. wood staves spaced a quarter of an inch apart and perforated with ½-in. holes, affording ample opening for the passage of water through the clothes. A lid which locks tightly when the washer is in operation, is provided in the cylinder for inserting the clothes and removing them from the rotating cylinder. The cylinder makes a complete revolution in one direction and then reverses.

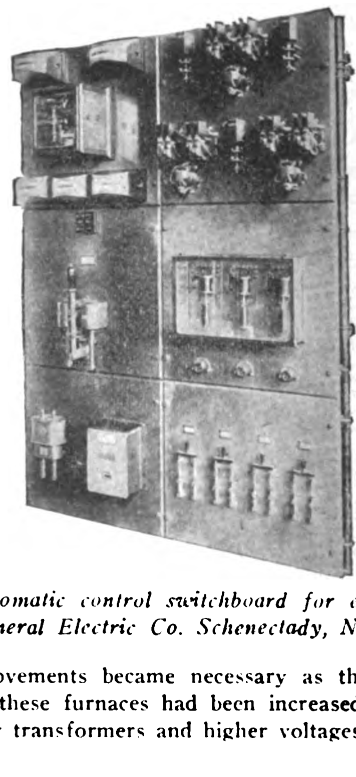


Washing machine made by Altorfer Brothers Co. Peoria, Ill. Driven by a Robbins & Myers motor.

The power is transmitted both to the wringer and washer by shaft drive. All gears are machine cut and run in oil. They are encased in metal shields. A ¼ hp. Robbins & Myers splash-proof motor is used to drive this machine.

ELECTRIC FURNACES GO TO HIGHER CAPACITIES

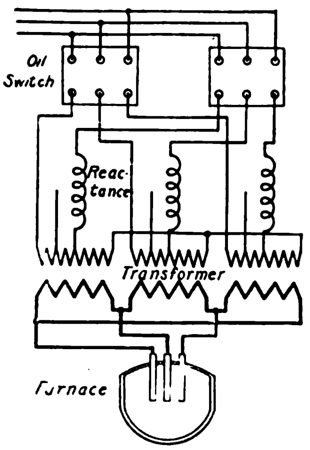
With the use during the past year of 20-ton electric furnaces, and indications of an advance to a standard maximum of 30 tons, the General Electric Company developed an improved system of automatic control to handle the motive power required to operate them.



Hand and automatic control switchboard for electric furnace. General Electric Co. Schenectady, N. Y.

These improvements became necessary as the rate of steel production in these furnaces had been increased by the use of higher capacity transformers and higher voltages, which permitted forcing power into the furnaces at considerably higher rates.

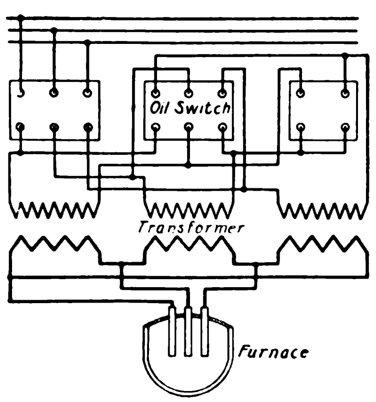
The control panel is made in three sections as shown in the annexed cut. The top section contains three shunt relays and three contactor groups; the total number of each being in accordance with the number of electrodes used. The middle section has three contact-making ammeters, each provided with dashpots to prevent hunting, and with coils provided with taps which are used to vary the amount of power supplied to the furnace Beneath are three small dial switches which are connected to the coil taps. On the lowest section there are four double-pole single throw knife blade switches with fuses, one switch being used for the line and the others for the electrode motors.



Connection diagram of furnace equipment. Variable voltage is obtained by means of high-voltage taps and external reactance is provided to be cut in during the melting period.

Each contactor group consists of three units all mechanically interlocked, two contactors being normally open and one being normally closed.

Facing the panel, the left-hand contactor of any group makes the necessary connections to raise the electrode, while the right-hand contactor causes the electrode to be lowered and the bottom contactor short circuits the motor armature through a resistance, in this way dynamically braking all moving parts and stopping them almost instantly. A higher resistance is connected in circuit with the armature when lowering than when raising, this being done to keep the speed approximately constant.



Connection diagram of three-phase furnace arranged for variable voltage operation by means of changing high-voltage connections. The high melting voltage is obtained by connecting high-voltage windings delta and the low refining voltage by connecting them "Y."

A shunt-wound electrode motor is connected to the line until the desired regulation is obtained, when the motor is disconnected and stopped almost instantaneously by means of dynamic braking, this method giving the simplest and most positive control of the electrode movement. The type of motor used was designed for this particular service, especially in regard to self-lubricating bearings, and ranges in size from 1 to 1½ hp. for small equipments, to 5 hp. for 15- to 20-ton furnaces.

Although 100-volt pressure remains standard for refining, voltages up to 173 have been used for melting, these voltages being obtained either by high voltage taps or high voltage star-delta. When it is considered desirable to use external reactance with high voltage taps, the method of using these reactances is shown in the cut.

The use of high voltages during melting down permits of decreasing the current for a given input, improves the power factor, and insures higher emergency input when most needed.

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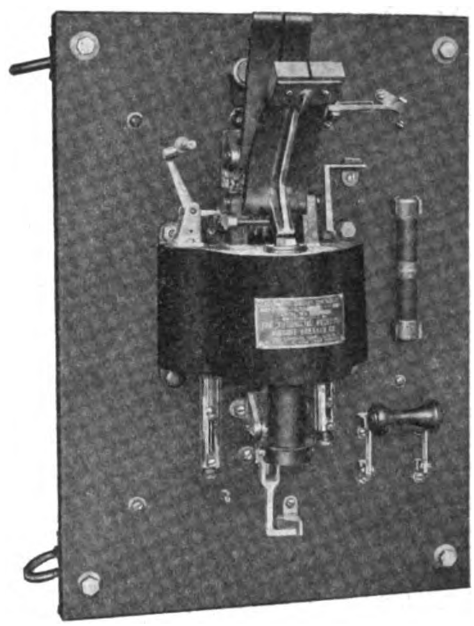
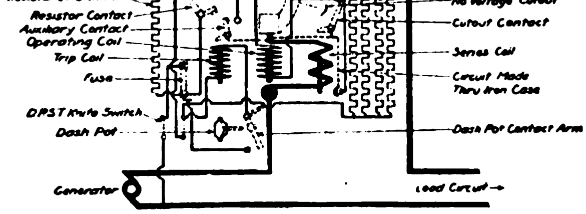
AUTOMATIC RECLOSING CIRCUIT BREAKER

The Automatic Reclosing Circuit Breaker Co., of Columbus, Ohio, has recently brought out an improved form of automatic reclosing circuit breaker known as Type CN. These breakers are provided with a low voltage lock-out arrangement so that when the breaker is opened either by an overload current or by voltage failure, the breaker cannot reclose until the trip coil has operated.



Type CN 400-ampere automatic reclosing circuit breaker. The Automatic Reclosing Circuit Breaker Co., Columbus, Ohio.

The trip coil can be adjusted so that it will not operate except when the voltage has been restored to 50 percent. or more of normal value and the load circuit by wires being together or by starting controllers being left in the running position.



Wiring diagram of type CN automatic reclosing circuit breaker.

The accompanying cut shows the wiring diagram of this breaker.

These breakers are designed especially for the protection of motor circuits in mines and industrial plants.

Breakers are built for 110, 250, and 600-volt direct current circuits.

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X-RAY PROJECTOR, NO. 60

This projector has been developed to meet the demand for a floodlighting unit that will keep insidious alien enemies from working havoc with factories by the aid of darkness. Arm your watchmen with light as well as with a gun, says the maker, the National X-Ray Reflector Co., of Chicago. Throw the equivalent of broad daylight on every valuable spot, adds the maker, and keep reduced the big fire loss of last year, a loss totalling 263 millions of dollars.

This floodlighting unit takes a 400-watt, G-40 mazda C lamp. It weighs only 20 lb., is convenient to handle, and easy to install.

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WHITE CROSS ELECTRIC LANTERN

Some of the uses to which this novel form of electric hand lantern may be put are shown in the accompanying illustration. It has a capacity of about 20 hours of continuous service, or

White Cross electric lantern. Lindstrom, Smith Co., Chicago, Ill.

40 hours of intermittent service. This is equivalent to about 10 minutes a day for 8 months on one battery.

It is made of metal, nickel plated, and measures 6 x 5½ in. over all. With battery, it weighs 24 oz. It is offered by the Lindstrom, Smith Co., Chicago, Ill.

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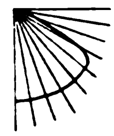
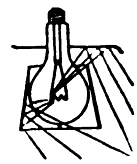
INDUSTROLITE

A recently developed industrial lighting unit is the Industrolite manufactured by the Luminous Unit Co., St. Louis. Each unit comprises two principal elements, both of which are formed from white porcelaain enameled sheet steel. The accompanying cut shows the relative arrangement of these two elements and also how light rays are redirected by them. The reflector is a pan-shaped stamping of relatively large diameter. The function of this reflector is to distribute the light rays which impinge on it from the incandescent lamp over a wide area. Thus the uniform, diffuse distribution of light which is so essential for successful industrial illumination is provided. The second element is the protector, which is a cone frustum. It also is formed from sheet steel. This protector cone is suspended, as detailed in the illustrations, by links, which also support the reflector unit from the sustaining socket above. The principal function of the protector cone is to protect the eyes of the worker from the direct glare of the dazzling tungsten filament. It has another and a very important purpose in that it redirects



Characteristic distribution of light.



Practically every ray of light is utilized.

Industrolite unit and charts showing rays redirected and diffused to prevent glare, also characteristic light distribution. Luminous Unit Co., St. Louis, Mo.

certain of the light rays which it intercepts. These are thrown to the area below the unit which is to be lighted. Thus all light rays above a 45 deg. angle line are intercepted by the cone.

One feature of the Industrolite unit which is worthy of notice is that it has no reflecting surface or projection which will collect dust readily. The occasional wiping with a damp cloth will restore to the reflecting surfaces their original luster and whiteness. Inasmuch as the bottom of the reflector cone is open, there is no obstacle preventing the dissemination of any dirt particles which might tend to collect inside of the cone or on the incandescent lamp bulb. The fact that the bottom of this cone is open also permits certain of the light rays to be projected vertically downward so as to illuminate objects directly under the unit. These unintercepted rays are in such directions that they would not, ordinarily, enter the eyes of the workers and produce harmful glare.

As shown, the protector cone provides a sort of a chimney which causes the cooling air currents as they rise around the lamp bulb to cool it. There is also an open air space between the reflector metal and the neck of the lamp where the neck passes through the reflector.

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FOUR-HEAT DISC STOVE

Landers, Frary & Clark, of New Britain, Conn., have recently brought out a new type of electric stove that operates on four heats. It is really two stoves in one, consisting of a 3-in. disc surrounded by a 6-in. ring. Both disc and ring have

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

heating units which can be operated independently or in conjunction with the other unit. Each unit has a wattage of 300, with a total wattage of 600. The terminals for controlling the wattage are numbered from one to four, as shown in the annexed illustration.

TELEGRAPHIC SIGNAL LAMP

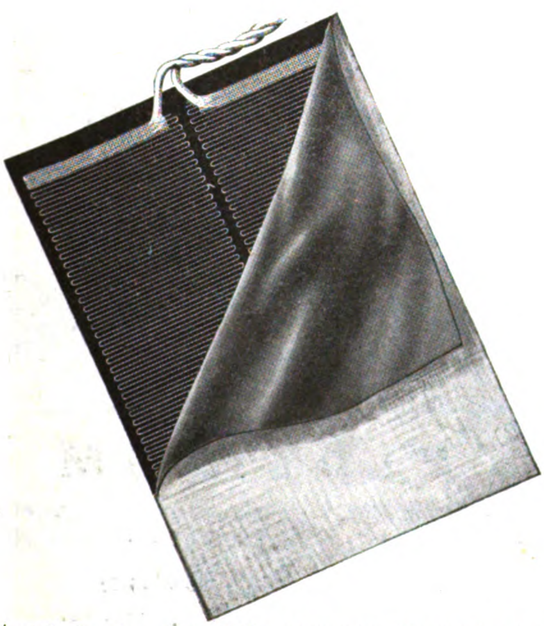
The demand for an electric signal lamp to be operated by an ordinary telegraph key has induced Frank W. Morse, 291 Congress Street Boston, to bring out the device shown in the accompanying illustration. It consists of a 7 x 10 in. brass

Electric signal lamp. Frank W. Morse, Boston, Mass.

anchor lamp with Fresnal lens and a Morse key with platinum points. The base of the lamp contains a condenser which is connected across the points of the key to prevent arcing and to shorten the lag between make and break.

WIRT ELECTRIC HEATING PAD

In this type of heating pad the heat producing element is enclosed between two sheets of rubberized fabric, permanently vulcanized together. The wire is laid in parallel strands 1/16 in.



Wirt electric heating pad. Wirt Company, Germantown, Philadelphia, Pa.

apart. This method of wiring, original with this manufacturer, insures a perfectly uniform heating surface.

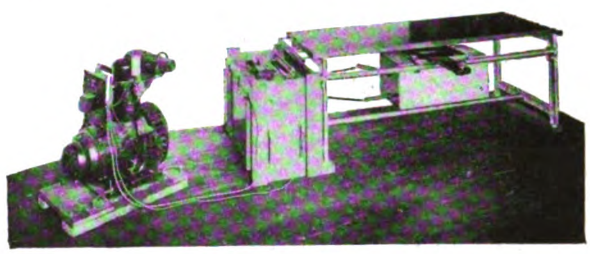
Many pads are equipped with a thermostat. A thermostat in this pad is unnecessary. Heat is generated by means of resistance. The wire used is such that as the heat increases the resistance increases, automatically reducing the watts consumed. Hence the wire in the Wirt pad is itself a perfect thermostat, which will always work, providing protection against excessive heat.

The rubberized fabric makes it impervious to moisture, the cause of most heating pad trouble, and eliminates the possibility of shock. No electric heating pad should be folded or rolled while in use, as this reduces the surface from which the heat can radiate, which may possibly result in overheating. It is made by the Wirt Co., Germantown, Philadelphia, Pa.

PORTABLE X-RAY SET FOR FIELD SERVICE

During 1917, the Research Laboratory of the General Electric Company made some experiments and developments in X-Ray apparatus of interest to the medical and surgical professions.

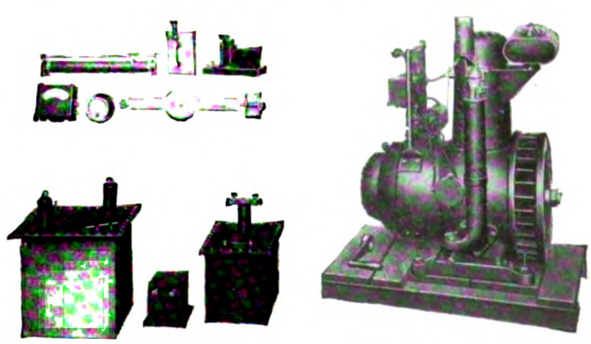
The concrete result of these efforts was a portable X-Ray outfit, in order that troops in active service at a distance from base hospitals might have the benefits of X-Ray examination promptly available.



Complete portable X-Ray field outfit. General Electric Co., Schenectady, N. Y.

This was accomplished by a process of elimination through a series of tests which resulted in the final assembly of the most suitable products of several manufacturers which are used in connection with the Coolidge tube. Particular care was taken to pick out those elements which were in actual production and available for immediate use.

The equipment consists of a single cylinder air cooled gasolene engine direct connected to a 1-kw. direct-current generator provided with slip rings, a main X-Ray transformer, a filament transformer for lighting the filament of the Coolidge tube, a voltmeter and milliammeter, the necessary controls and switches,



Details of General Electric portable X-Ray outfit.

and a special radiator type of Coolidge tube capable of rectifying its own current. Variation of X-Ray output is obtained by variations of engine speed. The carburator of the engine is controlled through a solenoid and the necessary changes in speed are effected by means of a simple resistance unit, located at the head of the operating table when the outfit is being used.

For radiographic work the set will deliver 10 milliamperes, at a voltage corresponding to a spark of 5 in. between points. For fluoroscopic work the current is reduced to 5 milliamperes, the voltage remaining the same.

Due to the rectification characteristics of the Coolidge tube, no separate rectifier is required. The entire equipment including the operation table can be rapidly assembled or disassembled for transportation, the complete set having a net weight of about 860 lb.

While sets for similar service have been developed in Europe, under the spur of urgent need, the equipment here referred to constitutes the first American portable X-Ray outfit of this capacity.

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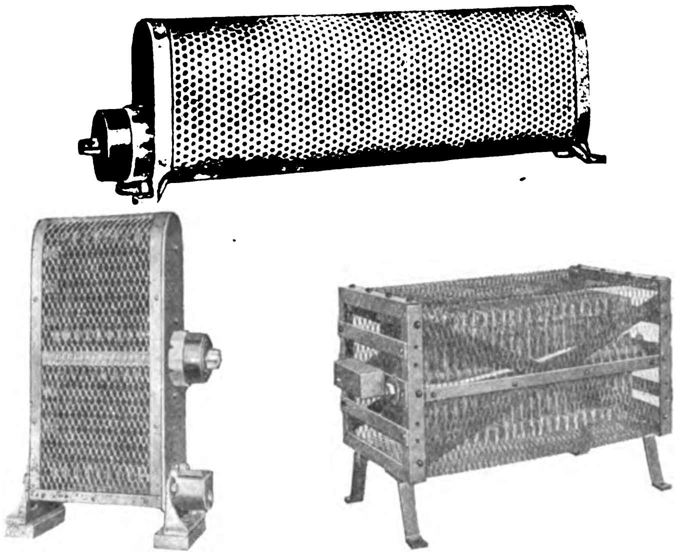
ELECTRIC AIR HEATERS

A new and improved line of electric air heaters is announced by the Cutler-Hammer Mfg. Co., of Milwaukee Wis. These heaters are self-contained, easily moved from one point to another, and possess the inherent advantages of all electrical heating devices. They form economical and efficient supplements to



Electric air heaters, Cutler-Hammer Mfg. Co., Milwaukee, Wis.

existing furnace or steam-heating systems. In central stations, large steel mills and other great industrial establishments maintaining large generating plants and delivering electrical energy at a cost of not in excess of 2 cents per kilowatt-hour, it has been found economical and convenient to use electric heaters entirely.

C-H heaters are made in various shapes, sizes and capacities and a heater to fit almost any space or condition of mounting may be selected. Several types are shown in the accompanying illustrations.

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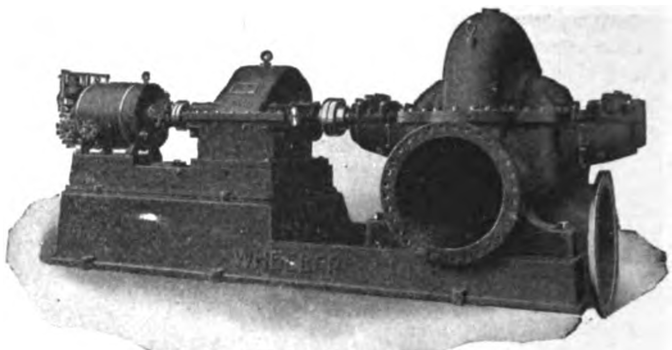
END SUCTION CENTRIFUGAL PUMP

Here is a new design of pump manufactured by the Wheeler Condenser & Engineering Co., Carteret, N. J., that is of special interest because of the unusual position of the suction opening. This opening, it will be noted, is directly beneath and parallel to the end bearing. In this position it is out of the way, yet it is in a convenient place for the erection men, for inspection, for upkeep.

This arrangement makes it possible to place a pumping unit in a room of small ground area considerably smaller than where the suction end is opposite the outlet end, as is the most common practice. In many cases this also facilitates the making



End suction centrifugal pump. Wheeler Condenser & Engineering Co., Carteret, N. J.

of pipe connections, sometimes saving elbows and reducing the length of piping more or less.

The capacity of the particular pump shown is 45,000 gal. per min. against a head of 20 ft. The diameter of the outlet pipe is 36 in. The speed of the pump is 240 rev. per min and is coupled by a 10 to 1 reduction gear to a steam turbine whose speed is 2400 rev. per min.

THE CLEARING HOUSE

Advertisements on this page 5 cents a word. No advertisement accepted for less than $1.00. Electrical Engineering reserves the right to open all letters addressed in its care und agrees to forward only answers that are germane to the product or subject advertised.

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Columbia Metal Box Co., N. Y. City.
Cutter Co., Geo., South Bend, Ind.
National Metal Molding Co., Pittsburgh, Pa.

BOXES, Cutout
Adam Electric Co., Frank, St. Louis.
Columbia Metal Box Co., N. Y. City.

BOXES, Fuse
General Electric Co., Schenectady, N. Y.

BOXES, Meter
Adam Electric Co., Frank, St. Louis.

BOXES, Outlet and Junction
Adam Electric Co., Frank, St. Louis.
Columbia Metal Box Co., N. Y. City.
National Metal Molding Co., Pittsburg.

BRUSHES, Motors and Generators
Calebaugh Self-Lubricating Carbon Co., Philadelphia, Pa.
Dixon Crucible Co., Joseph, Jersey City.
General Electric Co., Schenectady, N. Y.

BRUSHINGS
National Metal Molding Co., Pittsburgh, Pa.

BUS BAR SUPPORTS
Delta-Star Electric Co., Chicago, Ill.

CABINETS
Adam Electric Co., Frank, St. Louis.
Columbia Metal Box Co., N. Y. City.

CABLES, Aerial Power
" See Wires and Cables.

CABLE, Insulated
Okonite Co., The, New York City.
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Steel Taped
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Submarine and Lead Covered
General Electric Co., Schenectady, N. Y.
Hazard Mfg. Co., New York City.
Moore, Alfred F., Philadelphia, Pa.
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Rome Wire Co., Rome, N. Y.
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Telephone
" See Wires and Cables.

CABLE, Steel Armored
Okonite Co., The, New York City
Roebling's Sons Co., John A., Trenton, N. J.
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Underground
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Junction Boxes
Standard Underground Cable Co., Pittsburgh, Pa.

CARBONS, Brushes
Calebaugh Self-Lubricating Carbon Co., Philadelphia, Pa.
Dixon Crucible Co., Jos., Jersey City.
General Electric Co., Schenectady, N. Y.

CIRCUIT BREAKERS
General Electric Co., Schenectady, N. Y.
Palmer Electric & Mfg. Co., Boston, Mass.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CLEATS
National Metal Moulding Co., Pittsburgh, Pa.

COILS, Armature and Field
Chattanooga Armature Works, Chattanooga, Tenn.

COILS, Choke
Delta-Star Electric Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

COILS, Induction
Thordarson Elec. Mfg. Co., Chicago.
Western Electric Co., New York City.

COMMUTATORS
Chattanooga Armature Works, Chattanooga, Tenn.

COIL TAPING MACHINES
Chattanooga Armature Works, Chattanooga, Tenn.

COMPOUNDS, Boiler
Dixon Crucible Co., Joseph, Jersey City.

CONDENSERS
Allis-Chalmers Mfg. Co., Milwaukee.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CONDUCTORS, Armored
National Metal Molding Co., Pittsburgh.
Roebling's Sons Co., John A., Trenton.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT FITTINGS
Columbia Metal Box Co., N. Y. City.
National Metal Molding Co., Pittsburgh.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT, Flexible
American Circular Loom Co., New York City.
National Metal Molding Co., Pittsburgh.
Tubular Woven Fabric Co., Pawtucket.

CONDUIT, Interior
American Circular Loom Co., New York City.
American Conduit Mfg. Co., Pittsburgh.
National Metal Molding Co., Pittsburgh.
Tubular Woven Fabric Co., Pawtucket.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT, Rigid
American Circular Loom Co., New York City.
National Metal Molding Co., Pittsburgh.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT, Underground
Write to Ad. Editor.

Connectors and Terminals
Dossert & Co.

CONSTRUCTION Material
Southern Electric Co., Baltimore, Md.

CONTROLLERS
Allis-Chalmers Mfg. Co., Milwaukee.
General Electric Co., Schenectady N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

COOKING APPARATUS, Electrical
" See Heating Apparatus, Electrical

CORDS
Moore, Alfred F., Philadelphia, Pa.
Samson Cordage Works, Boston, Mass.
Standard Underground Cable Co., Pittsburgh, Pa.

CORD, Arc Lamp
Samson Cordage Works, Boston, Mass.

CORD, Flexible
General Electric Co., Schenectady N. Y.
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton
Samson Cordage Works, Boston, Mass
Southern Electric Co., Baltimore, Md.
Standard Underground Cable Co., Pittsburgh, Pa.

CORD, Telephone
Moore, Alfred F., Philadelphia, Pa.
Standard Underground Cable Co., Pittsburgh, Pa.

CORD, Trolley
Samson Cordage Works, Boston, Mass

CROSS-ARMS
Southern Exchange Co., The, New York City.
Western Electric Co., New York City.

CUT-OUTS
Brady Elec. & Mfg. Co., New Britain Conn.
Cutter Co., Geo., South Bend, Ind.
General Electric Co., Schenectady, N. Y.
Palmer Electric Mfg. Co., Boston.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

DYNAMOS AND MOTORS (Second Hand)
Chattanooga Armature Works, Chattanooga, Tenn.

ELECTRICAL REPAIRING
Chattanooga Armature Works, Chattanooga, Tenn.

ELECTRIC FIXTURES
Adam Electric Co., Frank, St. Louis.
Luminous Specialty Co., Indianapolis.
Southern Electric Co., Baltimore, Md.

ENGINES, Gas and Gasoline
Allis-Chalmers Mfg. Co., Milwaukee.
General Electric Co., Schenectady, N. Y.
Westinghouse Machine Co., E. Pittsburgh, Pa.

ENGINES, Steam
Allis-Chalmers Mfg. Co., Milwaukee.
Westinghouse Machine Co., E. Pittsburgh, Pa.

ENGINEERS, Consulting
Arnold Co., The, Chicago, Ill.
Byllesby, H. M. & Co., Chicago, Ill.
Cooper, Hugh L. & Co., N. Y. City.
Sanderson & Porter, N. Y. City.
Stone & Webster Boston, Mass.
White & Co., J. G., New York City.

ETCHING SOLUTION
Union Electric Co., Pittsburgh, Pa.

FANS, Exhaust
Robbins & Myers Co., Springfield, Ohio.
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

FAN MOTORS
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, Ohio
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

FIBRES
Continental Fibre Co., Newark, Dela.

FINANCIAL
Electric Bond & Share Co., N. Y. City

FIXTURES, Lighting
Adam Electric Co., Frank, St. Louis.
Luminous Specialty Co., Indianapolis.
Southern Electric Co., Baltimore, Md.

FRICTION Tape and Cloths
Okonite Co., The, New York City.

FROSTING SOLUTION
Union Electric Co., Pittsburgh, Pa.

FUSES, Electric
Delta-Star Electric Co., Chicago, Ill.
Economy Fuse & Mfg. Co., Chicago.
General Electric Co., Schenectady. N. Y.
Western Electric Co., New York City.

FUSES, Refillable
Economy Fuse & Mfg. Co., Chicago, Ill.

FUSE BOXES
" See Boxes—Fuse

GAS ENGINES
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

GENERATOR BRUSHES
" See Brushes—Motor and Generator

BUYERS CLASSIFIED INDEX (Continued)

GENERATORS and Motors
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, O.
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GLOBES, SHADES, Etc.
General Electric Co., Schenectady, N. Y.

GRAPHITE
Dixon Crucible Co., Jos., Jersey City

HAND LAMPS, Electric
Southern Electric Co., Baltimore, Md.

HANGERS, Cable
Standard Underground Cable Co., Pittsburgh, Pa.

HEATING Apparatus, Elec.
General Electric Co., Schenectady, N. Y.
Russell Electric Co., Chicago, Ill.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

HOISTS, Electric and Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

HYDRAULIC MACHINERY
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

INDICATORS
Duncan Electric Co., Lafayette, Ind.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

INSTRUMENT, Electrical
Duncan Elec. Mfg. Co., Lafayette, Ind.
General Electric Co., Schenectady, N. Y.
Norton Electrical Inst. Co., Manchester, Conn.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Inst. Co., Newark

INSULATORS
General Electric Co., Schenectady, N. Y.
Locke Insulator Co., Victor, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

INSULATING MATERIAL
Continental Fibre Co., Newark, Del.
General Electric Co., Schenectady, N. Y.
Moore, Alfred F., Philadelphia, Pa.
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

INSULATOR PINS
Southern Exchange Co., The, N. Y. C.

IRONS, Electrical
General Electric Co., Schenectady, N. Y.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMP CORD
Moore, Alfred F., Philadelphia, Pa.
Samson Cordage Works, Boston, Mass.
Standard Underground Cable Co., Pittsburgh, Pa.

LAMP GUARDS
McGill Mfg. Co., Valparaiso, Ind.

LAMPS, Carbon Arc
General Electric Co., Schenectady, N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Flaming Arc
General Electric Co., Schenectady N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Incandescent
General Electric Co., Schenectady N. Y.
National Lamp Works, Nela Park Cleveland, Ohio
Southern Electric Co., Baltimore, Md.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Westinghouse Lamp Co., N. Y. City

LAMPS, Miniature
General Electric Co., Schenectady N. Y.
Southern Electric Co., Baltimore, Md.

LANTERNS, Electric
Southern Electric Co., Baltimore, Md.

LIGHTNING ARRESTERS
Delta-Star Electric Co., Chicago, Ill.
General Electric Co., Schenectady N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LINE MATERIAL
General Electric Co., Schenectady N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LUBRICANTS
Calebaugh Self-Lubricating Carbon Co. Inc., Philadelphia, Pa.
Dixon Crucible Co., Jos., Jersey City.
Galena Signal Oil Co., Franklin, Pa.

MACHINERY GUARDS Perforated
Erdle Perforating Co., Rochester, N. Y.

MAGNET WIRE
American Steel & Wire Co., N. Y. C.
Moore, Alfred F., Philadelphia, Pa.
Roebling's Sons Co., John A., Trenton N. J.
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co. New York City

MECHANICAL STOKERS
Westinghouse Machine Co., E. Pittsburgh, Pa.

MERCURY RECTIFIERS
Cooper-Hewitt Electric Co., Hoboken N. J.

METAL, Perforated
Erdle Perforating Co., Rochester, N. Y.

METAL PUNCHING
Erdle Perforating Co., Rochester, N. Y.

METALS
American Platinum Works, Newark

METERS
Duncan Electric Mfg. Co., Lafayette Ind.
General Electric Co., Schenectady, N. Y.
Norton Elec. Inst. Co., Manchester, Conn.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

MINING MACHINERY
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.

MOLDING, Metal
National Metal Molding Co., Pittsburgh, Pa.

MOTORS
" See Generators and Motors

OILS
" See Lubricants.

OILS, Illuminating
Galena Signal Oil Co., Franklin, Pa.

OZONIZERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

PAINTS, Insulating
General Electric Co., Schenectady, N. Y.
McGill Mfg. Co., Valparaiso, Ind.
Standard Underground Cable Co., Pittsburgh, Pa.

PANELBOARDS
Adam Electric Co., Frank, St. Louis
Columbia Metal Box Co., N. Y. City
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

PERFORATED METALS
Erdle Perforating Co., Rochester, N. Y.

PHOTOMETER Standards
Electrical Testing Laboratories, New York City

PINS, Iron
Southern Exchange Co., The, N. Y. C.

PLATINUM
American Platinum Works, Newark.
Baker & Co., Newark, N. J.

PLUGS, Flush & Receptacles
Adam Electric Co., Frank, St. Louis
Benjamin Elec. Mfg. Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

POLES, Ornamental Street
Trady Elec. & Mfg. Co., New Britain, Conn.

POLES, Brackets, Pins, Etc.
Brady Elec. & Mfg. Co., New Britain. Conn.
Southern Exchange Co., The, N. Y. C.
Western Electric Co., New York City

POT-HEADS
Brady Elec. & Mfg. Co., New Britain. Conn.
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.

PRODUCERS, Gas
Westinghouse Machine Co., E. Pittsburgh, Pa.

PUMPS
Allis-Chalmers Mfg. Co., Milwaukee. Wis.

RAIL BONDS
American Steel & Wire Co., N. Y. C.
General Electric Co., Schenectady. N. Y.
Roebling's Sons Co., John A., Trenton. N. J.

RECEPTACLES
" See Sockets

RECTIFIERS
General Electric Co., Schenectady. N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

REELS
Minneapolis Elec. & Cons. Co., Minneapolis, Minn.

REFLECTORS
Erdle Perforating Co., Rochester, N. Y.
General Electric Co., Schenectady. N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

RESISTANCE RODS
Dixon Crucible Co., Jos., Jersey City

RESISTANCE UNITS
Dixon Crucible Co., Jos., Jersey City
General Electric Co., Schenectady, N. Y.

RESISTANCE WIRE
" See Wires

RHEOSTATS
Erdle Perforating Co., Rochester, N. Y.
General Electric Co., Schenectady. N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

ROSETTES
National Metal Molding Co., Pittsburgh, Pa.

SCREENS AND SIEVES, Perforated
Erdle Perforating Co., Rochester, N. Y.

SEARCHLIGHTS
General Electric Co., Schenectady. N. Y.
Western Electric Co., New York City

SEWING Machine Motors
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.
Wisconsin Elec. Co., Milwaukee, Wis.

SOCKETS and Receptacles
General Electric Co., Schenectady. N. Y.
National Metal Molding Co., Pittsburgh, Pa.

SOCKETS, Turndown
General Electric Co., Schenectady. N. Y.

SOLDERING IRONS
General Electric Co., Schenectady. N. Y.
Pittsburgh Elec. Specialties Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SOLDERING MATERIAL
Alex. R. Benson Co., Hudson, N. Y.

SOLENOIDS
General Electric Co., Schenectady. N. Y.

STAGE Lighting Apparatus
General Electric Co., Schenectady. N. Y.

STAPLES, Insulating
American Steel & Wire Co., N. Y. C.

STARTERS & CONTROLLERS, Motor
General Electric Co., Schenectady. N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

STOCKS AND BONDS
Electric Bond & Share Co., N. Y. City

STOVES, Electric
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STRAINERS, Perforated
Erdle Perforating Co., Rochester, N. Y.

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SUBSTATIONS, Outdoor
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SUPPLIES, Electrical
Delta-Star Electric Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

SUPPLIES, Telephone
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City

SURFACING, Steel and Tin
Erdle Perforating Co., Rochester, N. Y.

SWITCHBOARD Supplies
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SWITCHBOARDS, Light and Power
Adam Electric Co., Frank, St. Louis
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Enclosed
Palmer Electric & Mfg. Co., Boston, Mass.

SWITCHBOARDS, 'Phone
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SWITCHES, Flush and Snap
National Metal Molding Co., Pittsburgh, Pa.
Southern Elec. Co., Baltimore, Md.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Fuse
General Electric Co., Schenectady, N. Y.
Palmer Electric & Mfg. Co., Boston, Mass.

SWITCHES, Knife
Adam Electric Co., Frank, St. Louis
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Oil
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Pole Top
Delta-Star Elec. Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.

SWITCHES, Remote Control
General Electric Co., Schenectady, N. Y.
Palmer Electric & Mfg. Co., Boston, Mass.

TAPE
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.

TELEPHONE Equipment
Western Electric Co., New York City

TERMINALS, Cable
Dossert & Co., New York City
Standard Underground Cable Co., Pittsburgh, Pa.

TESTING, Electrical
Electrical Testing Laboratories, New York City

THEATER DIMMERS
General Electric Co., Schenectady N. Y.

TOOLS, Linemen's
Western Electric Co., New York City

TRANSFORMERS
Allis-Chalmers Mfg. Co., Milwaukee Wis.
Duncan Elec. Mfg. Co., Lafayette, Ind
Enterprise Electric Co., Warren, O.
General Electric Co., Schenectady N. Y.
Kuhlman Electric Co., Bay City, Mich
Moloney Electric Co., St. Louis, Mo.
Packard Electric Co., Warren, O.
Pittsburgh Transformer Co., Pittsburg
Thordarson Elec. Mfg. Co., Chicago
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J

TRANSFORMERS, Bell Ringing
Southern Electric Co., Baltimore, Md
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

TURBINES, Steam
Allis-Chalmers Mfg. Co., Milwaukee Wis.
General Electric Co., Schenectady N. Y.
Leffel & Co., James, Springfield, O.
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

VACUUM CLEANERS
Western Electric Co., New York City

VENTILATORS
Erdle Perforating Co., Rochester, N. Y

WASHING MACHINES Electric
Western Electric Co., New York City

WASHERS, Iron, Steel and Mica
Erdle Perforating Co., Rochester, N. Y

WATER Wheels and Turbines
Allis-Chalmers Mfg. Co., Milwaukee Wis.
Leffel & Co., James, Springfield, O

WATTMETERS
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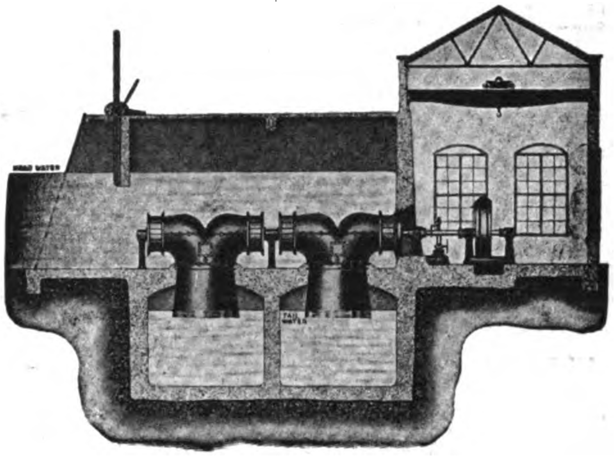
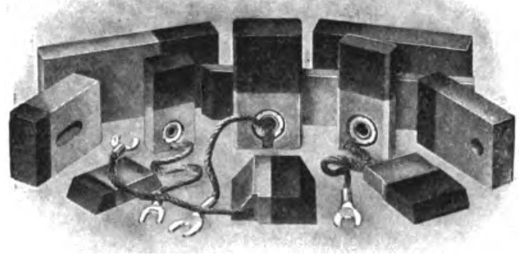
WIRES AND CABLES
American Platinum Works, Newark
American Steel & Wire Co., N. Y. C
Detroit Insulated Wire Co., Detroit
General Electric Co., Schenectady N. Y.
Lowell Ins. Wire Co., Lowell, Mass
Moore, Alfred F. Philadelphia, Pa.
Okonite Co., The, New York City
Roebling's Sons Co., John A., Trenton N. J.
Phillips Insulated Wire Co., Pawtucket, R. I.
Rome Wire Co., Rome, N. Y.
Southern Electric Co., Baltimore, Md
Simplex Wire & Cable Co., Boston
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co., New York City





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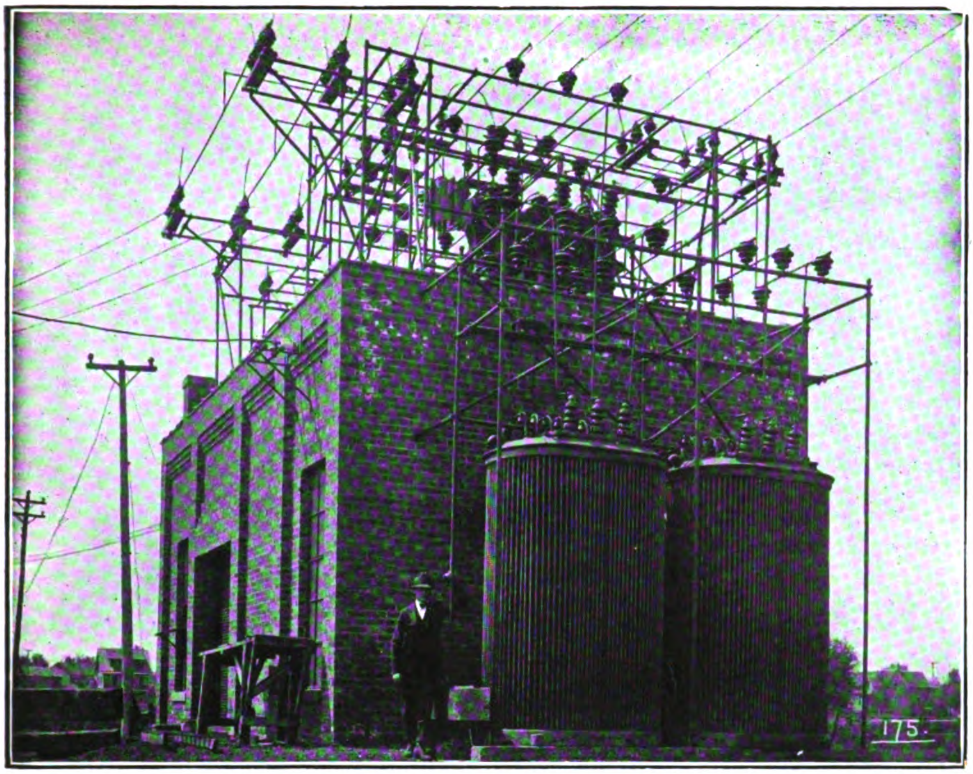

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Features in This Issue

VGH
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ELECTRICITY AND THE SHIP—Insulation of Wires. Methods of Distribution. Generating Sets. Switchboards. Lighting Fixtures and Appliances.

SAVING FUEL IN HOUSE HEATING—Five Ways of Preventing Waste of Fuel in Domestic Heating Apparatus, by an Expert in the Government Service.

WINDING ELECTRICAL MACHINERY—This Article Tells How to Rearrange the Windings of an Alternating-Current Generator or Motor to Correspond to Change of Electrical Pressure.

AERIAL LINE CONSTRUCTION—An Article for Engineers Who Are Confronted with the Problem of Installing Transmission Circuits where Local Conditions Prevent Open Wire or Conduit Construction.

ELECTRIC WELDING IN SHIPBUILDING—A Timely Story on the Substitution of Electric Welding for Mechanical Riveting in Modern Shipyard Practice.

Electrical Engineering

Incorporating Electrical Age and Southern Electrician
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CHAS. B. THOMPSON, President
GEO. A. WARDLAW, Editor

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In This Issue:

Other Items of Interest:

MEMBER ABC

SUBSCRIPTION PRICE—United States and Possessions, Mexico and Cuba, $2.00 a year. Canada, $2.50 a year. Foreign Countries in Postal Union, $3.00.

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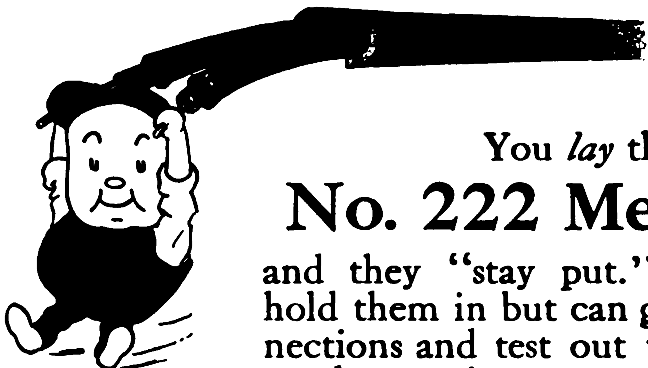

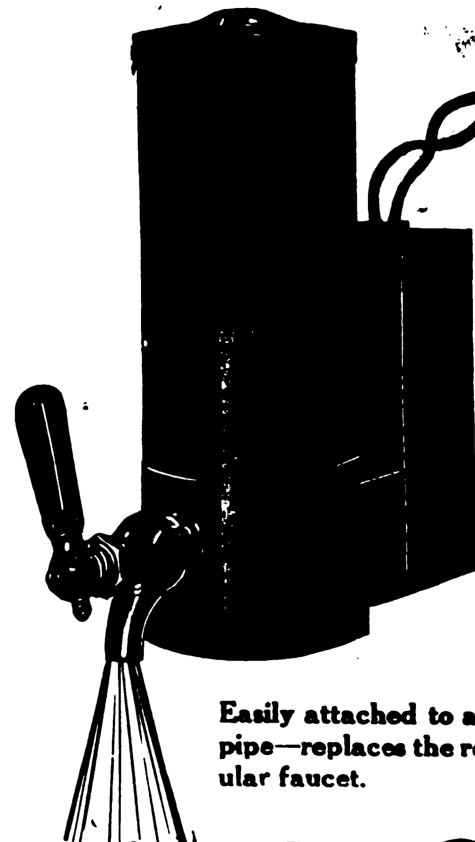

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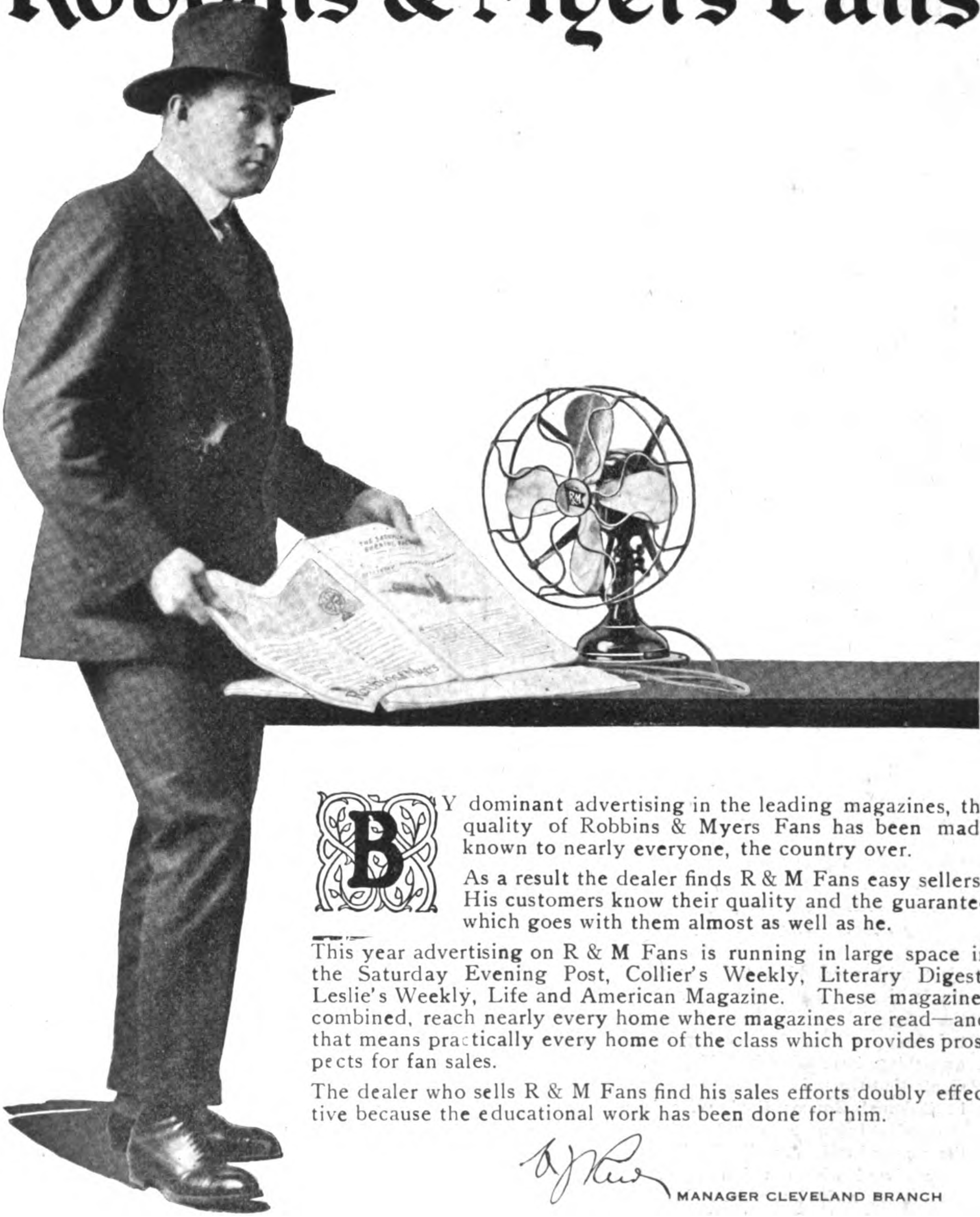


By dominant advertising in the leading magazines, the quality of Robbins & Myers Fans has been made known to nearly everyone, the country over.

As a result the dealer finds R & M Fans easy sellers. His customers know their quality and the guarantee which goes with them almost as well as he.

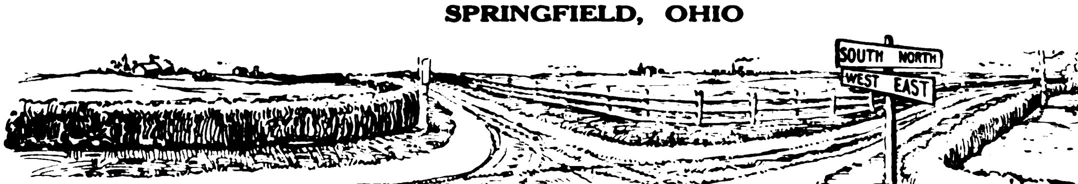
This year advertising on R & M Fans is running in large space in the Saturday Evening Post, Collier's Weekly, Literary Digest, Leslie's Weekly, Life and American Magazine. These magazines combined, reach nearly every home where magazines are read—and that means practically every home of the class which provides prospects for fan sales.

The dealer who sells R & M Fans find his sales efforts doubly effective because the educational work has been done for him.

MANAGER CLEVELAND BRANCH

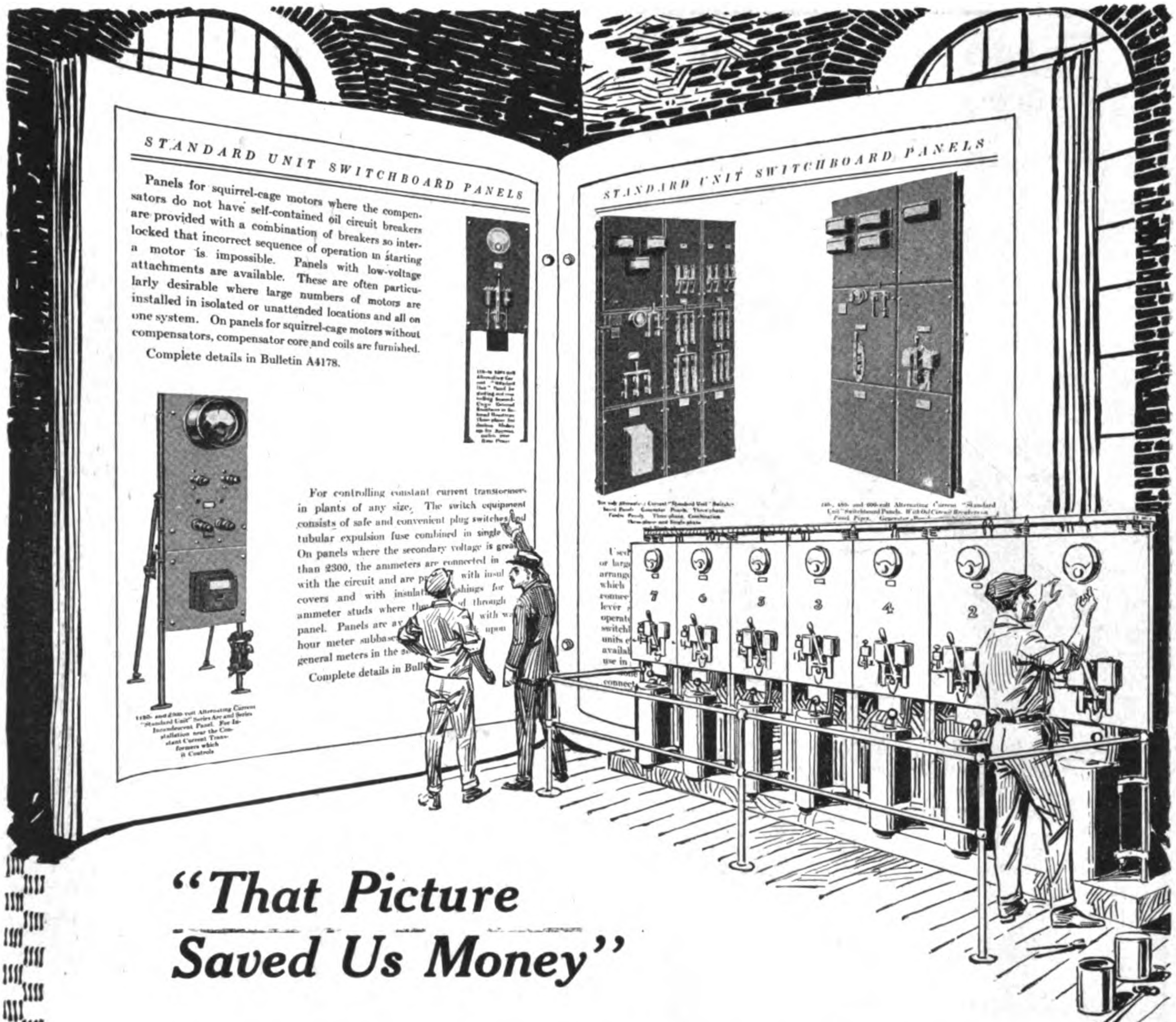
THE ROBBINS & MYERS COMPANY

SPRINGFIELD, OHIO



NATIONAL ADVERTISING


Let's Get Together!
We invite your co-operation, criticisms and Suggestions
We want to give you the best transformer that can possibly be produced for your service. The man in the field is in a position to see opportunity for changes and improvements that it is impossible for the man in the factory to see, unless by accident.
While we believe the records of our transformers in service will testify to the thoroughly practical efficiency of our transformers we know that we can't "know it all." And if you have in mind a real idea for an improvement on any type of KUHLMAN Transformer we'll be only too thankful for the suggestion.
Let's get together for the mutual betterment of KUHLMAN Transformer service. Let us hear from you.
Kuhlman Electric Company
Bay City, Mich.
New York Office, 114 Liberty St.
BRANCH OFFICES:
Toledo, Ohio 27-32 St. Clair St.
Buffalo, N. Y. 280 Carolina St.
Minneapolis, Minn. 21 N. Sixth St.
Charlotte, N. C. Commercial Bldg.
KUHLMAN TRANSFORMERS



"That Picture Saved Us Money"

"The growth of our power plant has been typical of thousands of other industrial plants. A recent expansion called for several induction motor panels to be installed as quickly as possible. Having heard of the G-E STANDARD UNIT PANEL idea, I sent for a copy of the bulletin. On looking it over, I found *that* picture showing the exact type of panel we required.

"The rest was easy. Being standardized there was no long wait for designing and manufacturing, and our switchboard will be in operation on time."

* * * * * *

STANDARD UNIT PANELS invariably save time, trouble and money. Index Bulletin 47001 explains the idea.

General Electric Company
General Offices: SCHNECTADY, N. Y.
Sales Offices in All Large Cities

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. 51 **MAY, 1918** **No. 5**

ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

By H. A. Hornor

(*Continued from page 23, April issue*)

Insulation of Wires

The specific purity of the copper conductor is no longer of great importance, as in general the manufacturer has settled down to the use of grades of copper which result in high conductivity. The same remarks are applicable in general to the rubber insulation, which is specially specified by the Underwriters. Practice in this case usually exceeds the requirements, as the owner is privileged to choose his design of conductor if it surpasses the requirements. On the basis of a saving in space by reduction of the outside diameter of the conductor, the opinion has been expressed that it might be preferable, and in the end a saving, to reduce the amount of insulation and make it of better material; that is to say, a higher percentage of pure rubber but a thinner wall.

The low potential here considered, and the chances of exposure to salt air and salt water, have resulted in the exclusive use of rubber as the correct material for insulating purposes. Except in the case of lead-covered conductors and for high potential circuits for electric propulsion, the use of cambric insulation has not been considered for marine applications. The quality of the insulation should be carefully specified by the owner, and should be of a good grade even if the first cost should be higher. The result will be a very much lower upkeep cost which is the most important consideration.

Methods of Distribution

The single-wire system using the steel hull as the return circuit was never admitted into American practice. Such systems were general for a long period in England, and certain installations were made on vessels built in this country as counterparts of vessels built in England. The classification societies of all countries will not permit the single-wire system on vessels carrying petroleum. Following land practice, the accepted direct-current distribution practice is a two-wire metallic system. It would be superfluous to discuss in detail the advantages or disadvantages of these two systems. The two-wire distribution would seem to be more expensive, as double the amount of copper is necessary, and the single-wire system is equivalent to halving the insulation. The cost of wire with double the insulation equalizes the cost of the conductor for either system. The labor for the single-wire system is probably increased due to the innumerable connections, or grounds made to the hull and the necessity of careful workmanship and inspection.

Several years ago an enthusiastic advocate of the single wire system frankly wrote:

"If on the other hand the wiring be on the single plan the risk of leakage is greatly increased, even if we furnish it with double the insulation usually applied to double wiring. When there is a ship return it is clear that a leak from the lead to the iron of the vessel may occur by the mere chance of water finding its way through the insulating material at any point. There is, in fact, a closely adjacent earth during the whole course of the leading wire. This fact demands that good work shall be put into the wiring at the outset, and that a *close watch be kept upon the insulation resistance thereafter.*"

It is this latter weakness that has brought a general adoption of the two-wire system of distribution. In the case of the wooden vessel, as there is no ground, the single-wire system is not adaptable.

As on land, the idea is always a centralization of control and fusing, so that it is usual to find distribution panels largely used. The branches from these panels, usually of 14 B & S wire pass through the fixture base block or water-tight box, where the taps are made. This is called "stringing lights." Where the ship structure or machinery intereferes with this method, mains are taken directly from the feeder, and as a change in wire size is necessary special fuse boxes are provided. Opinions differ as to the methods of making connections, or taps. Some electricians maintain that mechanical connection blocks should be used at all breaks in the wiring. On the other hand there are those who believe that the working of the vessel is liable to draw such mechanical connections apart, affording opportunity for open circuits, grounds, and short circuits. The latter electricians maintain that nothing is superior to a good twisted joint in the copper wire, well soldered, taped, and painted with insulating varnish.

Other methods of distribution are at the present time special. Many of the early vessels had most curious systems, which were fads at the time. The standard use of direct current has established the methods here described, but the introduction of alternating current on shipboard will doubtless change the methods of distribution to suit the new application.

Under a subsequent caption, "Motor Auxiliaries," it will be seen that alternating-current motors are soon to be introduced on a large scale to replace steam motors on oil tankers and general cargo vessels. As the practice will in general follow land practice three-phase, 60-cycle, three-wire, alternating current distribution will no doubt be selected. This will lead to the adoption of three-conductor cables so as to avoid inductance, and for the lighting system may result in a different method of distribution for the balancing of the lighting load. As this is an innovation, the old constructions will remain until changes that are desirable are found warrantable by experience at sea.

Generating Sets

Freight vessels of the largest size rarely require more than two generating sets of 20 kw. capacity. On very large passenger vessels the generating sets are increased in size. The general opinion is in favor of a number of units of moderate capacity rather than a few units of large capacity. The manufacturers' standard sizes very frequently settle this question. The small sets used on cargo vessels are a combination of a vertical reciprocating engine direct-connected to a compound-wound direct current generator, both mounted on a common bed-plate. Upon the development of the small steam turbine, a set similar in all respects but using a direct-connected turbine was introduced and well tried out in service.

The rotative speed of these sets was very high, ranging from 3000 to 5000 rev. per min. They were not found serviceable. There was then developed a small set with reduction gear between the turbine and the generator, but apparently the experience of owners with the direct-connected turbine sets has made them cautious in accepting the substitute, even for trial. The question of unit efficiency, that is the steam consumption of the generating set, does not carry great weight because the practice is to arrange these sets for both condensing and non-condensing operation. By so doing the exhaust may be carried to the boiler feed water heater, the main or auxiliary condenser, or to the atmosphere. As the boiler feed water heater gives a large practical gain in fuel economy the general practice is to discharge the exhaust from the generating sets into the feed water heater. The other methods are for emergency conditions and to provide flexibility.

There are two mechanical features which need careful consideration in the installation of generating sets. The first refers to foundations or the proper mounting of the set. Some experts hold the opinion that it is entirely satisfactory to bolt the sets directly to the steel deck; others claim that the sets should be mounted on a wooden base to provide a cushion. If the steel decking is of very light plating at the location selected for the sets, without much support underneath, certainly harmful vibrations will be set up. In such a case the steel deck, or platform, should be stiffened. Cautious practitioners go to the extreme in some cases of omitting the bolting down of the generating sets until after the vessel has been loaded and unloaded, basing their opinion on the point that a new structure needs to settle, and after it has settled is the appropiate time to make any attachments. In this same connection marine practice requires that flange connections must be used on the steam piping to the generating sets in order to reduce the number of joints and on account of the vibrations set up in the vessel by the main propelling engines.

As to the design of generator, electrical manufacturers have now gained sufficient experience so that they provide a machine arranged in such manner that oil cannot creep along the armature shaft, thus affecting the windings. Their apparatus is also provided throughout with non-corrosive parts. The shipbuilder usually mounts a hand rail or furnishes a sheet iron protective guard over the commutating end so that the pitching and tossing of the vessel will not throw the attendant against this delicate part of the apparatus.

The shunt and series windings are usually so proportioned that "flat compounding" is the result. "Flat compounding" is the automatic regulation of voltage so that the same voltage is obtained at no load and full load. The standard marine sets on the market today operate quite noiselessly, without much vibration and with very good regulation. The engines are arranged with both gravity feed and forced lubrication, which added safety factor gives them a reliability in the service which older designs did not possess.

The requirements of the Government are now causing an increased use of the storage battery on passenger vessels for an auxiliary lighting system and for emergency supply to the wireless equipment. The lighting circuits are those which illuminate the passageways, companionways, and especially dark exits in case of danger. Although the law permits the use of gasoline engine generators for this purpose, such sets have not been introduced to any extent, but the storage battery has entered this field and seems to be successfully retaining its reputaion. The carrying of gasoline or any volatile oil does not appeal to the cautious shipper. It would hardly awaken the sympathy of the average passenger though its functions were the anomalous one of saving life at sea. Eating breakfast on the crater of an active volcano is one thing, and intentionally sleeping on top of a gasoline tank is another.

Switchboards

In general design and as far as concerns the details of the individual devices installed, switchboards for merchant ships are similar to those used for land purposes. The use of non-corrosive parts for securing the apparatus to the board is essential because the salt air permeates the vessel and cannot be excluded by any of the methods successfully employed for preventing the entrance of salt water. As the switchboard is usually located in the machinery space, marine practice requires that it be designed as compactly as possible. It frequently happens that the board must be placed very near a bulkhead, and therefore the design must not fix the bus-bars in such manner that this cannot be done. Portions of apparatus, such as circuit breakers, pilot lamp brackets, or instruments, must not extend beyond the top line of the board as the distance between decks is often reduced to mere head room (6ft. 2in.), and the deck beams may also reduce the clear height.

If circuit breakers are placed at the top of the board and the distance to deck or deck beam is very small, it will affect very materially the installation cost in two ways: first, the deck or beam will require insulation to protect it from the arc when the circuit breaker opens under the load; second, the feeders from the switchboard will have to be run so as not to pass over the switchboard, thus increasing the amount of copper and introducing otherwise unnecessary bends. The connections from the generating sets may be taken overhead to the switchboard or run below if the generators are mounted on a platform underneath which the space is clear. If the plant consists of two or more generators they may be connected in two ways; namely, either separately or in parallel.

Owners differ in their practice. It would seem rational where the plant is to be operated by an oiler that the simple system of separate connections with a double set of bus-bars and double throw switches would be more advantageous, as no harmful mistakes could occur. In the parallel operation it is possible that the equalizing switch may be forgotten at the wrong moment, or at the right, in both of which situations trouble may result. For small installations the main generator connections are made through fused lever knife switches; but when the generating sets have a capacity of 20kw. or over, it is recommended that double arm circuit breakers be substituted.

Each side of all feeder circuits are protected by enclosed cartridge fuses preferably located on the face of the board.

The refillable fuse of proper design is now being introduced, but with the improved installation of lead-covered, steel-armored conductors the blowing of fuses should be reduced to a point where such performances means immediate correction of the trouble on the circuit involved. To make this clearer, when a fuse blows another fuse should not be put in its place before the cause of the blowing of the original fuse was discovered and corrected. This is a fundamental fire precaution because the temptation is to fuse more heavily at each blowing, with the result that in time the ground, or short circuit which caused the trouble, burns out.

Lighting Fixtures and Appliances

In those spaces of the vessel subjected to danger from mechanical injury, or in exposed locations, a guarded steam-tight fixture is selected. The owner originally specifies the catalogue number of some well-known manufacturer or describes the type customarily used in the merchant service. These fixtures are in general made of brass, although the practice of marine electricians leans towards the use of iron. It is also thought that owners of vessels are too liberal in their insistence upon the guard. That is to say, the guarded steam-tight fixture is installed in many places where the guard serves no useful purpose or where the fixture is not actually exposed to mechanical injury. This is very true. Frequently the fixture is located to one side of a compartment or directly over a table or between the beams.

On coastwise vessels carrying packet freight in between decks the cargo holds are lighted by permanent fixtures. These fixtures are located between beams or stiffeners and protected by narrow strips of steel laid across the beams. In the ocean freighter the cargo holds are lighted by portable clusters. Receptacles for plugging in the portable fixtures are located just under the cargo hatches. Usually these clusters are fitted with four moderate sized lamps, either 25 or 40 watts, but the same lamp socket permits the use of 60 watt lamps if desired. These clusters may be fitted with a high wattage lamp, either 250 or 500 watts and then used for general illumination in the engine hatch or for gangway lighting.

The illustrations show clearly the different types of steam-tight fixtures which are arranged to meet the varying conditions of installation. For overhauling machinery and other purposes hand portable lamps with a single lamp are provided. The development of design has gradually reduced the weight even to the extent of omitting the glass globe. The owner's engineer, if at all clever, could soon instruct a man to make what would be a more serviceable hand portable by simply purchasing a weather-proof molded lamp socket obtainable at any retail electrical supply store for 35 or 40 cents and a galvanized lamp guard costing probably less. By combining these two parts and attaching a twin conductor portable wire, a device is obtained for very much less money and in many respects more reliable. The molded socket may be thrown on the steel deck or hit a good blow with the hammer without undue injury.

The steam-tight fixture is not necessary or sufficiently aesthetic for the living portions of even an ordinary cargo steamer. In this country it is gratifying to state that money and care has always been given to the fitting up of the quarters for the crew. These spaces are the homes of men, and housing conditions at least are as important on sea as on land. The fixtures usually selected are such as can be conveniently mounted on wooden blocks, the metal is light in weight, and fashioned into some simple but ornamental form. The fixture as a rule takes the shape of the porcelain base forming the lamp socket; a bracket is carried for holding the glass globe or shade, and when assembled makes a very adaptable direct lighting unit.

Here is compactness which is requisite on account of the low ceilings. The majority of the fixtures are of the overhead ceiling type, although side bracket fixtures are occasionally installed. Each fixture is fitted with a 25-watt tungsten incandescent lamp either completely frosted or frosted around the tip. In passenger vessels the custom has been to locate one central lighting unit in each stateroom controlled by a switch at the door. As the ordinary cabins are all painted white this one direct unit is quite sufficient for illuminating purposes. In special suites where the decorations are more elaborate, the lighting fixtures take on a corresponding artistic dressing and are increased in number so as to provide lights over the bunk for reading at night, over the shaving mirror, and before the dresser or cheval-glass. All of these metal fixtures are carefully finished and lacquered so as to preserve them from the effects of salt air, but the experience of some vessel owners has been adverse to the use of metal fixtures due to the necessity of taking them down every few years for refinishing.

(To be continued)

WELDING SHIPS ELECTRICALLY

Arthur J. Mason has been authorized to test out on a large scale electric welding as applied to shipbuilding. This work will take the form of constructing part of a hull at the Federal Shipbuilding plant at Newark, N. J. The material will be assembled and tacked together by a process of spot welding, and finished and rendered watertight by various forms of arc welding. Suitable foundations are being prepared to allow of severe tests by pressure, as well as every agency to develop the merits of the system.

Keep mum on every subject of shipbuilding that might be of benefit to the enemy. The Kaiser's agents are not asleep and if you start a discussion in a street car or on the corner about shop work, you might let something slip that would be mighty interesting to Berlin. When you think of something to say that might be a little risky, just don't say it.

BELOW THE WATERLINE

Did ever ye serve in the warship's hold,
Deep under the waterline,
With hatches locked and the blowers on,
Close up to a hidden mine—

Bare to the waist and dripping wet,
A 'grimed and gasping crew,
To shovel coal and feed the fire
Until the sea fight's through—

Where check valves sigh with the hissing steam
And the greedy grates cry "more!"
Like galley slaves in the olden time,
Chained to the bench and oar?

No cherubs sit in the bunker's dust
To watch o'er us below,
While overhead the turrets clank
As they turn to find the foe.

The guardian angels keep aloft—
None here where the turbine moans;
There's nothing ahead, if things go wrong,
But tickets to Davy Jones.

Forget yourself, forget the world,
Forget the sun and sky!
In the boiler room you face your doom;
You're there to do and die!

Don C. Seitz in *Scribner's Magazine.*

FIVE WAYS OF SAVING FUEL IN HEATING HOUSES

By Henry Kreisinger

In last month's issue we published an article on fuel saving in household heating compiled by the assistant superintendent of the generating department of one of the big central stations. The matter of fuel conservation is so vital to all the central stations which require coal for fuel, and to all who depend upon these stations for light, heat, and power, that it becomes every householder—there are twenty-five million of them —to save all the coal he can. Five ways of saving it are shown in the accompanying article, published by courtesy of the Bureau of Mines of the Department of the Interior.

Introduction

This country faces a shortage of coal, and it is the patriotic duty of every citizen to save coal in heating his home. About 25,000,000 homes in this country are to be heated through the winter. If everybody does his bit, a ton of coal at each home can be saved easily during the winter. For the entire country this saving would amount to 20,000,000 tons of coal, which is nearly as much as all the coal mined in France during the present year. Five ways in which coal can be saved are as follows:

1. Of the coals available in your market select the one that requires the least attention in burning.
2. Use an economical method of burning your coal.
3. Keep your house temperature 62 deg. to 65 deg. F. instead of 72 deg. to 75 deg. F.
4. Heat a few rooms as the comfort of your family will permit.
5. Shorten the heating season as much as possible.

Selection of Coals

In house-heating equipment the fires can be given very little attention, therefore fuels that require little attention in burning are the most economical and give the best satisfaction. In time of war less desirable coal may have to be used, in order to simplify transportation problems, but the fact remains that some coals are more efficient than others when the same attention is given the fire. Usually the man of the house can attend to the furnace early in the morning and again in the evening. During the day the furnace is left in the care of the wife or the servant. The wife has her children, the preparation of meals, and other cares to take up her time, so that she can not give the furnace much attention. In some houses the furnace is attended only when the house becomes either too hot or too cold, and thus the fire is allowed to run from one extreme to the other, conditions which are very unfavorable to saving of fuel. About the same attendance can be expected from a servant.

Therefore, in order that a fuel may be burned economically in a house-heating furnace, the fuel should be of such kind that the fire requires little attention. The following fuels, in the order named, are the best fuels for house-heating purposes:

Anthracite coal in sizes from ½-in. to egg size.

Gas-retort or metallurgical coke in pieces ½ in. to 3 in. across.

Coal briquets 2 to 3 in. in diameter.

Screened Pocahontas (semibituminous) coal over ¼ in. and 3 or 4 in. screen.

Sized bituminous coal in pieces ½ to 3 in. across.

Use an Economical Method of Burning Your Coal

If these fuels can be bought, fine sizes, or slack coal or other fuels requiring frequent attention when burning should be left for power plants where the firemen can and should give the fires frequent attention.

Because of the great variety of fuels used for house-heating purposes, and because of the great variety of house-heating equipment and conditions of operation, only the most general rules can be given for firing the fuel. The details must be determined by actual trial in each furnace.

The conditions under which house-heating apparatus is used are difficult to meet. The temperature of the house is to be kept uniform, with the firings far apart and with little attention given to the fires. The question for each household to decide are: How much variation in the house temperature can be tolerated, and how much attention can be given to the furnace. The kind of heating apparatus has a great deal to do with the uniformity of the house temperature and the amount of attention that must be given to the fire. Hot-water systems will give much more uniform temperatures with less attention to the fires than hot-air systems. No one set of rules will work satisfactorily in all cases.

Firing Anthracite

When firing anthracite, the best results are obtained by spreading the coal evenly over the entire fuel bed. The fire should not be allowed to become too low before putting on a fresh firing. A fuel bed 5 to 10 inches thick gives good results. The fire should be disturbed as little as possible.

Firing Briquets

Briquets, when properly made, are very good fuel for house heating purposes. However, the supply is decidedly limited. When burning briquets the fuel bed should be kept 8 to 12 in. thick. The fresh charges should be spread evenly over the grate area. The fire must not be disturbed. Poking breaks the briquets and spoils the fire.

Firing Semi-bituminous Coals

The semibituminous coals of the Pocahontas type are good fuel for heating a house. They are nearly smokeless and make but little soot. For regular firing, the coal can be spread evenly over the entire fuel bed; or, it can be fired like bituminous coal, the fresh charges being placed alternately on one side of the grate and part of the surface of the fuel bed left uncovered. The alternate method should be used if the firings are heavy. The fire keeps better over night if the the last firing is heaped to one side of the grate. Good results are obtained with fires 8 to 10 in. thick.

Firing Bituminous Coals

The bituminous, or soft coals, are smoky and cover the flue surfaces with a large amount of soot and tar, which reduces the transfer of heat and impairs the draft. Bituminous coal should be fired by placing the fresh charge on one side of the grate only, leaving part of the surface of the fuel bed uncovered. The volatile matter rising from the freshly fired coal is ignited by the red-hot coal of the uncovered part of the fire and a large part of it burns.

If the entire surface of the fuel bed is covered with a heavy charge, the volatile matter from the fired coal does not ignite for a considerable length of time after firing and passes away unburned as tarry, greenish-yellow smoke. The furnace and the flues become filled with the smoke and when the fire finally works its way through the fresh layer of coal the smoke and the gases may ignite with an explosion violent enough to blow the pipes down and fill the house with smoke. These explosions are particularly apt to happen if the coal contains much slack; therefore, with such coal particular care should be taken that part of the bright fire remains uncovered. This method of firing reduces the amount of soot deposited in the flues so that less frequent cleaning is necessary; it also reduces the heat losses from incomplete combustion, thus directly effecting a saving of coal.

Draft Regulation

Draft regulation is perhaps the most important factor in burning coal efficiently in house-heating furnaces. The draft is regulated mainly with three dampers; one of these is on the ash-pit doors, one on the firing door, and one in the pipe connecting the furnace with the chimney. For many furnaces the damper in the flue pipe is an opening covered with a hinged lid *A*, in Fig. 1. When this lid is closed the full

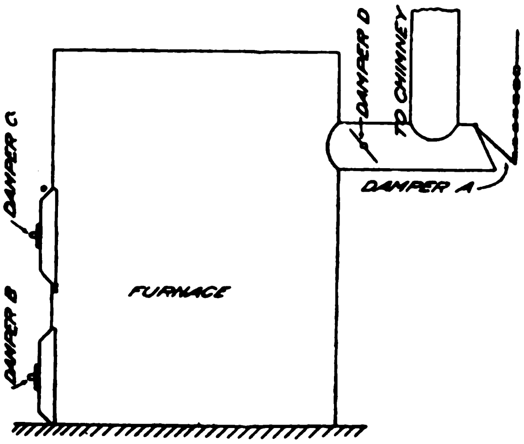


Fig. 1.—Position of dampers in a house-heating furnace. Damper A regulates the draft in the furnace and should be used with dampers B and C. Damper B regulates the supply of air through the grate and the rate at which the coal burns. Damper C regulates the supply of air over the fire and the completeness of combustion. Damper D controls the draft and should be used with damper A.

chimney draft is effective in the furnace. When the lid is lifted, the chimney draws air from the cellar instead of drawing the gases out of the furnace, and the draft in the furnace is reduced almost to nothing. Between the two extremes any draft can be obtained by proper adjustment of the lid.

The damper *B* on the ash-pit door regulates the flow of air through the fire, and the amount of air flowing through the fire determines the rate of combustion, or the amount of coal that the furnace can burn in an hour. Therefore, to control the rate of combustion and thereby regulate the amount of heat the furnace delivers to the house, the furnace attendant adjusts the damper in the ash-pit door and the damper to the chimney.

The damper *C* in the firing door supplies air over fire needed to burn the gases rising from the fuel bed; therefore, its regulation controls the completeness of combustion of these gases. When soft coal is burned a large volume of combustible gases rises from the fuel bed immediately after the firing; therefore, the damper in the fire door must be opened enough to allow the air necessary for burning the gases to enter the furnace. After the smoky gases cease to rise from the freshly fired coal, the quantity of air supplied over the fuel bed can be reduced by partly closing the damper in the firing door.

There should be a damper, *D*, in the smoke pipe; this damper can be used in addition to damper *A* to control the draft.

No rule can be given for the exact adjustment of the dampers. The proper adjustment must be ascertained by trial; with a little care and some patience the proper adjustment of the dampers of any furnace can be determined. In general, to make the fire burn faster, close the lid *A* (Fig. 1) in the pipe leading to the chimney and open the damper *B* (Fig. 1) in the ash-pit door. To make the fire burn slower, raise somewhat the lid in the check draft *A* and partly close the damper *B* in the ash-pit door. The damper *C* in the firing door is more difficult to adjust because there is no way to determine the completeness of combustion. In burning soft coal this damper should be slightly open all the time. In burning hard coal or coke enough air for complete combustion may enter the furnace through various leaks, even when the damper is completely closed.

Keeping the House Temperature Lower

In heating houses considerable fuel can be saved by keeping the temperature in the house 5 deg. to 10 deg. F. lower than is customary; instead of the temperature being between 70 deg. and 74 deg. F., it can be kept between 62 and 68 deg. F. without any discomfort or any danger to health. In fact, some medical authorities ascribe the "colds" common in winter to living in too warm houses. Thus Dr. William Brady writes:

Air need never be heated above 65 deg. F for comfort. Anything above that point represents waste and extravagance. It simply runs up a big coal bill and opens various doors to the coming of the doctor. The onset of cough in winter is almost a sure sign of such extravagance.

Those interested in saving the country's fuel and lowering their own coal bills will be glad to know that keeping the house at 65 deg. instead of 72 deg. F. means a saving of 15 to 20 percent. of their fuel. It may also mean a saving on the doctor's bill.

Keeping the house temperature lower is the easiest way to save fuel. It is fuel saved by doing less work. As to the question of health, more sickness is caused by having a house too warm than by keeping it too cold.

Heating Fewer Rooms

Another easy saving of fuel can be effected by heating fewer rooms in the house. In many houses the family can get along comfortably by keeping warm three or four rooms instead of heating six or seven rooms. And this can be done without any real hardship on the family. If one stops to think that 55 percent. of the families in Berlin, Germany, live, sleep, cook, and eat in the same room, living in three or four rooms will seem a comfort. Really, only the three rooms in which the family lives need to be heated at all. If consumptives can get well by sleeping outdoors, why could not well people keep well by sleeping in unheated bedrooms with the windows wide open?

Shortening the Heating Season

In some homes the furnace is started too early in the fall and is run too late in the spring. The chimneys of these homes are belching smoke and spreading soot over their neighborhood, while the neighbors keep windows and doors open to the outside air and even sit on the front porches. These faint-hearted people in their fear of catching cold, heat their houses unnecessarily; thus they waste the country's coal, increase their coal bills, invite sickness into their homes, and make life unpleasant to their neighbors. When mornings and evenings are chilly a grate fire for a short time in one or two rooms will make the house comfortable.

Conclusion

Every householder by endeavoring to save coal in the ways suggested can render his country valuable service, and he will not be doing his full duty toward his country unless he renders such service as he can. In addition, he should remember that besides helping his country he will help to shorten the misery and the horror of the great war.

ADAPTING THE CONNECTIONS OF AN ALTERNATING CURRENT WINDING TO A CHANGE IN VOLTAGE

By T. Schutter

Altering the connections of a winding to correspond to a change in voltage occurs more often with a motor than with a generator, but the methods used are alike in both cases. The change in winding in the case of the motor may be due to change of location where a different pressure prevails, to change of voltage in the supply circuits, or to change of pressure in the power supply due in turn to the change from an isolated plant

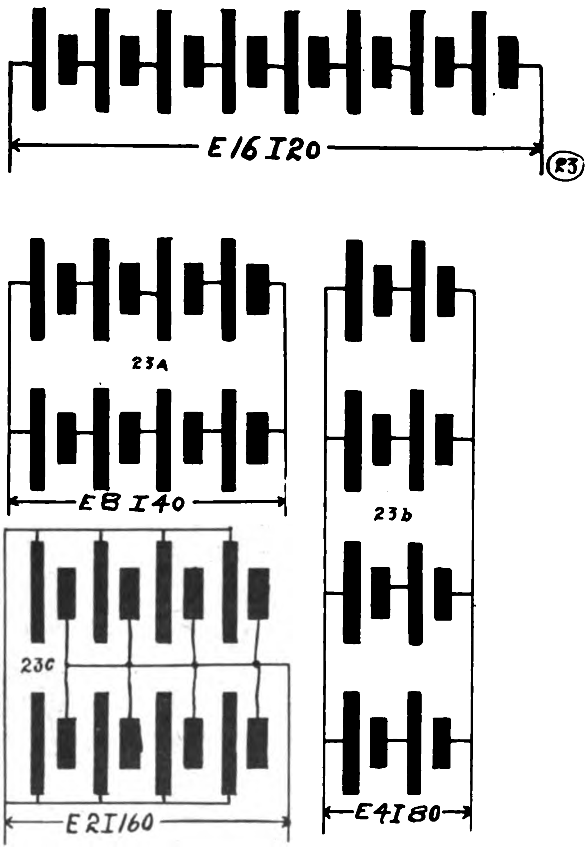


Fig. 23, A, B, C.

to that of a central station. For any of these reasons, it may be necessary to reconnect the winding to suit the new voltage. Sometimes complete rewinding is necessary.

No doubt the reader is familiar with the fact that the voltage generated in the winding of a generator depends on the number of conductors or coils in series, the speed at which they revolve, and the number of lines of force they cut per second. A change in any one of these three variables will alter the voltage. This applies to a motor as well as to a generator, except that in the case of the motor it is the counter electromotive force that is affected.

Since it is impossible to change the speed of an induction motor without changing the number of poles or the frequency, the only thing that can be changed in this type of machine to suit the new voltage is the winding; that is, by reconnecting or rewinding.

To give the reader a simple illustration of the method of reconnecting, take a battery of eight cells, each cell producing 2 volts and having a capacity of 20 amperes, and an internal resistance of 0.1 ohm. When these cells are all connected in series as in Fig. 23, they will produce 16 volts and 20 amperes at the terminals; when they are connected as in Fig. 23a; that is, four cells in series and two sets in parallel, they will produce 8 volts and 40 amperes at the terminals. From these two connections, it will be seen that reducing the number of cells in series reduces the voltage proportionately, while the amperage is increased in the same proportion. By reducing the connections still further, as in Figs. 23b and 23c, the results are as shown at the terminals.

If we liken each cell of the battery to one or more coils in a winding, we will see that altering their connections so as to increase or decrease the number in series increases or decreases the voltage in the same proportion. The analogy is too obvious to require further elucidation.

Before proceeding with the reconnecting of the windings, the matter of insulation should be considered to determine if it is suitable for the new voltage or not. If the new voltage is lower than the original voltage at which the winding was operated, the insulation need not be taken into account. If the new voltage is higher than the old, the insulation should be carefully examined and tested. If the insulation is clean and and dry (free from oil) and the new pressure does not exceed 550 volts, the insulation will be satisfactory under ordinary conditions. Most any insulation which is used on a machine which is to be operated on a 100-volt circuit will also do for a 550-volt circuit, provided it is free from oil, dust and other foreign matter.

When readjusting a motor to new operating conditions, the

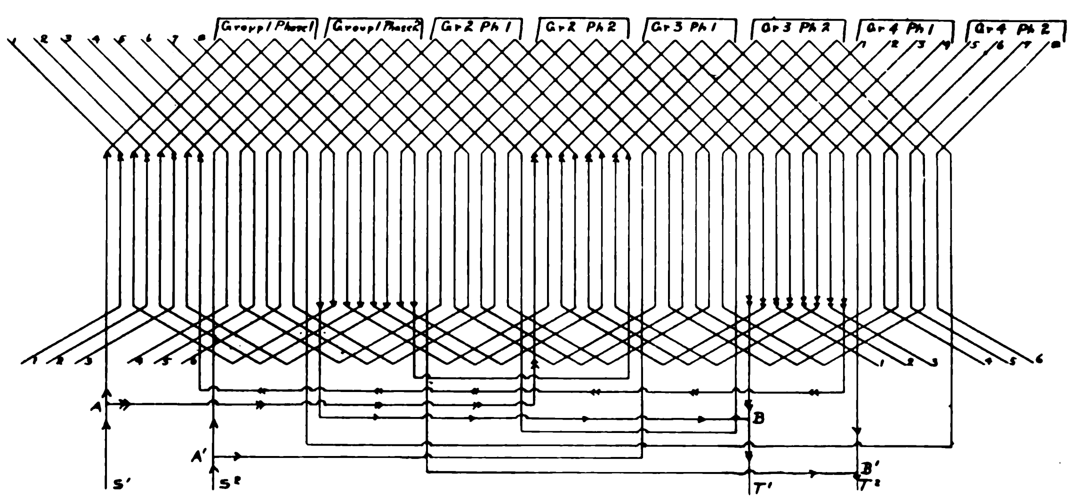


Fig. 24

first thing to determine is if it is possible to make the required change by rearranging the present connections, bearing in mind that the voltage across or between the various coils or groups of coils must not be increased.

Fig. 24 shows a winding diagram of a 220-volt, two-phase 4-pole, 32-coil stator, of the whole coil type. In this instance, there will be as many groups of coils per phase as there are poles. It will depend entirely on the original connections, whether it is possible by reconnect it for twice its original voltage.

By following the connections in this Fig., it will be seen that there are two groups in series and two sets in parallel per phase; that is, the current enters at S^1, and at point A it divides and enters the winding through groups 1 and 3. It leaves the winding through groups 2 and 4, unites at point B, and returns to the line through T^1. The same is repeated through phase 2 at points A^1 and B^1.

Comparing these connections with Fig. 23a, it will be seen that the full voltage is delivered from each set of four cells in series; that is, 8 volts (2 volts each times four cells = 8 volts) there being two sets in parallel. It can easily be seen that connecting the two sets of four cells in series as in Fig. 23 causes the voltage to be doubled.

If this principle is applied to the winding diagram, and instead of having two groups in series and two sets in parallel they are reconnected as shown in Fig. 25, there will be four groups of coils, each consisting of four coils, all in series between terminals S^1 and T^1 for the first phase. The same conditions will be found between the terminals S^2 and T^2 for the second phase.

In regard to the voltage per group of coils being kept the same in both Figs. 24 and 25, it will be observed that in Fig. 24 there are two groups in series across 220 volts, or a drop of 110 volts across each group. In Fig. 25 there are four groups in series across 440 volts, the drop across each still remaining 110 volts; therefore, it is possible to reconnect this winding (providing the insulation is good) to operate on a 440-volt circuit. Had this winding been connected as in Fig. 25 at the start, it would have been impossible to reconnect it to run on a 440-volt circuit.

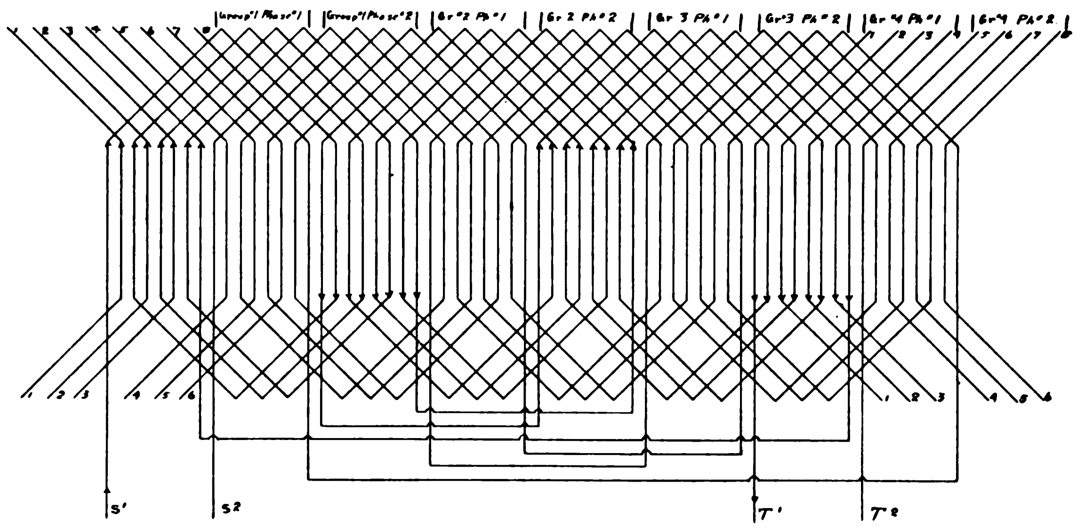


Fig. 25

If the pressure of the winding in Fig. 24 were to be reduced from 220 to 110 volts, it would be done as in Fig. 26 where all the four groups belonging to the same phase are connected in parallel instead of two in series and two in parallel. This would still keep the same drop across the different coils, which was 110 volts.

In changing the voltage of the foregoing winding, the reader will observe that the number of coils in a group is not disturbed, only the connections between the different groups being altered.

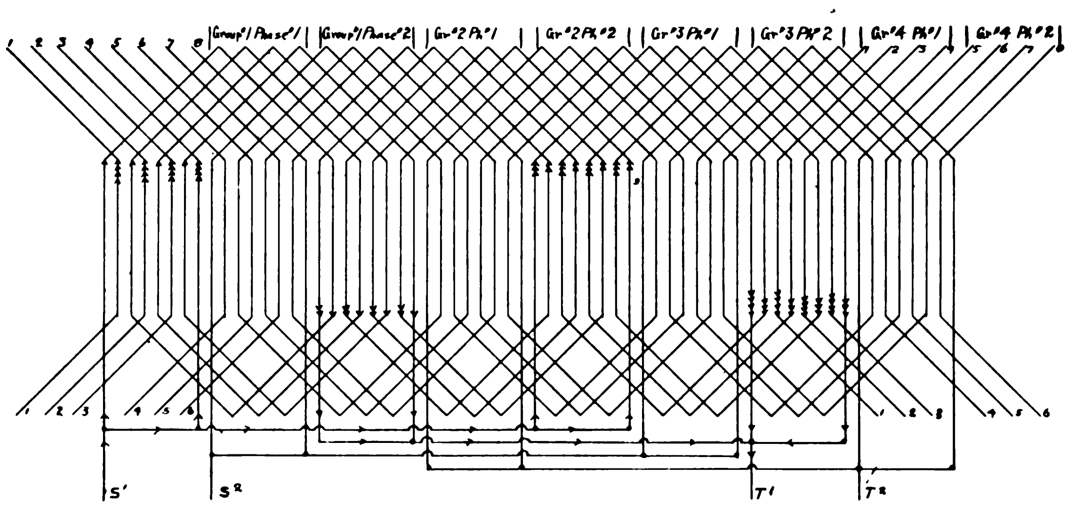


Fig. 26

The methods employed in the case of this two-phase winding can also be applied to single-phase windings, since a two-phase winding is nothing more than two single-phase windings placed 90 electrical degrees apart on the same armature.

Fig. 27 shows a winding diagram of a three-phase, 4-pole winding, 36 coils, operated on a 440-volt circuit, star connected. There are two ways in which this winding may be reconnected to be operated on 220 volts: first, by regrouping the winding; second, by changing from a star connection to a delta connection. In Fig. 27, there are four groups of three coils each in series per phase, and, as shown in Fig. 28, between terminals A and B there are two phases in series connected to a 440-volt supply.

If the method of regrouping the winding is selected, it would mean that the connections must be so arranged that instead of having four groups in series per phase, there will be two groups in series and two in parallel per phase, as shown in Fig. 29 where groups 1 and 2 are in series, and in parallel with groups 3 and 4, (groups 3 and 4 are also connected in series) in each phase, thereby reducing the number of coils by one-half, which will in turn reduce the voltage at the same rate.

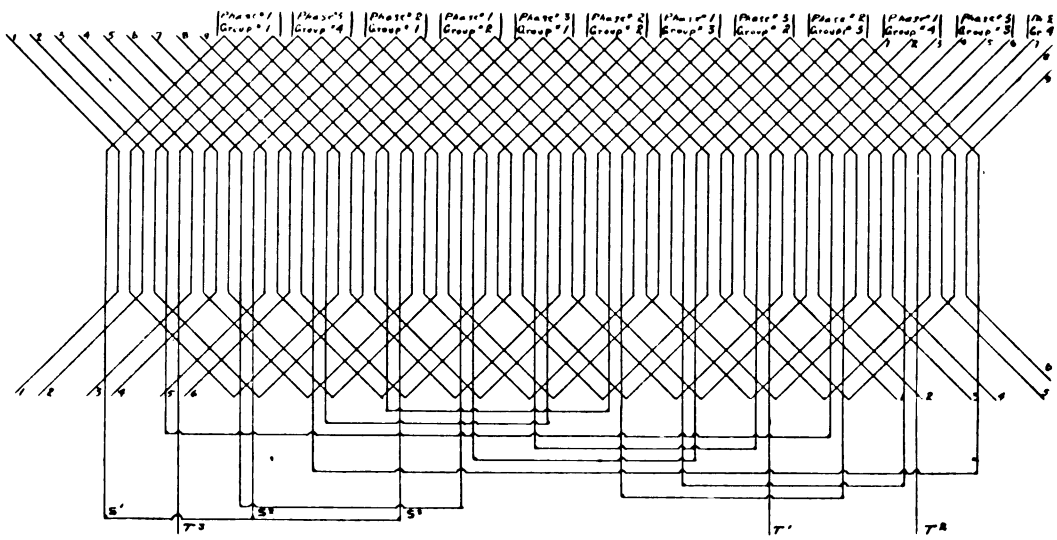


Fig. 27

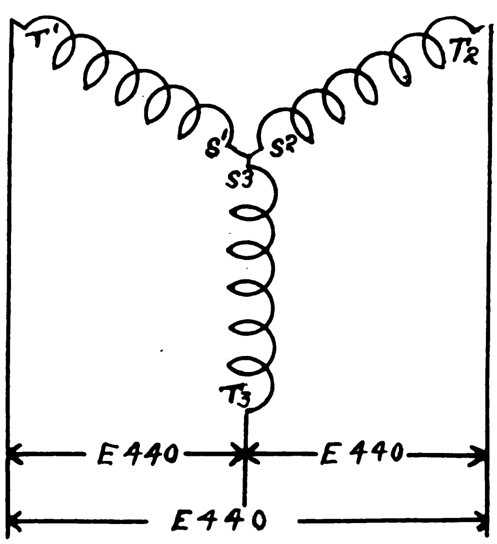


Fig. 28

If the method of changing from a star connection to a delta connection is selected, it will only be necessary to open the connection between S^1, S^2 and S^3 in Fig. 28 and interconnect S^1, S^2, S^3, T^1, T^2, and T^3 as shown in Figs. 30 and 28a.

This method is not as satisfactory as the regrouping method.

In Fig. 28 the pressure across terminals A and B is 440 volts; then the voltage per phase will be

$$\frac{E}{1.732} = \frac{440}{1.732} = 251.+ \text{ volts in Fig. 28a.}$$

When the winding is reconnected from star to delta, it would require 251 volts to operate the motor at the same power as 440 volts did previously. The heating of the copper would be about one-third greater when delta connected.

Connecting data for Fig. 24.

Beginning of group 1 connects to line S^1.

End of group 1, phase 1, connects to the end of group 2, phase 1.

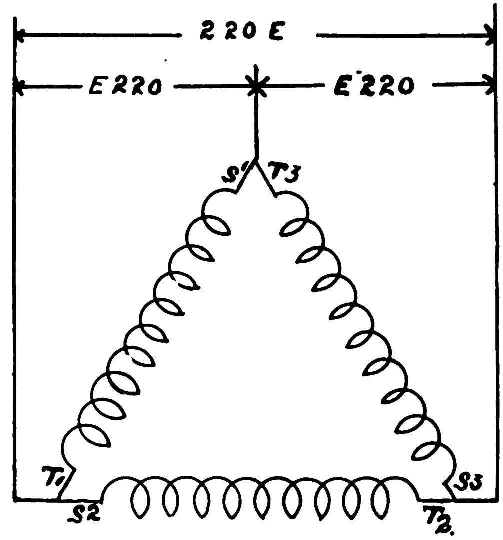


Fig. 28a

Beginning of group 2, phase 1, connects to line T^1.

Beginning of group 3, phase 1, connects to line S^1.

End of group 3, phase 1, connects to the end of group 4, phase 1.

Beginning of group 4, phase 1, connects to line T^1.

Beginning of group 1, phase 2, connects to line S^2.

End of group 1, phase 2, connects to the end of group 2, phase 2.

Beginning of group 2, phase 2, connects to line T^2.

Beginning of group 3, phase 2, connects to line S^2.
End of group 3, phase 2, connects to the end of group 4, phase 2.
Beginning of group 4 connects to line T^2.

Connecting data for Fig. 25.
Beginning of group 1, phase 1, connects to line S^1.

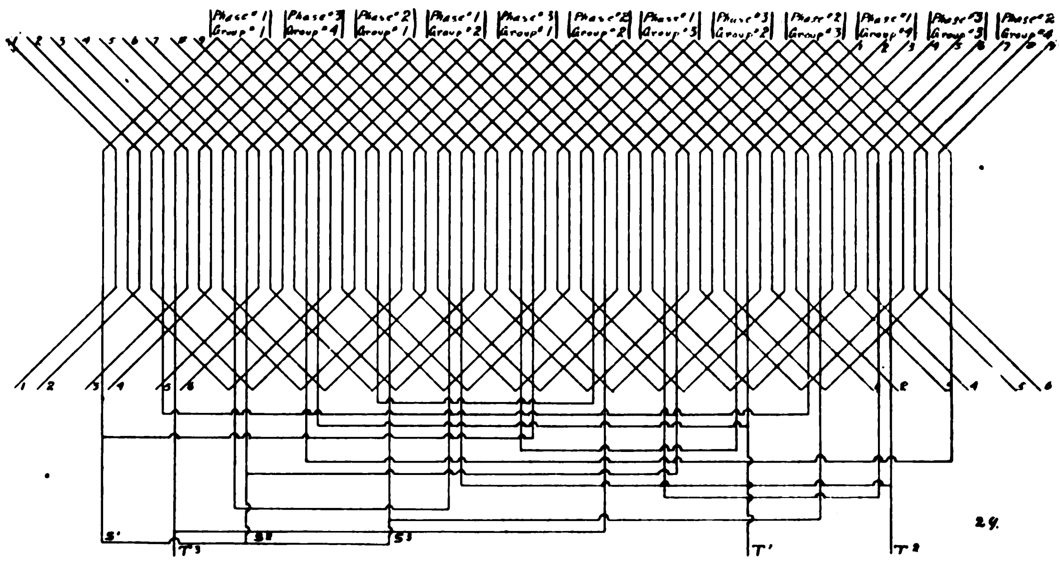


Fig. 29

End of group 1, phase 1, connects to the end of group 2, phase 1.
Beginning of group 2, phase 1, connects to the beginning of group 3, phase 1.
End of group 3, phase 1, connects to the end of group 4, phase 1.
Beginning of group 4, phase 1, connects to line T^1.
Beginning of group 1, phase 2, connects to line S^2.
End of group 1, phase 2, connects to the end of group 2, phase 2.
Beginning of group 2, phase 2, connects to the beginning of group 3, phase 2.

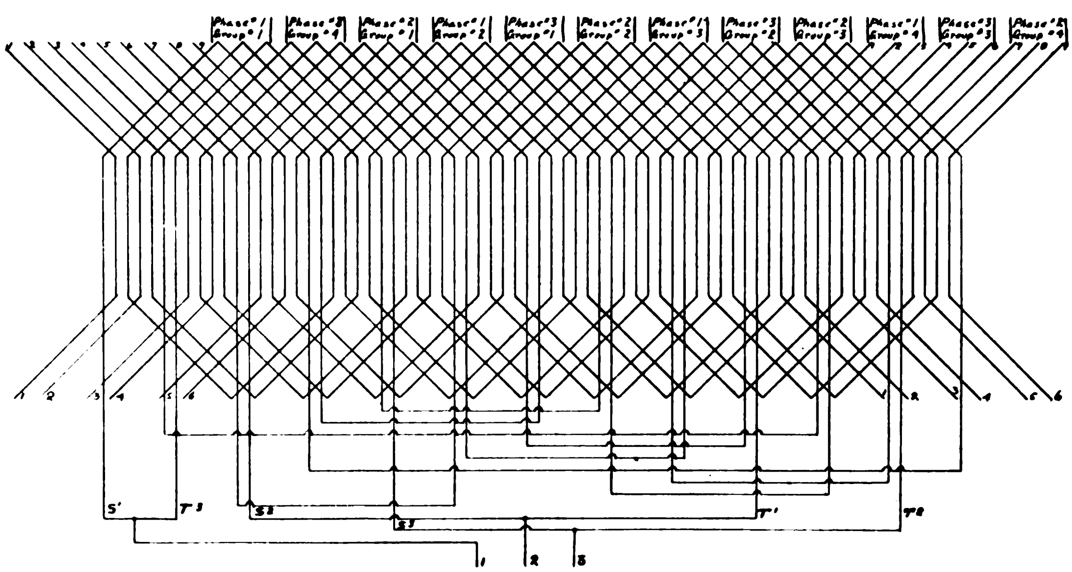


Fig. 30

End of group 3, phase 2, connects to the end of group 4, phase 2.
Beginning of group 4, phase 2, connects to line T^2.

Connecting data for Fig. 26.
Beginnings of groups 1, 2, 3 and 4, phase 1, connect to line S^1

Ends of groups 1, 2, 3 and 4, phase 1, connect to line T^1.
Beginnings of group 1, 2, 3 and 4, phase 2, connect to line S^2.
Ends of groups 1, 2, 3 and 4, phase 2, connect to line T^2.

Connecting data for Figs. 27 and 30.
Beginning of group 1, phase 1, connects to line S^1.
End of group 1, phase 1, connects to the end of group 2, phase 1.
Beginning of group 2, phase 1, connects to the beginning of group 3, phase 1.
End of group 3, phase 1, connects to the end of group 4, phase 1.
Beginning of group 4, phase 1, connects to line T^1.
Beginning of group 1, phase 2, connects to line S^2.
End of group 1, phase 2, connects to the end of group 2, phase 2.
Beginning of group 2, phase 2, connects to the beginning of group 3, phase 2.
End of group 3, phase 2, connects to the end of group 4, phase 2.
Beginning of group 4, phase 2, connects to line T^2.
Beginning of group 1, phase 3, connects to line S^3.
End of group 1, phase 3, connects to the end of group 2, phase 3.

Beginning of group 2, phase 3, connects to the beginning of group 3, phase 3.

End of group 3, phase 3, connects to the end of group 4, phase 3.

Beginning of group 4, phase 3, connects to line T^3.

Connecting data for Fig. 29.

Beginning of group 1, phase 1, connects to line S^1.

End of group 1, phase 1, connects to the end of group 2, phase 1.

Beginning of group 2, phase 1, connects to line T^1.

Beginning of group 3, phase 1, connects to line S^1.

End of group 3, phase 1, connects to the end of group 4, phase 1.

Beginning of group 4, phase 1, connects to line T^1.

Beginning of group 1, phase 2, connects to line S^2.

End of group 1, phase 2, connects to the end of group 2, phase 2.

Beginning of group 2, phase 2, connects to line T^2.

Beginning of group 3, phase 2, connects to line S^2.

End of group 3, phase 2, connects to the end of group 4, phase 2.

Beginning of group 4, phase 2, connects to line T^2.

Beginning of group 1, phase 3, connects to line S^3.

End of group 1, phase 3, connects to the end of group 2, phase 3.

Beginning of group 2, phase 3, connects to line T^3.

Beginning of group 3, phase 3, connects to line S^3.

End of group 3, phase 3, connects to the end of group 4, phase 3.

Beginning of group 4, phase 3, connects to line T^3.

✦ ✦ ✦

AMERICA'S COAL PROBLEM IN 1918

By H. A. Garfield, Fuel Administrator

We begin the new coal year of 1918-19 with an obligation resting upon every citizen of the United States to do his part in order that the coal supply of the country may be made adequate to meet the home needs of our people and the ever increasing demands for coal for fuel which grow out of the conflict in which we are now engaged.

The Fuel Administration must have the support and the active co-operation not only of those who are engaged in production and distribution of fuel but of every coal user in the country. Each must bear his share of the patriotic sacrifice which must be made if the coal supply is to be properly increased and adequately distributed.

An adequate coal supply is vital to the winning of the war. Without it we can not make munitions or other war supplies or build the ships which must carry men and materials to the battle front. Without it industries will be stopped, labor thrown out of employment, and the homes of the people will be cold.

Guided by the experience of the past winter, the Fuel Administration has taken the necessary steps to clear the way for the ceaseless activity of the mines of the country in increasing the supply and for the steady, swift distribution of the nation's fuel as rapidly as it can be taken from the ground and moved over our overburdened transportation systems.

The prices fixed by the Government for coal at the mine have now been established on a stable foundation which will not be disturbed during the coming year, except in cases of extraordinary urgency. These prices have been adjusted by scientific and practical investigation based upon uniform cost-sheet reports to insure the greatest possible stimulation of production while maintaining a reasonable and equitable price of coal to the consumer.

By carefully drawn regulations the Fuel Administration has insured the shipment of "clean coal" from the mines. Coal containing an undue amount of foreign matter will be penalized in price, and producers who take extraordinary measures in the preparation of their coal will be recompensed. These measures will keep off the railroads and out of the bins of the consumers a large amount of unburnable material which was included in last year's production.

Every effort has been made by the Fuel Administration to so arrange the distribution of the coal supply that it will impose the least possible burden upon the railroads of the country. Through the zone system of distribution, which becomes effective April 1, the movement of bituminous coal between the mine and the consumer will be restricted to the shortest possible transportation lines consistent with the maintenance of an adequate and proper coal supply to all consumers.

In arranging these restrictions the Fuel Administration, in many cases, has allotted to consuming territory producing fields which can only fill the demand of the consumers they must supply if production is maintained steadily throughout the coal year.

The Fuel Administration expects the coal consumers, continuing their patriotic co-operation with the Government in all its war measures, to maintain a steady and constant demand for coal in order to attain this result. Consumers must buy their winter supply of coal during the spring and summer for storage during the winter if the production is to be maintained at a maximum and the country enabled to avoid a serious coal shortage this winter. The Fuel Administration will co-operate with all communities in an effort to provide storage for emergency stocks of coal to be set aside during the spring and summer to meet emergencies of weather and transportation which may arise next winter.

But the great capacity of the country lies in the bins of the individual consumer, and there the country's coal reserve must be built up during the spring and summer when coal production is unhindered and the transportation facilities of the country are operating at their highest efficiency.

As an inducement to "early buying" the prices of anthracite coal have been reduced 30 cents a ton on all domestic sizes from April 1 to August 31, and in many of the bituminous fields prices have been cut to an even greater extent.

To safeguard the consumer the Fuel Administration has prescribed regulations to prevent profiteering and to govern the distribution of coal by licensed jobbers and by retailers. Each domestic consumer will be permitted to secure a full normal supply of coal but no more.

Every ton of coal that is hoarded against future needs and is not used during the winter is actual waste. The labor and transportation used to bring the coal to the consumer and the actual energy of the coal itself are withheld from doing their part toward a speedy victory. Consumers should secure just a little less coal than they believe they need and should make every shovelful give its full value in heat and power. Every shovelful saved means help for the industries in turning out supplies for our troops abroad, help for the ships that must bridge the 3,000-mile gap between our shores and the battle front, and help toward ultimate victory.

LABORATORY APPARATUS FOR TECHNICAL SCHOOLS

In technical schools which are not over endowed with cash or long-time credit it is often something of a problem to get a sufficient variety of electrical apparatus to meet the demands of instructors and students. These demands, says J. J. Lamberty, in a recent issue of the General Electric Review, are met in some degree by the apparatus described below. By means of interchangeable rotors, one machine is made to play a variety of roles. The alternating-current generator, for example, may be operated as a synchronous motor, a squirrel-cage induction motor, a phase-wound induction motor, or a frequency changer. The synchronous converted may also be made to operate as one of five different machines.

Some types of modern commercial apparatus are directly available for use in a college laboratory, but electrical lighting and power machinery of to-day is built in sizes too large and too costly for the laboratory. Accordingly, a line of small machines has been designed that incorporate the general characteristic features of large commercial units, but of dimensions, capacities, and interchangeability of parts adapted to experimental and instruction purposes. These machines enable educational institutions to equip their electrical laboratories through a comparatively small investment of capital.

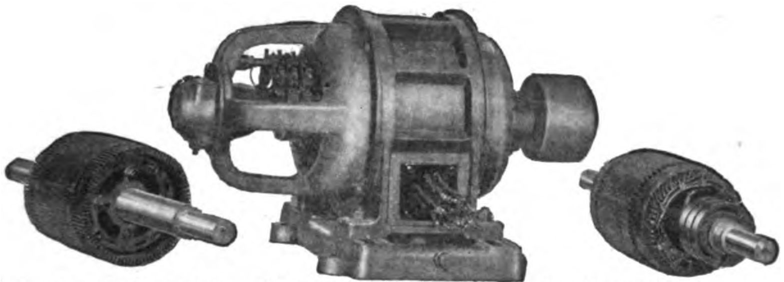


Fig. 1—4-pole, 15-kva., 1800-r.p.m., 220-volt, 60-cycle alternating-current generator with extra rotors

The alternating-current belt-driven generator shown in Fig. 1 will operate as a generator, a synchronous motor, a squirrel-cage induction motor, a phase-wound induction motor, or a frequency changer. The complete set consists of a stationary armature with a sliding base, a revolving salient-pole field, a squirrel-cage induction motor rotor, a phase-wound induction motor rotor with drum controller and resistor, and other accessories.

The three rotating elements of the set; namely, the salient-pole generator field, the squirrel-cage rotor, and the phase-wound rotor are interchangeable. If the squirrel-cage rotor is substituted for the revolving field, the machine will operate as a 15-hp. constant-speed induction motor; if the phase-wound rotor is used it will operate as a 15-hp. varying-speed induction motor.

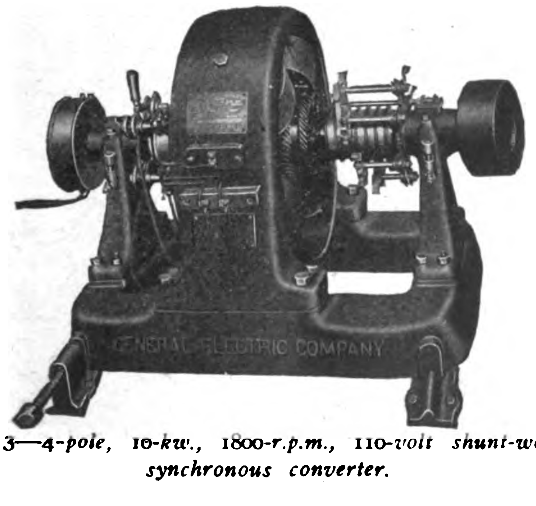


Fig. 3—4-pole, 10-kw., 1800-r.p.m., 110-volt shunt-wound synchronous converter.

Using the phase-wound rotor the set will also operate as a frequency changer by impressing voltage on the armature cir-

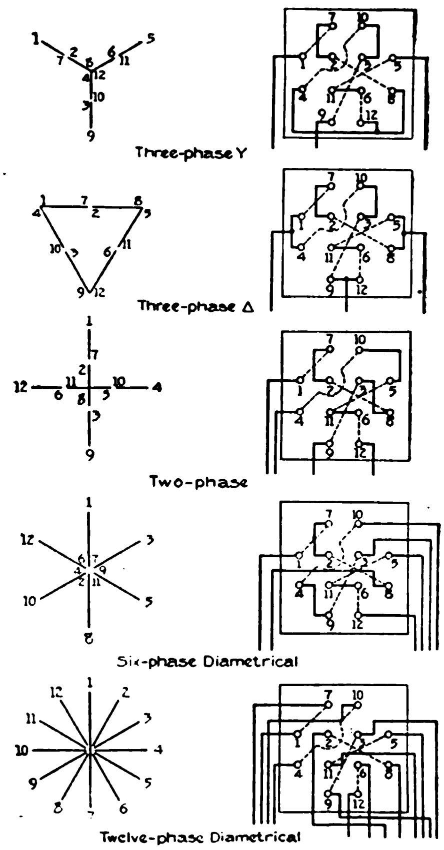


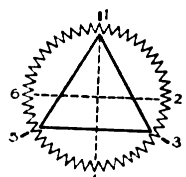
Fig. 2—Theoretical diagrams and terminal-board connections for alternating-current generator. Dotted lines represent winding coils.

15	*Kva., 12-phase diametrical*	110	*volts*
15	*Kva., 6-phase diametrical*	220	*volts*
15	*Kva., 3-phase "Y"*	381	*volts*
15	*Kva., 3-phase delta*	220	*volts*
15	*Kva., 2-phase*	311	*volts*
10	*Kva., single-phase*	381	*volts*
7½	*Kva., single-phase*	311	*volts*
5	*Kva., single-phase*	220	*volts*

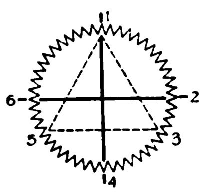
cuit and driving the rotor, the frequency and secondary collector ring voltage depending on the impressed voltage, the speed, and the direction of rotation of the driven rotor. For example, if the rotor is driven at normal 60-cycle speed in the opposite direction to which it would revolve as a motor, and if normal voltage at normal frequency is impressed on the armature, approximately 210 volts at 120 cycles is obtained.

The alternating-current generator is also built for 110 volts.

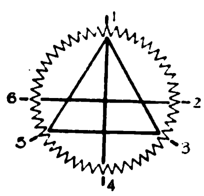
The phase-displacement set comprises two of the similarly rated generators, direct connected and mounted on a common base. A spacing ring in the coupling provides for the individual operation of the machines. Each stator is provided with a shifting device so that it can be adjusted through an angle of 45 mechanical degrees, or 90 electrical degrees.



Three-phase voltages, 71-100 142; *rings,* 1-3-5
Corresponding direct voltages, 110-160, 220



Two-phase voltages, 82-115, 164; *rings,* 1-4, 2-6
Corresponding direct voltages, 110-160, 220

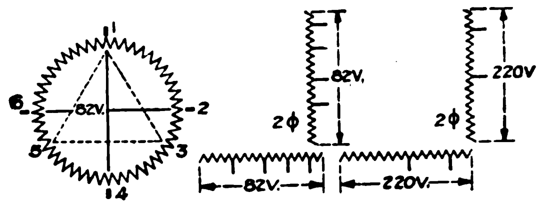


Single-phase voltages, 82-115, 164; *rings,* 1-4, 2-6
Corresponding direct voltages, 110-160, 220
Single-phase voltages, 71-100, 142; *rings,* 1-5, 3-5, 1-3
Corresponding direct voltages, 110-160, 220

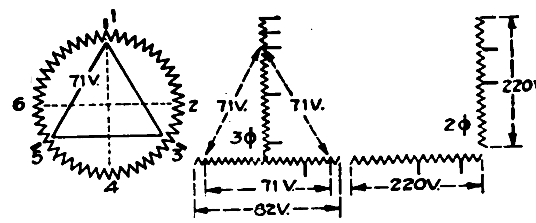
Fig. 4—Connections for synchronous converter

The synchronous converter shown in Fig. 3 is designed to operate either as a synchronous converter, a double-current generator, a direct-current generator, an alternating-current generator, a direct-current motor, a synchronous motor, or an inverted converter. The outfit consists of a stationary salient pole field frame with a cast-iron base and rails, a revolving armature, a speed-limiting device, and endplay device, and other accessories.

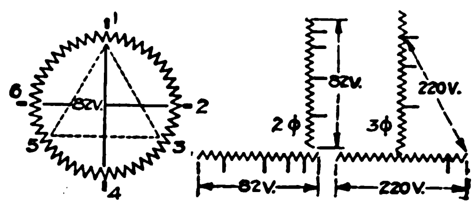
The synchronous converter is also built for 220 volts but is not designed for such a wide voltage range as the 110-volt converter. The alternating and the direct voltages for the different connections are given in Fig. 4.



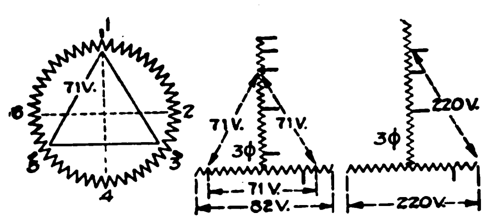
Two-phase voltage, 82; *rings,* 1-4, 2-6. *Corresponding direct voltage,* 110.



Three-phase voltage, 71; *rings,* 1-3-5. *Corresponding direct voltage,* 110.



Two-phase voltage, 82; *rings,* 1-4, 2-6. *Corresponding direct voltage,* 110.



Three-phase voltage, 71; *rings,* 1-3-5. *Corresponding direct voltage,* 110.

Fig. 7—Connections of synchronous converter with core-type, two-phase, or three-phase transformers.

Figs 5 and 6—Core-type, 60-cycle, 5-kva., 220-volt primary, 82-volt (two-phase) 71-volt (three-phase) secondary transformers.

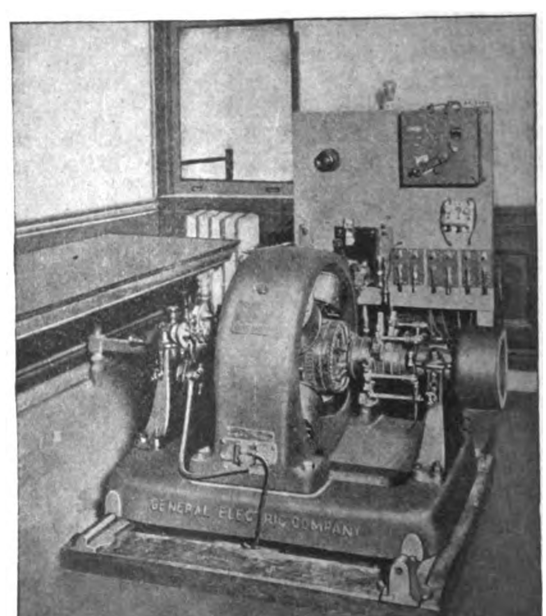


Fig. 8—Laboratory synchronous converter, Y. M. C. A., 23rd St., New York City.

The regulating-pole converter is similar to the synchronous converter, except that the field is divided in two sections; namely, the main field and the regulating field. A rheostat is provided for each section of the field; one rheostat is of the ordinary type used in the shunt-field circuits of small converters, and the other of the double-dial type arranged to secure a gradual change in excitation of the regulating-field circuit from maximum lower to maximum boost without opening the circuit.

The machine will operate single-phase, two-phase, or three-phase within the voltage limits of the synchronous converter.

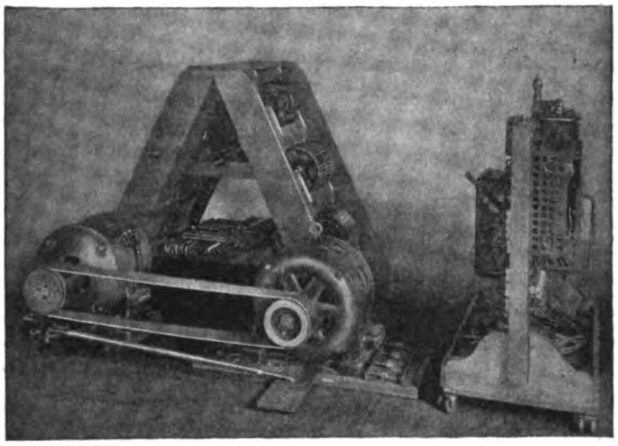


Fig. 9—Laboratory alternating-current generator, University of Minnesota, Minneapolis, Minn.

It will also operate as a regulating-pole converter at 100 to 125 volts direct, impressing 80 volts three-phase alternating on rings 1, 3, and 5.

To operate as a double-current generator, an additional field rheostat with two settings is required in the regulating-pole field circuit; one setting to be used when operating as a regulating-pole converter, and the other when operating as a double-

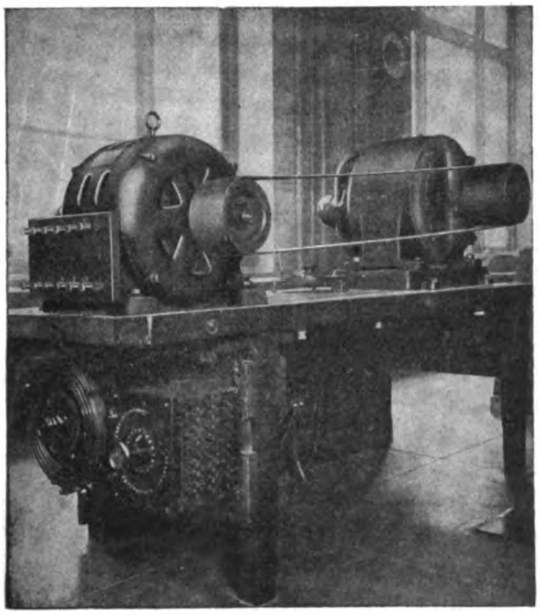


Fig. 10—Laboratory alternating-current generator, Cooper Union, New York City.

current generator. The equipment for this rheostat includes an interlocked concentric operating mechanism, so that both the regulating field and the main field rheostats can be adjusted by one handle.

Core-type oil-filled self-cooled transformers (Figs. 5 and 6) are designed to be used with the 110-volt converters. Two transformers with a combined output of 10 kva. are required. The units, with main and teaser interchangeable, have the necessary taps to operate on either a two-phase, or a three-phase 220-volt primary circuit, and in either case may be connected to deliver to the converter 82 volts (two-phase), or 71 volts (three-phase). Fig. 7 shows the various transformer and converter connections and their respective voltages.

Similar transformers are built for use with the 220-volt converters.

Commercial types of switchboards are furnished to control the sets which have been described. Panels of natural black slate with dull black finished instruments are mounted on 90-in. pipe framework.

Varied arrangements are employed to take care of the different voltage and current conditions. Many of the instruments have several windings to provide for the various combinations; the wattmeter, for instance, has two current coils which can be connected either in series or in parallel.

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FUEL BURNING AND ELECTRIC HEATING

At a convention of the Canadian Society of Civil Engineers held in Toronto last month to discuss the fuel situation, H. G. Acres, hydraulic engineer of the Ontario Hydro-Electric Commission asked what fundamental condition accounts for the fact that a house in Toronto can be more cheaply heated by means of Pennsylvania coal than by Niagara power, supplied at actual cost? To work this out let us first take one kilowatt of potential heat from the falling waters of Niagara. Under peak load conditions, there will be 85 percent. of this unit of heat left when it has passed through the turbine; 80 percent. when it has passed through the generator; 76 percent. when it has passed through the step-up transformer; possibly not more than 66 percent. when it has passed over the transmission line; 62 percent. when it has passed through the step-down transformer; 57 percent. when it has passed through the local distribution system and 52 percent. when it has passed through the service transformer. In other words, about one-half of this unit of heat would be left for effective use as heat on the premises of the consumer.

Then take a pound of coal from a Pennsylvania mine—the whole of this pound is delivered to the consumer's premises. It contains about 2 kw.-hr of effective potential heat for which you pay ½ cent on the basis of present price of coal, or ¼ cent for 1 kw.-hr., as against 9/10ths of a cent for the kilowatt hour of heat from Niagara, on the basis of present rates.

This kilowatt of potential heat from Niagara undergoes six distinct steps of conversion before it is delivered on the consumer's premises as heat. The potential heat of the Pennsylvania coal undergoes one conversion only before being put to its ultimate use. The efficiency of conversion from the natural state to ultimate use is probably about the same, but in one case you require a power plant, a step-up transformer; 80 miles of transmission line; a step-down transformer; a distribution system and a service transformer. In the other you require a $200 furnace and a 50 cent shovel. These two conditions relative to the delivery of the commodity must be considered as having a more or less fixed influence on comparative costs, and the only factors which will tend to any appreciable extent to reconcile the present disparity will be an enormous increase in the price of coal, or a compensating reduction in the cost of electric power.

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Construction of a plant at Great Falls, Mont., for the production of ferro manganese, which will release 50,000 tons of shipping now carrying manganese to this country from Brazil, has been undertaken by the Anaconda Copper Company. The shipping released would be capable of carrying 300,000 tons of food and material annually to Europe for the American armies.

JOIN THE SAVERS

Our readers have been invited to "back up" our soldiers at the front by joining or forming a War Savings Society. Full information will be supplied upon addressing the War Savings Society Bureau, 51 Chambers Street, New York City, or the National War Savings Committee, Washington, D. C.

Members of War Savings Societies promise to avoid competing with the Government for labor, materials and transportation by buying only what they need and only when they need it, and agree to invest their savings weekly or monthly in Thrift or War Savings Stamps or in Liberty Bonds.

A War Savings Society may be formed within a society, class or club, or in any group of people who work together or eat together, who play together or otherwise frequently "get together." The society will include all members of the group who are willing to sign the patriotic agreement individually to support the Government in two ways—(1), by each doing his buying thoughtfully and (2), by loaning his savings to the Government.

There will be a chairman and secretary whose first effort will be to secure as members of the War Savings Society all members of the group, each one signing the application blank and promising to purchase a certain number of Thrift or War Savings Stamps every week or every month. From time to time, the secretary will check up the stamp purchases of the members so that none may neglect their promises. Weekly or monthly reports of the total purchases and total number of members will be sent to the National War Savings Committee.

At such times as the members may determine ten minutes or more will be given to the War Savings Society of that group for war savings and other war time discussions. In some offices or factories occasional brief, informal talks may be practicable. For these talks and the more formal meetings speakers will be suggested and material will be supplied from time to time.

NEW PRIORITIES LIST

Beginning April 15, 1918, the United States Fuel Administration will be governed in the distribution of coal and coke by a slightly amended list of priorities recently arranged by the War Industries Board. The board has listed certain industries for preference, whose operation is of exceptional importance, measured by the extent of their direct or indirect contribution either toward winning the war or toward promoting the national welfare. Not only will the industries coming under the new classification be given preferential treatment by the Fuel Administration, but also in transportation by the railroads.

Included in the list of preferred industries we find the following:

Chemicals: plants engaged exclusively in manufacturing chemicals.

Electrical equipment: plants manufacturing same.

Electrodes: plants producing electrodes.

Machine tools: plants manufacturing machine tools.

Newspapers and periodicals: plants printing and publishing exclusively newspapers and periodicals.

Public utilities.

ENGINEERING INSPECTOR WANTED

The New York State Civil Service Commission at Albany, N. Y., announces that it is in need of an engineering inspector in the State Architect's office. The position requires technical knowledge of the following: High and low pressure steam, and hot water heating systems; plumbing; electric wiring and switchboard work; house sewage disposal; refrigerator, laundry, and electrical and steam power equipment; materials of construction; testing and testing instruments; machinery foundations; architectural plans and specifications; also practical experience in supervising the installation of machinery, etc.; familiarity with the various makes of machinery and apparatus used for the foregoing purposes, and general knowledge of the Underwriters' rules. Graduation or partial course in mechanical or electrical engineering is desirable. Subjects of examination and relative weights: Practical questions, 5; experience and education, 5. Time allowed, 8 hours. Salary, $1800 to $2200, and necessary traveling expenses. For application form address a postal card to the State Civil Service Commission, Albany, N. Y. Application forms will not be sent out after May 13. Applications received at the office of the commission after May 15, will not be accepted.

FREE COURSE IN RADIO ENGINEERING

A course in radio engineering for technical graduates will be given at the University of Pittsburgh, starting May 20, and lasting for eight weeks. This course will be open only to graduates in electrical or mechanical engineering who are recorded in Class 1 of the National Army Draft. Men enrolling in it will be placed by the Government in Class V until completion of the course, when they will be inducted into the Signal Corps and sent to an army school for further training. The need for men familiar with the technique of radio communication is great, and the chances for obtaining a commission ultimately are good. There will be no charge for tuition, but students must provide their own living and travel expenses. As the number of men is limited, application should be made at once to Prof. H. E. Dyche, Department of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa.

TAPING COILS BY THE BLIND

Last fall the question of securing some help from the blind was taken up the Westinghouse Electric & Mfg. Co., with the Pennsylvania Association, a branch of which is located in Pittsburgh. A sample lot of motor coils to be taped was sent to the association in order that the inmates might be given a chance to show what they could do. The returned coils showed that this work could be done satisfactorily, and arrangements were made with the management of the association to allow some of the blind to do this work, payment to be made on a piece work basis.

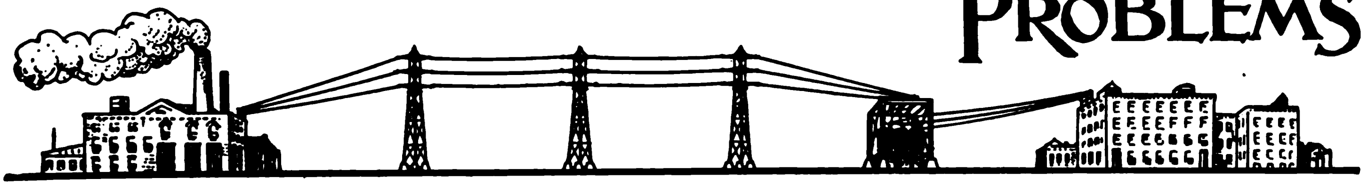
As this was an entirely new line of endeavor for them, it was decided to have a representative of the association go to East Pittsburgh to become familar with the work so as to be in a position to instruct those assigned to do the work. The representative selected for this training was the wife of a former Westinghouse employe, who was deprived of his sight last summer, and who is now employed at the association. She went to East Pittsburgh and was employed until such time as the management felt that she was sufficiently proficient in the taping of coils to teach the blind and to inspect their work.

At the present time seven blind persons are employed. As this is new work, the speed is not so great as with those who can see, but this will increase as they become more proficient, and also the number employed will be increased.

In order that they may not suffer any loss of revenue, while learning this new work, the association is paying them the difference between that earned at their former employment, and what their present production would entitle them to receive.

Idaho Power Co., which supplies electric light and power service in more than 40 communities, has 21,555 electric and 439 water customers. During the year ending December 31, 1917, the kilowatt-hour feeder output was 119,553,000. With its subsidiaries, this company earned $1,585,792. Operating expenses and taxes amounted to $884,894.

POWER PLANT, LINE AND DISTRIBUTION PROBLEMS



A Record of Successful Practice and Actual Experiences of Practical Men

AERIAL CABLE TRANSMISSION LINE CONSTRUCTION

By C. A. Dalrymple

Engineers who are confronted with the problem of installing transmission circuits where local conditions prevent the use of open wire construction, and other reasons preclude the use of underground conduits, can get 'round the difficulty by installing aerial cable. The most approved method of installing such cable is told here by a well-known cable engineer.

Aerial cable is manufactured without a lead sheath, which accounts for the cable being extremely light in weight. It will stand severe weather conditions and is easily handled. Fig. 1 shows a cross-section of a 4/0, three-conductor 13,200-volt aerial cable.

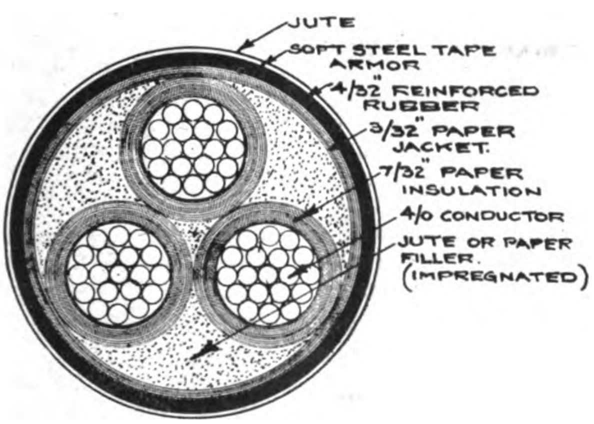


FIG 1. SECTION 4/0-3 CONDR. 13200 V AERIAL CABLE.

Each conductor is insulated with paper strips properly saturated with compound, wound spirally and overlapping, and built up to a thickness of 7/32 in. The three insulated conductors are laid together spirally with jute or twisted paper laterals to make the whole cylindrical. Over the conductors thus laid is wound, as above described, a jacket of paper 3/32 in. in thickness, thoroughly saturated with compound. Over this paper jacket is applied an additional jacket of reinforced rubber which is built up to a thickness of 4/32 in. The entire insulation is covered with best drill tape, well saturated with compound, wrapped with one-half lap. Over the tape is applied a cotton braid thoroughly saturated with weatherproof compound. The cable is then covered with soft galvanized steel tape armor over which is applied a covering of jute saturated with weatherproof compound. Cable manufactured as described above should stand a factory test of 30,000 volts before acceptance.

On account of the light weight of the cable it can be installed on pole lines with normal spacing. Fig. 2 giving the approximate weights and diameters of 13,200 volt three-conductor aerial cable ranging in sizes from No. 4 B. & S. gauge to 350,000 cm.

Class B chestnut poles are used and set with a normal spacing of 90 to 100 ft. Where necessary, sections as long as 150 ft. can be installed, but in those cases the adjacent section is not to exceed 130 ft. Sections longer than 150 ft. in length should be given special attention by the engineer in charge. Class A chestnut poles are used on all long sections and points of special strain.

The location and frequency of guys should be decided by the engineer in charge. At dead ends and at corners the strain is excessive; it frequently is as great as 25,000 lb. and must be given special attention. These points of strain must be well guyed. Both the anchorage and the guys must be strong enough to develop at least the full strength of the messenger strand; that is, so strong that the messenger will fail before the pole is pulled over.

FIG. 2. APPROXIMATE WEIGHTS AND DIAMETERS. 13200 V. 3 CONDUCTOR AERIAL CABLE.

SIZE	WEIGHT PER FOOT. (LBS)	DIAMETER. (INCHES)
4	3.50	2.25
2	4.05	2.41
1	4.45	2.50
1/0	4.80	2.57
2/0	5.70	2.66
4/0	6.70	2.91
250,000 CM.	7.05	3.00
350,000 CM.	8.05	3.22

For the suspension of the messenger strand, a 11/16 in. hole is bored through the center of the pole at right angles to the line and at a proper height for attaching the cable. A 5/8 in. double-end bolt is then placed through the hole, a 2¼ in. square washer placed on the bolt at each end, and made fast with a square nut. A suspension clamp is then put on the bolt and is held in place with a square nut as shown in Fig. 3. The messenger strand should always be placed above the bolts so that the weight of the cable shall not be supported by the clamp.

For supporting the aerial cable a 5/8 in. extra strength galvanized steel stranded messenger cable is used, and is placed as low as practicable consistent with obtaining proper clearances. It is rarely necessary to erect the messenger at a height more than 25 ft. above the ground. It should be placed in position to clear such obstacles as electric light or power wires by at least 4 ft. It is desirable, however, to have a clearance of 6 ft. where it can be obtained. The messenger strand should be drawn up very tight so as not to have excessive sagging after the aerial cable has been erected. In order to reduce the number of splices in the messenger, it should be strung in as long lengths as can be conveniently handled. Continuous lengths of 5,000 to 6,000 ft. can be handled to good advantage. The splices in the messenger are usually made at poles.

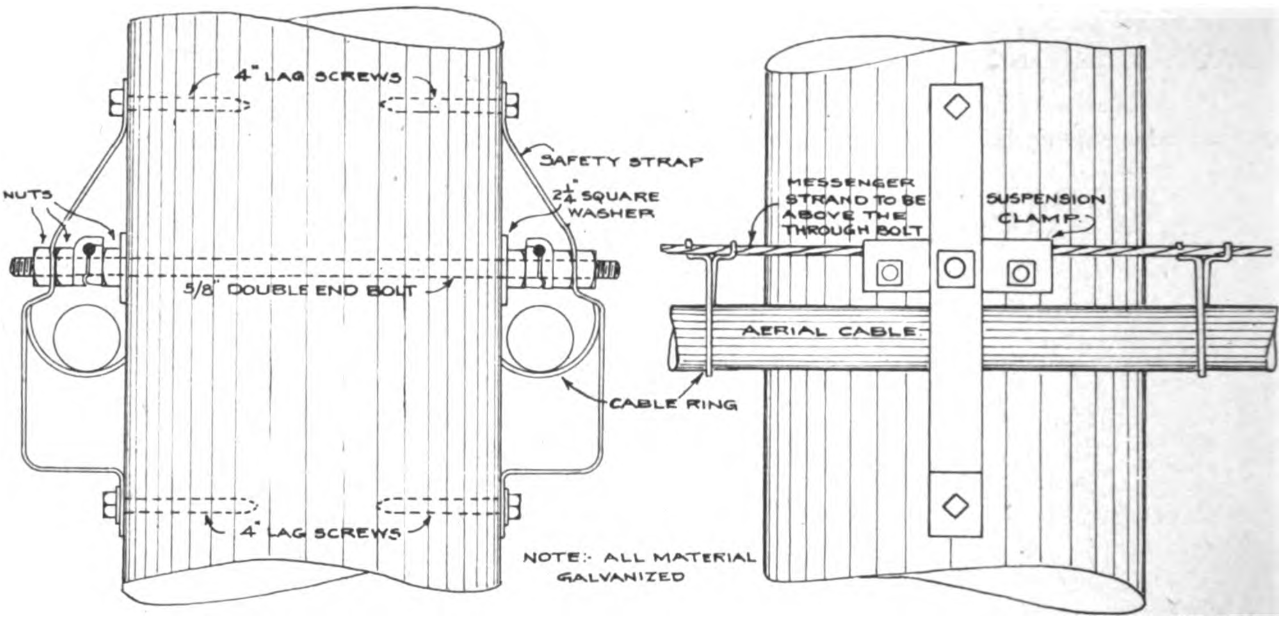


FIG. 3. DOUBLE END BOLT AND SUSPENSION CLAMP FOR SUPPORTING MESSENGER ALSO SHOWING SAFETY STRAP.

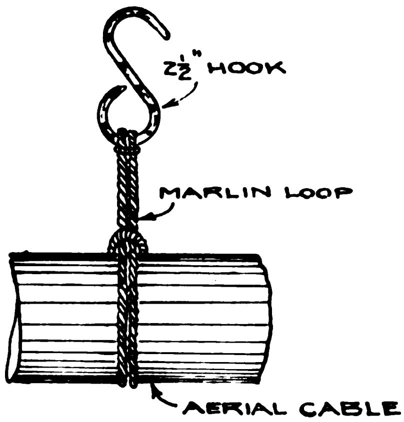


FIG. 4. MARLIN LOOP WITH S HOOK.

After the messenger strand has been erected and the poles well guyed, the next step is the erection of the aerial cable. This is handled by a combination gang of linemen and cablemen, consisting of one foreman, one chauffeur, five linemen, and six cablemen. With an automobile truck equipped with a windlass, 1500 ft. of aerial can easily be erected in one day.

Cable running blocks are made fast to the first five poles, a snatch block to the sixth pole, and a snatch block to the bottom of seventh pole. A 5000 lb. steel standard pulling-in line is then passed through the snatch blocks, and over the cable running blocks to the first pole where the cable reel is set up.

The cable is set up on reel jacks in the usual manner, and a woven wire cable grip is slipped over the cable end. The end of the pulling-in line, which is equipped with a swivel and a pair of sister hooks, is then connected to the cable grip.

When the cable is taken off the reel, marlin loops with S hooks attached, as shown in Fig. 4, are placed around the aerial cable and spaced about 2 ft. apart. As the cable is drawn up over the first block the S hooks are hooked to the messenger by a lineman. A lineman is stationed at each pole to remove the S hooks from the messenger on one side of the pole and attach it to the messenger on the other side of the pole as the cable passes by.

After a section of cable, which is generally ordered in lengths of 500 ft., has been pulled up in place, galvanized cable rings 3½ in in diameter are placed around the aerial cable and made fast to the messenger strand as shown in Figure 3. The rings are put on by a lineman riding the messenger strand in a bosun's chair. The rings are spaced 12 in. apart. As each ring is put in place it is clamped to the messenger with a power crimper or hand crimping pliers and the marlin loops are removed as fast as the galvanized rings are put in place. After the rings have been made fast, the aerial cable is made fast at the first pole and a strain is applied at the other end of the cable so as to take up the slack that is in the line. This operation is repeated until the desired amount of aerial cable is erected.

Where aerial cable is installed on steel grades so that there is danger of the cable slipping on the messenger, the cable is clampd to the messenger as shown in Fig. 5. The clamp is placed about 1 ft. from the pole on the down grade side of the pole. Additional clamps may be placed in the section if necessary. In order to increase the holding power of the clamp, a single layer of friction tape should be wrapped around both the messenger strand and aerial cable before the clamp is put in place. The clamp is installed as soon as the section of cable is installed on a grade.

At points where aerial cable is to turn corners the centenary method of installing the cable is desirable.

As the cable is ordered in lengths of 500 ft., the location of the joints depends on the spacing of the poles. On account of the cable not having a lead sheath, care must be taken so as to make a waterproof joint. Only thoroughly experienced cable splicers should be employed to make this kind of joint. As the joints are generally located between poles, it is necessary to erect a special platform for the splicer to stand on while making the joint. The joint is made in the following manner:

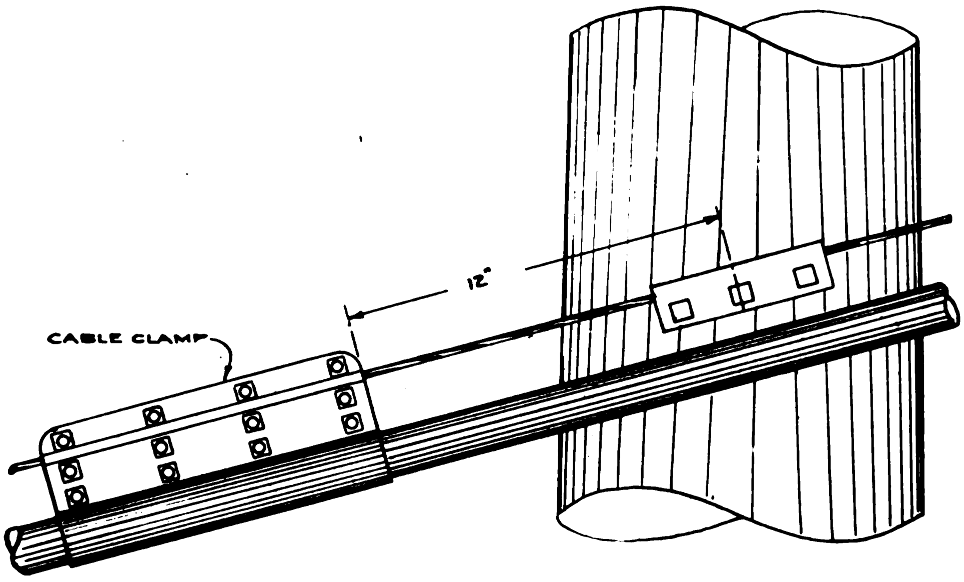


FIG. 5. SUPPORTING CABLE ON STEEP GRADE.

After the ends of the cable have been sawed off, the ends butted squarely together, and the conductors connected in the usual manner with copper connectors, each conductor is insulated with black, bias cut, varnished cambric tape which is built up to a thickness 30 percent. greater than the original insulation of the conductor. Between each layer of varnished cambric tape, insulating compound is applied with a brush so as to fill up the voids made by the lapping of the cambric tape. After the three conductors have been insulated, a jacket of varnished cambric tape is wrapped round the three conductors and is built up to a thickness of 4/32 in. The varnished tape is applied in the same manner as previously described. An additional jacket of high grade rubber tape is then put over the cambric jacket, built up to a thickness of 6/32 in. and painted between each layer with rubber compound. Four layers of friction tape are then wrapped round the joint and painted between the layers with rubber compound. Two layers of soft galvanized steel tape are then wrapped round the joint over which is applied four layers of friction tape thoroughly painted with weatherproof compound.

In addition to the cable rings located each side of the joints, supports should be provided for holding the joint in place. This is accomplished by clamping the joint to the messenger, also by lashing the cable at the ends of the joint to the messenger with marlin, as shown in Fig. 6. On account of the difficulties of rigging up a platform and installing special supports for the joint, a cable splicer will only make one joint in a day, which make the cost of the joint rather high.

It is sometimes necessary to install part of the transmission circuit through an underground zone. The aerial cable is then connected to the underground cable at the pole nearest the manhole where the underground cable terminates. An iron pipe lateral is installed from the manhole to pole and carried up the side of pole to a point a few feet under the aerial cable. Lead covered cable is then pulled in the iron pipe and spliced on the aerial cable as shown in Fig. 7.

The aerial cable is anchored to the messenger strand with a cable clamp so that there will be no strain on the joint. The end of the lateral pipe is equipped with a cable bell which prevents the creeping of the cable and the abrasion or chafing of the cable sheathing through coming in contact with the edge of the lateral. The bell is thoroughly packed with cotton waste packing and sealed with cement compound.

Where aerial cable is to connect to an open wire circuit, the cable is bent up and carried up the pole to a point just under the open wire circuit on the opposite side of the pole, and a suitable high voltage open air pot-head is spliced on the end of the cable as shown in Fig. 8. A pothead equipped with turnbuckle stems is preferable so that the open wires may be easily disconnected if necessary. The aerial cable at the pole where the pothead is installed is thoroughly anchored.

A galvanized eye bolt ⅝ in. in diameter is installed through the pole, a cable clamp placed around the cable, and a turnbuckle connection is made between the clamp and the eyebolt. The turnbuckle is drawn together so that there will be no strain on the pothead. Fig. 8 shows the method of anchoring the cable.

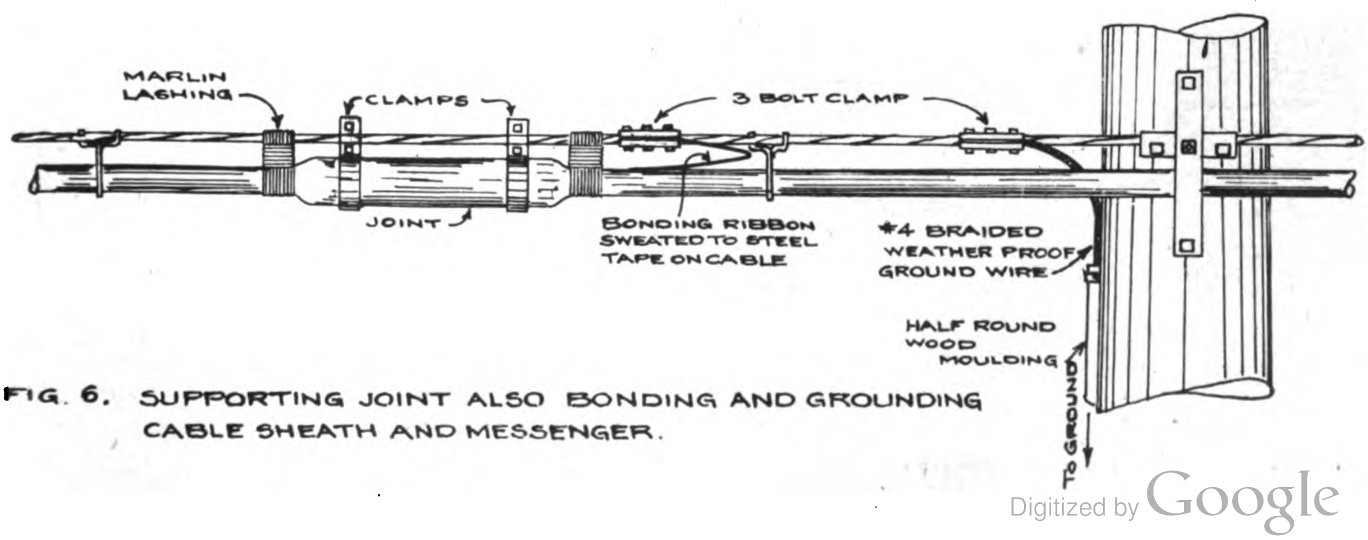


FIG. 6. SUPPORTING JOINT ALSO BONDING AND GROUNDING CABLE SHEATH AND MESSENGER.

The messenger strand is grounded at every fourth pole where the soil conditions are favorable; where the soil conditions are unfavorable the ground are installed at every second pole. If it is impossible, ground connection shoul possible, ground connection should be made to a water pipe; if that is not possible, however, a standard artificial pipe ground should be installed. The ground wire is a No. 4 braided weather proof and is connected to the messenger strand with a three-bolt clamp, as shown in Fig. 6. The messenger strand and the soft steel tape of the cable are bonded together at every joint with flat tinned copper bonding ribbon as shown in Fig. 6. The ground wire on the side of the pole is covered with wood molding.

When it is necessary to protect the cable from abrasion, the cable is covered with additional soft galvanized steel tape wrapped with one-half lap.

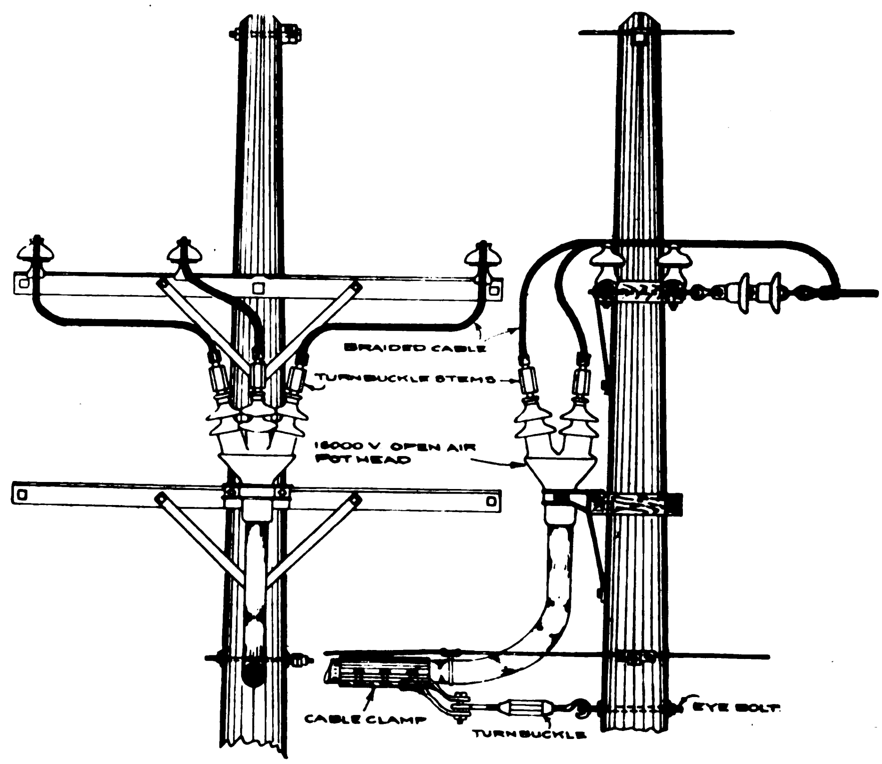


FIG 8. CONNECTING AERIAL CABLE TO AN OPEN WIRE CIRCUIT.

Galvanized safety straps are installed at every pole and made fast to the double-end bolt with a nut. Above and below the aerial cable is held in place with 4 in. lag screws, as shown in Fig. 3. The safety strap serves a double purpose of reinforcing the double end through bolt, and of preventing the aerial cable from falling to the ground in case the cable rings should fail. The straps are sufficiently strong to withstand the maximum loads to which they will be subjected.

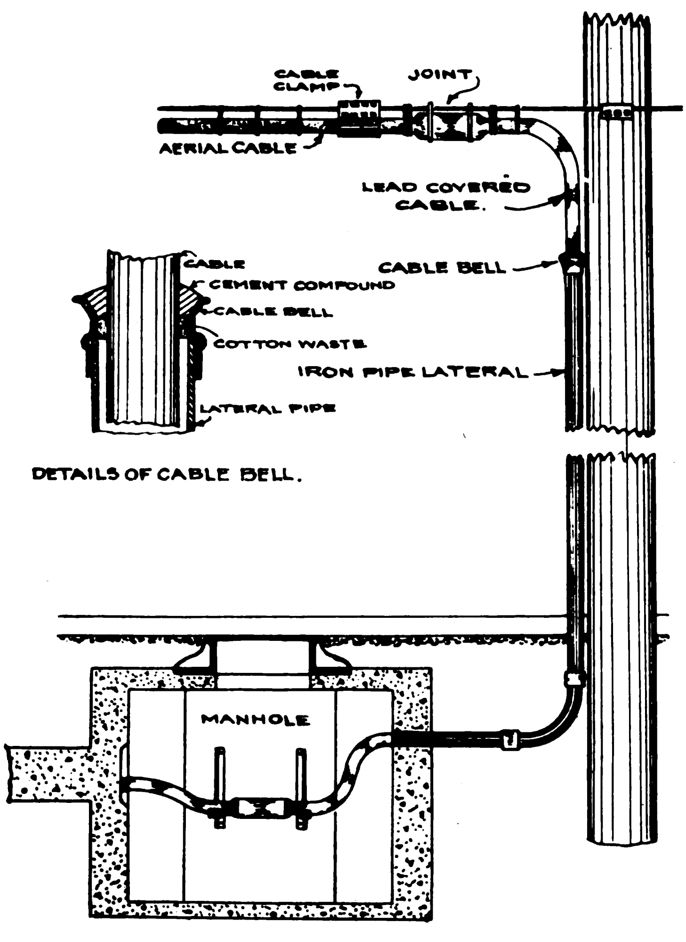


FIG. 7 METHOD CONNECTING UNDERGROUND CABLE TO AERIAL CABLE.

A brass tag, stamped with the proper circuit designation, is securely attached to the cable at each pole. It is very important that the cable be tagged, so that in case of trouble in a circuit the cable can be identified if there is more than one cable on the pole line.

Aerial cable has many advantages. It is an ideal form of construction for crossing over railroads, under bridges, over private property, and can be installed on poles in highways where open wire construction is not permitted by local authorities and where conduits cannot be installed either on account of coil condition or where the street pavement cannot be taken up on account of it being under bond. Linemen may work on pole lines where aerial cable is operating without danger to their lives. The maintenance cost is very low.

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A LETTER FROM AN ENGINEER AT THE FRONT

I had to come to France to learn that it is the army of the rear, back in the States, that is going to win or lose the war. The Army in France will do nothing new or extraordinary in building several hundred miles of railroad to the front. * * * but it was a momentous event when Wilson pooled the equipment and management of the railroads of the United States. Our engineers are building several hundred kilometers of military highway, but the Romans did as much a couple of thousand years ago, and did it much better—so well, in fact, that we still use their foundatio s. * * * The important thing is: Will you send us the trucks and supplies to roll over these roads? The mere act of digging a trench is nothing in itself—the Wops are the best at it—but will you build the ships to send the men to fill them?

The men here have done a big thing in surrendering comforts and facing death, but in the meantime life is a dreary skein of nagging details, a series of sickening endurances against boredom, fatigue, and hunger—but principally against boredom.

When I compare the importance of your work with ours I grow really envious. Before us we have the Boche—but alongside of you you have the pacifist, the defectionist, the selfish laborite, the greedy manufacturer and, worst of all, the loafer. I wish they could give you a sack of bombs and carte blanche to be after every loafer in field, factory, office, or Washington bureau.

We over here are absorbed in finding devices to keep warm at night; in schoolboy tricks in the barracks; in endless exercises with the grenade and bayonet; in minute study of the course and efficacy of tiny shell fragments. And down at the front they spend weeks watching a low dirt parapet or a clump of shattered trees.

In the meantime we must continue our flea hunting, our drills, our mathematics, and every once in a while take the big risk * * * and while you tackle the big problems our outlook is a few square kilometers of mud or a block or so of barracks, and our concern is whether the new lot of tobacco will arrive Wednesday and whether it will be horse or cow for supper.

THAWING FROZEN WATER PIPES

The thawing of frozen pipes with electricity is an extremely quick, simple and efficient method of gaining results which in the ordinary way takes days instead of minutes to obtain, says J. A. Vahey, in *Edison Life*.

It consists in connecting one side of an electrical supply to the pipe inside the building and the other side to the pipe system on the street, or in the case of mains, between two hydrants or other street connections, making sure that the frozen section is in the electrical circuit. The inside connection is generally made at the shut-off inside the building wall, and the outside connection to a hydrant or street shut-off. If there is no hydrant or other connection at hand, the current can be sent from one house to another, and, better still, if the pipes in two near-by houses are frozen both can be thawed at the same time. It makes no material difference how far the outside connection is from the building, as the current is forced to traverse the frozen section in order to return to its source.

A faucet or stop-cock being opened in the house, the current is turned on, and the pipe offering some resistance to the flow of electricity, as it is a somewhat poor conductor, heats sufficiently to loosen the ice particles and the water pressure does the rest. This pressure is a very great factor in the process, as it is only necessary to loosen the ice; whereas without the pressure it would have to be melted.

Remarkable as it may seem, the heat generated by the electric current is hardly appreciable, the pipe being barely warm to the touch and the time of application very short.

The average time that the current is applied in house services is about five or six minutes before the water appears.

In the Boston overhead districts the thawing outfits consisted of one or two transformers to lower the voltage taken from the lines, with a total capacity of about 600 lights. A barrel of water with heavy metal electrodes, one of which was movable, and a home-made windlass completed the apparatus, together with the necessary measuring instruments. This barrel contained a solution of common salt or chemical to make the water a better conductor and was used as a resistance to regulate the flow of current in the pipe circuit.

In the underground districts downtown, the transformers were unnecessary, current being taken directly from the direct-current system.

There were about thirty of these Boston Edison teams in action throughout the company's territory during the last winter's cold snap, the work being done by local electrical contractors for the various water departments. One well-known Boston contractor had sixteen outfits in operation practically night and day during the cold spell.

In places where there were no overhead or underground lines, the Edison laboratory had two storage battery sets in use, which made the simplest and most efficient of the thawing outfits.

Unlike other methods of thawing, electricity never damages the pipes, as there is no local application of heat to cause bursting. The warmth is gently applied to the entire length of pipe affected at the same instant, and an equal temperature being thus maintained no bad effects result.

The magnitude of the thawing work done this winter is greater than one would realize. Approximately 3,000 pipes were thawed this winter in Boston Edison territory, using about 30,000 kw-hr. electricity.

House services and mains up to 10 in. in diameter were successfully thawed, averaging in time from 10 to 24 hours on large mains, to from 1 to 15 minutes on house service. The duration of the freeze-ups varied greatly, from 24 hours to 6 weeks. Fire hydrants, sprinkler pipes—all came into the same category, and were handled successfully.

The average amount of current used was 250 amperes for ordinary sized pipes, to 700 amperes for large mains.

Considerable work was done on private country estates, sometimes necessitating the running of a mile or two of wire to reach the location.

THE DON'TS OF LIGHTING

The Industrial Commission of Wisconsin says:

Don't judge illumination at the work by the brightness of the lamps.

Don't work with a flickering light as the source of illumination.

Don't expose the eyes to an unshaded light source.

Don't work facing the light source.

Don't use a bright light against a dark background.

Don't work with dim illumination.

Don't expose the eyes to glare reflected from polished parts of the work table or desk.

Don't allow your body or other objects to cast dense shadows on the work.

MEASUREMENTS BY MEANS OF THE MERCURY COLUMN AND BAROMETER

Operatives engaged in power house work are sometimes called upon to determine the amount of vacuum in order to get true pressure in pounds per square inch, head in inches or millimeters of mercury at a stated or understood temperature, or in inches of vacuum referred to the mean atmospheric barometer. A U-tube containing mercury is employed for this purpose. How measurements are made by means of the mercury column and barometer is set forth in the following easy reading way in a booklet recently issued by the Wheeler Condenser and Engineering Co.

A U-tube filled with mercury, as used for measuring pressure above the atmosphere, is shown in Fig. 1. Changes in the pressure of the atmosphere itself need not be taken into account because the pressure of the atmosphere acts upon the

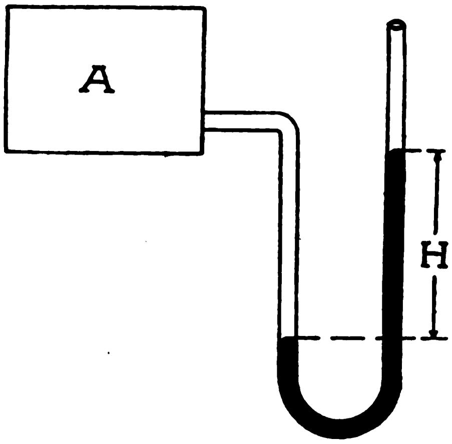

Fig. 1. Measurement of pressure above atmosphere.

mercury in one leg while the pressure to be measured acts upon the mercury in the other. The most important error in measurement of this kind is that due to the temperature of the mercury or other measuring liquid. There are other errors, i. e., those due to capillary attraction, the altitude, etc., expansion of the glass if the measuring scale is on the glass, or of a brass or wooden scale, etc.

Fig. 2 illustrates the method of using a U-tube filled with mercury for measuring pressures *below* the atmosphere or obtaining what are called vacuum readings. Vacuum column

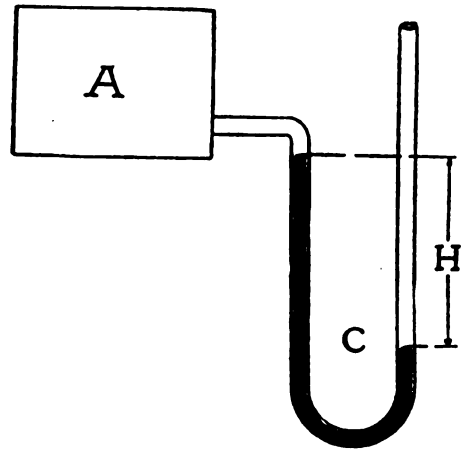

Fig. 2

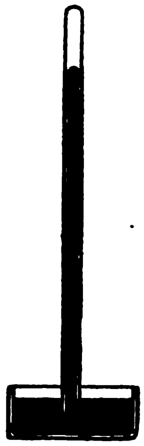

Fig. 3

Fig. 2.—Measurement of pressure below atmosphere.
Fig. 3.—Measurement of atmospheric pressure.

readings are indirect measurements for obtaining absolute pressures above 0. Thus in Fig. 2 the height H does not measure the pressure in A, but the difference between atmospheric pressure and the pressure to be measured. At C the atmospheric pressure is acting upon the surface of the mercury and at A the reduced pressure in the vessel, which may be a condenser, is acting upon the other surface of the mercury. The mercury therefore rises in one leg and falls in the other until a balance or equilibrium is secured. The difference in pressure for a square inch is measured by the *weight* of the mercury contained between the two levels in a vertical column of one sq. in. cross-section. If mercury did not change in volume at different temperatures, this weight of mercury would be measured by height H. But mercury expands and contracts with changes of temperature, and therefore mercury measurements must be based on some standard temperature.

As the atmospheric pressure is not constant, the vacuum reading has no invariable significance except it be corrected to an absolute pressure or referred to a standard barometer height. As shown in Fig. 3, the barometer consists simply of a sealed tube which is first filled with mercury and is then inverted with its open end beneath the level of mercury in a reservoir. Above the surface of the mercury in the tube, there is, ignoring the pressure of the mercury vapor, a practically perfect vacuum, so that the pressure bearing on the surface of the mercury in the reservoir supports in the tube a column of mercury, whose *weight* is a measure of the atmospheric pressure. As a means of determining this weight, we read by a vernier and scale the height of the mercury column and then apply corrections for expansion of the mercury, etc., from which the true atmospheric pressure is obtained in terms of mercury at a stated temperature, which corresponds to a known weight and therefore known pressure.

If the barometer and vacuum column readings are reduced to inches of mercury at 32 deg. F., then their difference will give the inches absolute pressure (with mercury at the physical standard of 32 deg. F.) within the condenser or other apparatus. If this inches absolute is substracted from 29.92 in., the difference will be the vacuum in inches of mercury referred to a barometer of 29.92 in. Lastly, if the barometer and the vacuum column are corrected to a temperature of 58.4 deg. F., then the difference between the figures will give the absolute pressure within the condenser in inches of mercury at 58.4 deg. F., and if this figure is substracted from 30 in. we have the inches of vacuum referred to a standard barometer of 30 in.

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HUMMING METERS

A paper entitled "Watthour Meter Maintenance," read by George Hewitt at a recent meeting of the Minnesota Electrical Association, contains some comments on the humming of meters that may be utiziled in a practical way by those of our readers who are engaged in installing and repairing these important central station adjuncts. Humming of meters, he said, may be due to internal causes such as loose irons in the laminations, improper assembling of the operating elements, etc., or to defects in the meter. Noise in some meters is often caused by the top bearing pin becoming rusted, or by clogging due to dirt and old dried oil between stationary and rotative parts, by loose play between the first and second register wheels, or a defective ball bearing. In other meters the noise is often caused by defective top bearings, flat jewels, weak jewel spring, looseness of the light-load compensator. Among the other makes of meters gummed up top bearings, or loose parts, and flat jewels are common sources of humming. These flat jewels are the cause of much noise when used in an induction meter; in fact, you should almost imagine that meters were designed to hum because the flat jewels allow the rotating element to shift easily. A slight amount of vibration is present in all induction meters, and the buzz and rattle is caused by the interaction of the vibrating alternating current magnetic field and the magnetic field produced by the permanent magnets. This may be explained by stating that the field of the current inducted into the disc by the magnets is attracted and repulsed by the field set up by the alternating currents in the potential and current coils of the meter. This action occurs 7200 times per minute and results in a continuous singing hum, or loud rattle, as the disc shaft is forced up one side of the jewel, then down again.

Before deciding that a meter is actually objectionable because of inherent humming, an investigation should be made to see if the trouble cannot be corrected by changing the meter's location or setting up a solid support. Unless a meter is located upon a solid support, the small vibration due the meter may be amplified, therefore it may be accepted as a fundamental rule that meters should not be located upon hollow walls or thin partitions which by their very nature act as sounding boards or amplifying media which take up and intensify any slight vibration of the meter. A meter tester can often help reduce the noise by putting rubber washers at the rear of the meter to act as cushions, he can adjust the meter to the local conditions, check up connections and perhaps at the same time detect tampering with the meter.

Noisy meters are most objectionable, as the continual hum and rattle is not only annoying but causes a customer to think that his meter is operating even though he has no lights burning, which results in many complaints being made to the office of central stations.

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UTILITY RATE ADVANCES ALLOWED

The extent to which rate advances have been allowed utility corporations for electric power, gas or street and interurban railway transportation service is shown by a compilation which is now being made by a well-known investment institution in New York City that is closely associated with numerous public utility corporations and their financing. The preliminary data show that public utility commissions have been quick to observe the dangers that lie in steadily mounting costs of operation with no corresponding increase in the cost of service to the consumer, and they have already granted fully five hundred requests for rate advances or fare adjustments in all parts of the country.

Another encouraging feature is that public utility corporations are able to charge more for their new service on new contracts and also that decisions are being given with greater promptness than formerly, showing that the rate-making bodies have sensed the situation quickly and also have found that public opinion is not so hostile to increases and reasonable adjustments as was supposed. In some instances there is no opposition whatever to rate adjustments.

It is believed, although the figures to support the argument have not yet been compiled, that the increases referred to will almost certainly wipe out practically all the increase in operating costs and put the operating corporation back in the position it occupied before last year's war prices for everything overwhelmed the country and all industry. This prospect will be strengthened by the fact that corporations which were whipsawed last year through failure to contract for coal supplies at reasonable prices and had to buy at the enormously swollen open market prices, are not going to be caught again and are making contracts ahead so they know just what is in front of them.

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WAR COURSE FOR ELECTRICIANS AND TELEPHONE MEN

A war training course for electricians and telephone men needed for the United States Army has just been published by the Federal Board for Vocational Education. This course, it is planned, will be given to drafted men, enlisted and detailed on subsistence and pay to schools co-operating with the Federal Government in the preparation of mechanics and technicians for military service. The course consists of 36 lectures and four class room, field and shop units on electric wiring, testing, motors and generators and telephone work. The instruction book is known as Bulletin No. 9 and may be secured free upon application to the Federal Board for Vocational Education, Ouray Building, Washington, D. C.

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SCIENTIFIC PIRACY

At a discussion on American versus German manufacturers at a meeting of the Cleveland Engineering Society a short time ago, it was the consensus of opinion that the modern impression of Germany's remarkable mental ability and scope is due, not to any real mental superiority in the person of the Teuton but to his skill and persistency in advertising that so-called fact. W. R. Mott, who has had a lot to do with electrical research work, said that we greatly overestimate German intelligence and cleverness.

"I made a search about 15 years ago," he said, "covering the entire literature on aluminum anodes, lightning arresters, and rectifiers. I read all the English, German, French, and Italian literature I could find on these subjects. I found that the Americans and the French had anticipated the Germans in the inventions in these lines by about 10 to 25 years, but that the Germans had taken the scientific world by storm as having invented the aluminum anode. The man I refer to was Bottome (U. S. Pat. 458,652, Sept. 1, 1891), the American inventor of the aluminum four-cell rectifier. The French inventor was Cael, who discovered the value of sulphate, chromate and phosphate solutions for rectification of currents with aluminum anodes. (See Cael, Annales Telegraphiques, vol. III, page 250, May-June, 1876.) However, Graetz, the German inventor, without referring to the work of Bottome or Cael, claims credit for their essential results. (See Zietschrift fur Elektrochemie, vol. 4, page 67, 1897.) The situation is that Graetz is given credit throughout the world for results first obtained in America and France many years earlier. (This is probably the result of the good abstracting system of the Germans.) The Germans are good imitators. They are like the ancient Greeks: they take the information that other people have and they are willing to improve upon it.

"In going over this literature I ran across certain characteristics that may be of interest. I will mention them very briefly. The Germans, it seems to me, have the power to do creative thinking along lines of essential similarity. The French excel in the study of elements of essential differences. The Italians excel in thought structure parallel to the plot and counter plot —a balancing of opposing factors. The Russians excel in drawing conclusions by the use of the close relation of properties at the two extremes of a series. The Americans excel in initiative and resourcefulness of their creative work. The English excel in aggressiveness and persistence.

"The dominant characteristic of the German literature is its enormous volume and its enormous power of abstracting all the other literature of the world. If there is anything in the abstract way that you want, you go to the German literature with its specialized journals, handbooks and dictionaries in every line."

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The following table given by Ives and Luckiesch shows candlepower per square inch of modern illuminants:

Carbon arc (crater)	84,000
Flaming arc	5,000
Nernst glower	3,010
Tungsten (1¼ watt c.p.)	1,600
Carbon incandescent (2½ watt c.p.)	400
Welsbach mantle	31
Cooper Hewitt tube lamp	15.9
Kerosene flame	9

In addition to the above table the intrinsic brilliancy of the gas-filled tungsten or nitrogen lamp is approximately 2,200.

A MECHANICAL RECTIFIER

By F. E. Austin

The following article is written to assist amateurs in constructing a simple device for the rectification of alternating current of ordinary commercial frequencies.

The greater proportion of circuits supplying private residences with electricity are so-called alternating-current circuits; that is, the applied pressures are alternating pressures, which when applied to any electrical device produce alternating currents in it. The frequency of the alternating-current must always be the same as that of the alternating pressure producing it, and the most common frequency found in practice is 60 cycles per second.

A single cycle of pressure or of current may be denoted by a simple curve like Fig. 1, having one lobe designated as positive (+) and the other lobe as negative (—). A 60-cycle pressure or current would mean 60 complete curves such as designated by Fig. 1. Very few alternating pressures or alternating currents are so simple in form as the curve shown in Fig. 1.

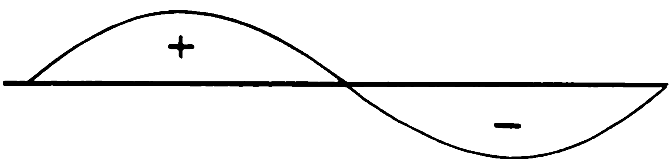

Fig. 1

The function of any rectifying device for an alternating current is to reverse one half the curve as indicated in Fig. 2. While both lobes are now positive (+), the direct current thus produced is pulsating. The pulsating nature of the direct current is not objectionable for many purposes, since its heating and power effects depend upon a certain averaged or effective value of all its varying instantaneous values.

A rectifier is therefore a device that reverses the direction of a current or pressure, during every other half cycle, in any given circuit.

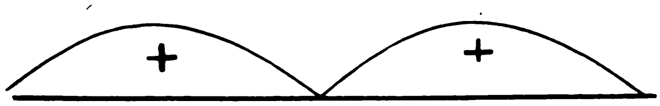

Fig. 2

One important practical application of rectified alternating currents is in the charging of storage batteries, whose use is greatly increasing.

Two important features are to be considered in any device for the rectification of alternating currents; simplicity and efficiency. Simplicity in construction will mean low first cost, and low maintenance charges, which factors greatly affect the economy of operation.

As the amateur often desires some simple device for obtaining a direct current supply from alternating-current service mains, the following simple apparatus which may be constructed by an ordinary experimenter with but few tools, is described.

As the operation of the device is based upon the principle of the so-called synchronous motor, a brief description of the principle of this type of motor may be advantageous.

If an alternating pressure is applied to the terminals of an electromagnet, an alternating current is produced, and the magnetism of the electromagnet reverses in direction twice every cycle. When the windings of an electromagnet are subjected to an alternating pressure at 60 cycles, a 60-cycle current is produced in the windings, and the polarity of the magnet reverses 120 times each second; that is, each end of the electromaget will be a *N* pole sixty times and a *S* pole sixty times, alternating with each other, during each second.

If the electromagnet has a solid iron core, the rapid reversals of magnetism, involving as they do the reversal of the molecules constituting the material of the iron, cause a considerable increase in the temperature of the iron. This heating effect may be greatly lessened by construcing the iron core of thin plates or making the core laminated.

The principle of operation of the synchronous motor may be explained by reference to Fig. 3. In this figure *MS* denotes a laminated electromagnet wound with two coils each having about 1800 turns of No. 22 cotton covered magnet wire.

If an alternating pressure, *E*, at 60 cycles is applied to the terminals of the electromagnet, the pole of the magnet designated as *S* will become a *S* pole sixty times every second and a *N* pole sixty times during the same second.

If a number of electromagnets are mounted in a cylinder of wood on a shaft as indicated in Fig. 3, so as to pass between the poles of the alternating magnet, if the moving electromagnets are so arranged as to allow a direct current to pass through their windings in the proper direction to make the end facing the observer a *N* pole, just as it nears the alternating magnet at the instant the pole of this magnet, next the observer is a S pole, an inpulse or pull is exerted between the two electromagnets, which tends to cause rotation of the movable magnets. Since unlike magnetic poles attract each other, the *N* and *S* poles on the other side of the device shown also attract each other, thus doubling the impulse on the rotating member. As shown in Fig. 3, the moving or rotating electromagnets receive a direct current from a battery through brushes *b*, *b*[1], and sectors

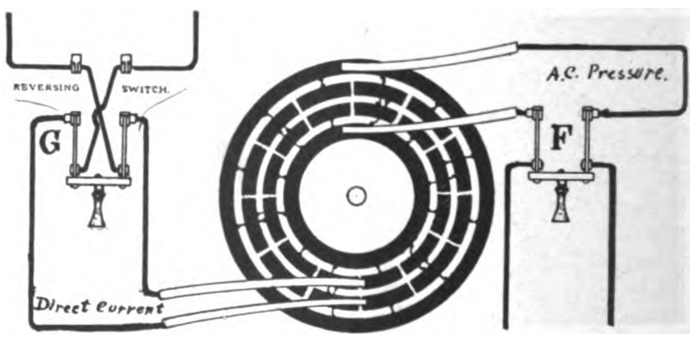

Fig. 4

of brass or copper, 1, 2, 3, 4, etc., fastened to the face of the wooden cylinder holding the movable electromagnets. It is evident that no electromagnet receives current except the one moving into the field of the alternating current magnet *MS*. because of the arrangement of segments and brushes.

The cores of the twelve electromagnets are of solid soft iron about ¼ in. in diameter and 2 in. long. As the current in these electromagnets is a direct current, it is not necessary to have the cores laminated like the large alternating current magnet *MS*.

Since there are twelve electromagnets mounted on the rotating cylinder, it is evident if the speed of this cylinder is 5 rev. per sec. (or 300 rev. per min.) that 60 impulses per second will act to cause the cylinder to rotate, if they occur at the proper time with reference to the position of the movable electromagnets and the alternating current magnet.

The speed of the revolving cylinder must evidently be properly timed with reference to the alternating magnetism of the alternating current magnet.

For the arrangement of twelve magnets as shown in Fig. 3, synchronous speed will be 300 rev. per min. if the frequency of the current in the magnet *MS* is 60 cycles per second. If the frequency of the current in *MS* should be only 30 cycles, the synchronous speed would be 2½ rev. per sec., or 150 rev. per min.

On the other hand, if there were just one-half as many movable magnets, or only six, then synchronous speed for 60 cycles will be 600 rev. per min.

If the rotating magnets are first speeded up above synchronous speed by switching on the battery current, allowing the rotor to act as a direct-current armature, and then the alternating current is switched onto the laminated alternating current *MS*, the revolving cylinder or the rotor will fall into step with the impulses of the alternating current magnet and when revolving at the proper synchronous speed will continue at this speed so long as the alternations do not vary excessively. A balance wheel weighing about 2 lb. attached to the rotor shaft will assist in keeping the rotor at the proper speed.

after the coils and cores have been assembled, by means of screws *H, I, J, K*, seen in Fig. 3.

The alternating current magnet *MS* may be held in position by wood blocks and wood screws, while hard wood blocks held to a base broad by wood screws will serve as bearings for the ¼ in. shaft holding the rotor and commutating device.

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PLASTIC REFRACTORY FOR BAFFLES

Defective baffling is the most common cause of high chimney temperatures. The baffles may have fallen down or bricks or blocks may have slipped out from between the boiler tubes, allowing the short-circuiting of a large amount of gas. The

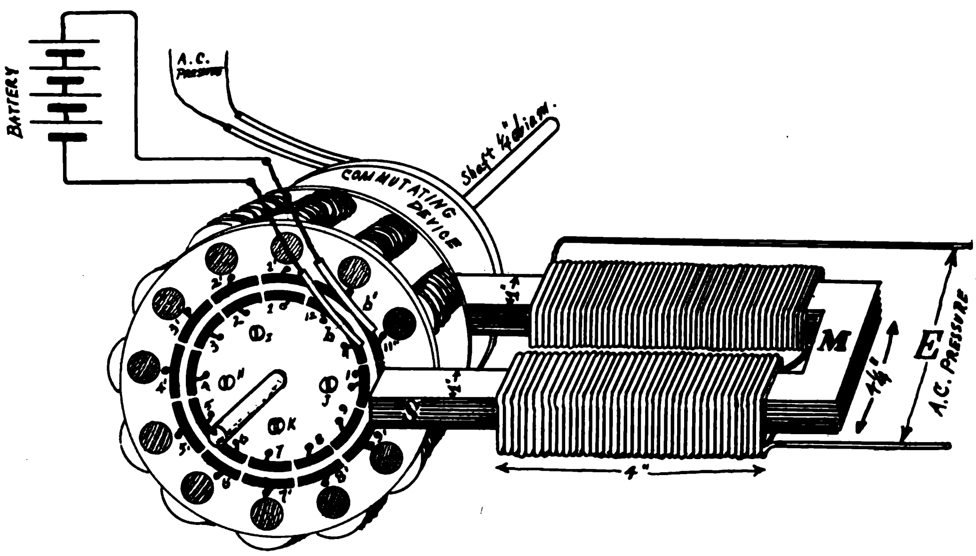
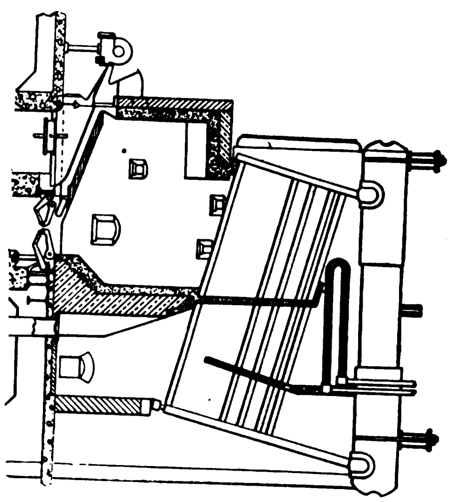


Fig. 3



The plastic material can be used for sloping baffles and tapering gas passages.

A commutator device shown in Fig. 4, made of brass or copper rings and segments, is fastened to the shaft to which the movable magnets are attached, and therefore rotates in unison with the magnets; or at the same speed.

The sectors of the commutating device are connected with the two slip-rings, *A* and *B*, as indicated; each alternate outer sector being connected with the outer slip ring, and the other outer sectors connected with the inner slip ring. The corresponding connections are made between the inner sector and the inner slip ring.

Brushes *D* and *C* lead the alternating current, at any pressure desired, into the commutating device, and brushes *F* and *G* lead it out, at the same pressure, a direct current, when the speed of the commutating device is at synchronous speed as compared with the frequency of the alternating current.

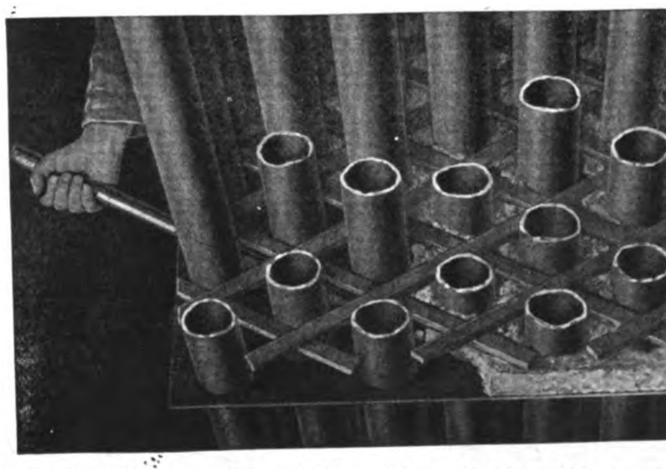
When the commutator arrangement shown in Fig. 4 is operating at synchronous speed, it is the proper speed for reversing each half lobe by the sectors, and the alternating circuit may be switched on to this commutator by closing the switch *F*. Closing switch *G* will allow the direct current, or the rectified alternating current to flow in any desired device or apparatus.

The wire for the rotating coils may be No. 16 or No. 18 double cotton wound, B. & S. gauge copper, wound on the ¼ in. diameter soft iron cores, in even turns and layers, and all coils wound in the same direction. The inside terminals are each fastened to a separate outer sector, while each outside terminal is attached to an inner sector. This insures that each end of the magnetized core facing the observer is of similiar polarity, when approaching the alternating current.

One of the twelve electromagnets is shown in Fig. 5. Hard fiber or heavy cardboard washers may be driven on the ¼ in. cores at a sufficient distance from the ends (about ¼ in.) to allow the protruding ends to be inserted into the wooden rings joining the rotor. The wooden rings may be held together

strongest reason for the installation of pyrometers to measure flue gas temperatures is that they serve to notify the operating force at once regarding baffle failures. Where abnormally high temperatures are found, a broken-down baffle is always to be expected.

The accompanying illustration shows how jointless, and therefore gas-tight, baffles can be made by the use of a refractory

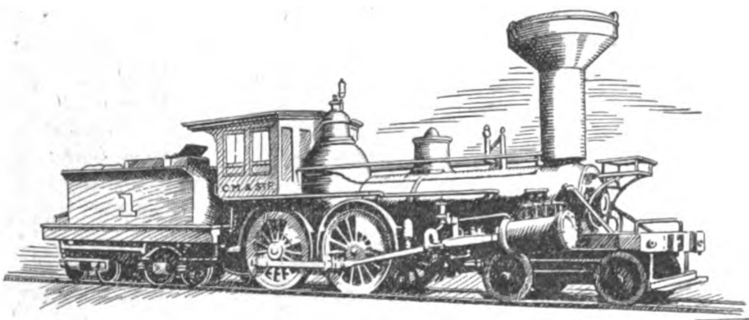


Method of placing and compacting Betson plastic, which is retained in place by a criss-cross of slats until set by the fire.

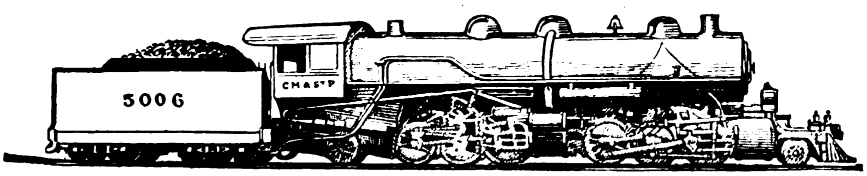
known under the trade name of "Plastic Fire Brick" and manufactured by the Betson Plastic Fire Brick Co., of Rome, N. Y. This material was originally introduced for lining boiler furnaces, and is compounded of refractory materials so prepared as practically to eliminate expansion and contraction with changes in temperature.

LOCOMOTIVE DEVELOPMENT 1848-1918

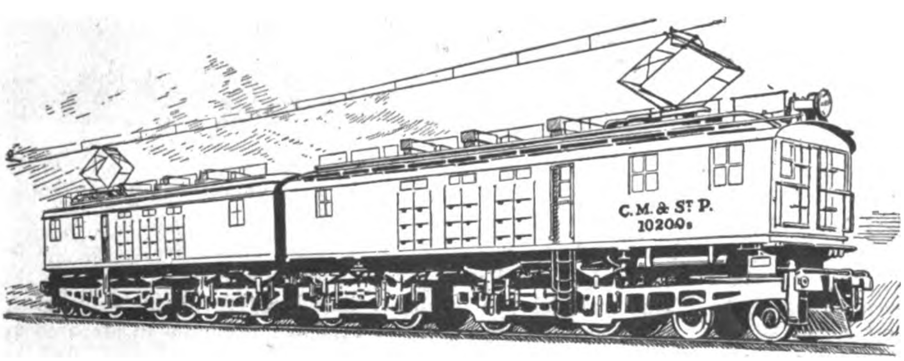
The accompanying cuts, used in illustrating a pamphlet entitled, "Electrifying the Rockies," recently published by the Champion Coated Paper Co., of New York, show three of the various types of locomotives that have been used since 1848 for freight and passenger service on one or more of the lines that now comprise the Chicago, Milwaukee and St. Paul R. R. The first cut shows the first engine to be used in Wisconsin. This is the kind of locomotive that was used to haul traffic in 1848. In 1910 the mallet compound locomotive shown in the second cut was adopted. Many of these locomotives are still in use on the divisions which have not yet been electrified. With the electrification of that part of the St. Paul system which extends for 440 miles from Harlowton, Mont., to Avery, Ida., through the Belt, Rocky, and Bitter Root Mountains, the St. Paul system adopted the type of electric locomotive shown in the third cut. Electric locomotives similar to that shown here are now in daily use in hauling freight and passengers over this division, the tunnels being traversed without the smoke, fumes, and cinders that formerly accompanied the passage of steam trains through these tunnels.



The first railroad engine to turn a wheel in Wisconsin, 1848.



Mallet compound locomotive, weight 561,700 *lb.,* 1900.



Latest type of Electrical locomotive, weight 568,000 *lb.*

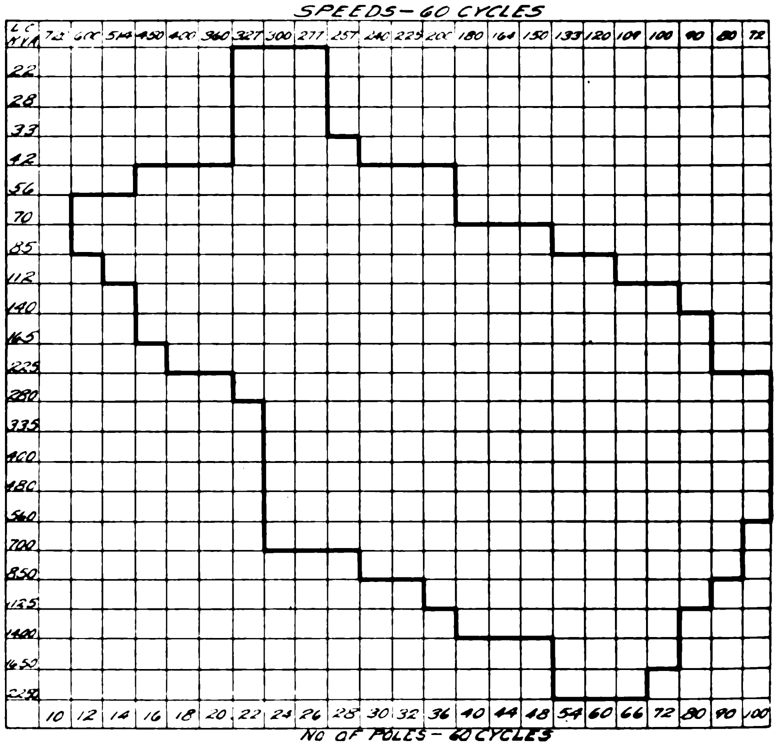


Chart showing range of sizes and speeds of all vertical alternators now being marketed by the Electric Machinery Co., Minneapolis, Minn.

FIRST TOWN LIGHTED BY ELECTRICITY

Carlow, a small Irish city, situated about 38 miles from Dublin, and in the centre of the richest agricultural section of the Green Isle, claims the distinction of being the first town of its size in the world to be lighted by electricity says the *Edison Monthly*. The system was installed in 1884 and was in operation in 1887, the year of Queen Victoria's Golden Jubilee. American education and training were, however, responsible for Carlow's leadership as William J. Handley, the engineer who did the work, was the American son of Irish parents. He made his studies in electricity in Cornell University and served a short apprenticeship at the Edison shops in Menlo Park, N. J. As a reward for his initiative, Her Majesty bestowed upon him a special decoration, and the South Kensington (London) Society presented him with a gold medal.

The original electric lighting system in Carlow consisted of iron posts about eight feet high, on each of which was placed a single incandescent lamp behind which was set a reflector about 12 in. in diameter. The posts were set 200 ft. apart and were extended over two and one-half miles of street.

EDITORIAL

NIAGARA'S REAL MISSION

At last month's meeting of the Canadian Society of Civil Engineers in Toronto, called for the purpose of discussing the scarcity of fuel, it was reaffirmed that at the present price of coal, electric service for heating purposes must sell in bulk for about a quarter of a cent a kilowatt-hour before it can hope to compete with the ordinary type of coal furnace as a heat maker. Electricity in bulk cannot be furnished at this extremely low price until the water powers are harnessed; until they are considered not as marvels of scenic grandeur but as practical devices contrived for practical purposes. The most impressive water power of them all, Niagara, comes first in the priority list of fuel conservers, as it is first in the scenic wonders of North America. To Niagara, then, we must turn to get electricity in sufficient bulk to compete with coal for heating purposes, and thus release coal for essential industry and transportation purposes. In times of stress, like those we are now passing through, what we need is not scenery but munitions. Waterfalls must be thought of as valuable only as they possess the quality of being converted by electrical means into heat, light, and power. Between the will to win the war and the desire to be impressed by the majesty of falling waters, the desire stands no chance at all. The thunder of mighty waters must give way to the thunder of guns on the Western Front, and Niagara as an extractor of atmospheric nitrogen and maker of munitions on both sides of the border must take precedence over Niagara as a spectacle if Britons and Americans would retain the right to mold their own destinies. These practical conclusions are concurred in by all engineers who put life, liberty, and the pursuit of happiness above the desire to be thrilled by the sight and sound of that wonderful cataract.

The hydraulic engineer of the Ontario Hydro-Electric Commission voiced the thoughts of all patriotic engineers when he said at this convention that probably ninety percent of the civilized inhabitants of this planet know Niagara only as a scenic spectacle, though most of them have felt the commercial influence of Niagara without realizing it. Most of their information about this wonderful water power has been obtained from picture post-cards. Since power was first developed at Niagara Falls, a continuous campaign of opposition to its commercial exploitations has been carried on. This opposition, based on aesthetic grounds, has left its mark on legislation on both sides of the line, and is reflected in the Boundary Water Treaty. This opposition is largely responsible for the shortage of power and fuel at this time, the waste of power at Niagara affecting in some degree all our essential industries.

The phrase "commercial exploitation" may sound cold-blooded, this engineer continued, but one might as well call a spade a spade and admit frankly that the true glory of Niagara lies not in the roar and the rainbows but in the vast potentiality of the falling waters considered in the light of an instrument placed in our hands by Providence for a beneficial purpose. For the last twenty-five years—the first dynamos were installed there in 1893—the scenic idealists and the non-scenic practicalists have contended over the disposition of these foaming and tumbling waters. If practical men like Sir Adam Beck felt eight years ago that Niagara should be looked upon as something designed "to raise the scale of living of our citizens and to multiply and cheapen the comforts of life"—he was probably thinking of its huge water power in terms of knives, scissors, clocks, matches, lead pencils, and such trifles—how much more potent now is the argument for utilizing all of its power when that power might easily be the deciding factor in the contest between those who would enslave and those who would liberate mankind.

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WORKERS WANTED

The Government is already seriously hampered by lack of labor. In England the Government started a labor bureau to care for unemployment. In one month it was changed to a bureau to procure employees. Our Government is already taking steps to meet this emergency. Remember, it will itself be the great purchaser and consumer.

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APPEAL TO REASON

At the last session Congress passed a law which establishes a postal "zone" system for magazines and periodicals. It passed a law increasing the postage on periodicals to you, the readers of this publication, from 50 to 900 per cent. And it did it by reestablishing a postal zone system that was abolished by President Lincoln in 1863. Instead of a flat rate, made as cheap as possible in order that there could be a chance for the intelligent consideration of public questions to reach the farthest limits of the country and the most

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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?

remote habitation on an equal basis, the magazines containing all this discussion and all the best fiction and all the best art must hereafter pay an excess rate like so much fish or canned lobster or fabricated steel. You are going to buy your education by the pound-mile now. It isn't a free flowing stream from which all may drink. It has been dammed and its flow checked. Congress did it. If it would bring any increase to the revenue of the country that would amount to anything, it would never be opposed. But it wont. It will drive magazines out of business. Write to your congressman about it. Demand the repeal of this particular passage.

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WHY WE MUST SAVE

Our Government wants to spend 19 billion dollars this year, a sum so vast that it cannot be comprehended. From 1791 to January 1, 1917, a period of 126 years, the Government spent only 26 billion, 300 million for all purposes—for wars and in times of peace, for pensions, for the Panama Canal, and for every other expense of the Government. This is only about five billion dollars more than has been appropriated by Congress to be spent in one year to provide for the tremendous demands of the war. This sum cannot be borrowed except from the people. It cannot be raised except by taxation or loans. It cannot be raised by either method except from the current income of the people. We must save, save, save and lend those savings to the Government.

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ELSEWHERE IN THIS ISSUE

If any one phrase is worn threadbare from over use in the sanctum sanctorums of trade papers, that phrase is "elsewhere in this issue." In point of frequency, this phrase runs a dead heat with the word "recently" in the news columns, with "the trouble is" in conversation, and "in connection with" in the discussions at meetings of erudite engineering societies. Accompanied by other original verbal gems like "as pointed out," "as Mr. Smith so aptly says," "according to the statement made by John Jones at last month's meeting of the Verbosity Association," "he went on to say," hackneyed elsewhere in this issue is used to take the curse off leaders which repeat in substance and in form much that can be found in the story part of the paper. Leaders of this kind are easy to put together: in the language of the street, they'rea cinch. Any one can write 'em, provided he is equipped with a set of phrases like "owing to the fact," "all that sort of thing," "and so forth," "more or less," "somewhat in the nature of" and "the point I wish to make." Editors who are ready to go to press and are short on inspiration; editors who are temporarily persona non grata with the Muses; editors who have nothing to say and can't scratch up an idea—all know the trick of utilizing these connectors in writing bass drum leaders that make a big noise but have nothing much to say beyond that which is already said in a better sort of way elsewhere in the issue.

Elsewhere in this issue will be found the sort of stuff that ought to be found in a magazine that concentrates on the theory and practice of electrical generation and transmission, and the utilization of electrical energy. It is set in eight point leaded, some of it being embellished with pictures and diagrams. There it is for our readers who are equipped with heads, eyes, and brains—all of them are normal in this respect, we hope—to take in, digest, and then draw their own conclusions. Believing they are capable of reading understandingly and of forming their own conclusions, we feel it is not part of our job to regale them with the same old stuff reset in ten point leaded and mechanically transferred to another page, there to strut sans picture and sans diagram, to take on originality and dignity, and to promenade at the fashionable hour with those ubiquitous bromides, elsewhere in this issue it is pointed out and so forth.

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INCREASED COST OF SERVICE

In granting the Portland Railway, Light & Power Co. the right to increase its street railway fares from 5 to 6 cents, the Public Service Commission of Oregon says that few are aware, even among the best informed, of the revolution that has taken place in the last 10 or 15 years in the relations between public service corporations and the communities which they serve. The popular imagination still beholds the corporation seated astride the people's neck, dominating its policies, corrupting its officals, using its streets and thoroughfares without compensation and exacting enormous profits from fictitious investments. But, however true this picture may have been in the past, the public control of utilities has restored the authority of the people over these servants. The properties of these utilities are now carefully examined and appraised at their true value. Any water in their stocks is disregarded and rates are established on the basis of reasonable cost to the consumer and fair return to the investor.

It is time for the public to realize, the commission added, that the powers conferred upon public service commissions, thoroughly tested and upheld by the courts, are ample for the protection of the public against all the evils from which they have suffered in the past. It is time also to realize that good service can be obtained only by just and equitable treatment. No starved horse ever pulled a heavy load. The utilities have been deprived of the power to make unjust profits. They must also be protected against unjust losses. If a utility is driven into a position where its credit is impaired and it can obtain money for operations and extensions only at unreasonable cost, the public must share the loss.

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OUR OBLIGATION

As a nation we have drafted men to fight for us. That means we have chosen them to suffer hardship and to sacrifice life, if need be, to protect us and our interests. This places upon each one of us an equal obligation to suffer whatever hardships are necessary to give them all the equipment they need for success.

ELECTRIC WELDING IN SHIPBUILDING

By James H. Collins

The other day the Emergency Fleet Corporation announced that training centers would be opened for teaching electric welding to shipyard workers. Electric welding of ship parts is now being done at several yards—the Submarine Boat Corporation, Newark, N. J.; Chester Shipbuilding Company, Chester, Pa., and the American International Shipbuilding Corporation at Hog Island, near Philadelphia. A large scale electric welding job is also being carried out as a test by Arthur J. Mason at the Federal Shipbuilding plant in Newark, N. J., involving the construction of part of a hull by this process. Furthermore, the Emergency Fleet Corporation has recently had the benefit of advice on this new method from Capt. James Caldwell, a British government expert sent to the United States for that purpose.

Rivetless Ship Predicted

Progress in electric welding has been so rapid that some prophets predict the speedy advent of the rivetless ship; that is, a steel ship put together entirely by welding. But, while the welded ship is undoubtedly coming in the future, probably the prophets are a little ahead of their time as usual, for present applications of this process are chiefly to the joining of internal parts. There is no doubt about electric welding on hulls so far as strength and water tightness are concerned, but the process is so radically new, most shipbuilders say, and involves such changes in the erection of material on the ship that probably our present shipyards equipped for erection under bolting and riveting conditions could not be economically diverted to the welded ship—special shipyard equipment will be needed and perhaps a specially designed type of ship.

What is this electric welding process? There are really two processes, spot welding and arc welding. Both utilize the tremendous heat generated by electric current to fuse ship steel and join it together. Spot welding approximates riveting. Instead of punching holes in steel plates and fastening them with a hot rivet, the two electrodes are applied to opposite sides of the plates to be joined, electric current is turned on, the plates act as a resistance, the metal at one spot about the diameter of a rivet is fused in a few seconds and while in a molten condition enormous pressure—as high as twelve tons per square inch—is applied, pressing the plates together and making a joint said to be stronger than the plates themselves.

Stronger Than Plates

Spot welded joints of this kind have been tested by pulling apart and their strength is shown in the giving way of the steel plate instead of the welded spot. 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 ends and add some of their material to the point.

Two forms of electrodes are used—the bare and the covered. Under the terrific heat generated there is likelihood of oxygen becoming mixed in the fused metal where the bare electrode is used, causing bubbles or weakness. To overcome this difficulty in England the spot weld electrodes are coated with some other material which prevents the access of oxygen.

Quite a technical discussion now turns on the subject of bare versus covered electrodes in the spot welding process. We have had considerable success in this country with the bare electrodes and for practical purposes the difference in the two methods seems to be about this: With the covered electrodes, used chiefly in England, spot welding can be done with less skill than is required where the bare electrode is used, but where an operator acquires skill with the bare electrode welding can be done much faster.

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Reprinted from *Emergency Fleet News.*

Forms Continuous Seam

Arc welding is done with copper electrodes which do not fuse and the operator draws them steadily along the edges of plates to be joined together, forming a continuous fused seam. Instead of the electric current, using the steel plates as a resistance, it fuses them with almost incredible rapidity, transforming part of the metal into vapor. This metal vapor forms an arc for the passage of the current; the whole process is carried out in a period of from ten to twenty seconds. It is done so quickly that the metal has no time to burn or crystallize. Spot welding is the equivalent of riveting, while arc welding along a continuous seam is the equivalent of caulking.

At the New York Shipbuilding Corporation yard in Camden recently, a standard water-tight navy bulkhead door was constructed entirely by electric welding, the spot process being used instead of rivets, and the arc process for caulking. It is said that no door of this type made by riveting and caulking has ever been submitted to a test of more than fifteen pounds water pressure per square inch. The electric welded door was subjected to a test of twenty-three pounds per square inch and did not leak a drop.

Both processes of electric welding are highly important to the building of our emergency fleet to-day, because they offer a way to speed up work. Wherever ship parts can be put together in this manner the rate of progress in actual joining is estimated to be twice or three times as fast as riveting, while all the operations of punching plates, bolting them together, and heating and driving the rivets are eliminated.

So, pending the time when the prophets' predictions are realized, and we have the true welded ship without a rivet in her make-up, there is an immediate advantage in applying electric welding to that large percentage of ship work inside the hull and on deck houses, hatches and other superstructure. Electric welding can be done faster than riveting and will enable each shipyard volunteer to apply his energies more directly and double his output. When electric welding has been fully installed it may also reduce costs in shipbuilding, but cheapness to-day is a secondary factor—speed is what Uncle Sam urgently needs, and electric welding will undoubtedly give speed and hurry the ships into the water.

Used First On Light Jobs

The development of electric welding in British shipyards grew out of shortage in acetylene and oxygen, for under the enormous requirements created by war industries the supplies of these gases soon proved inadequate. So the electric current was called on to the job and used at first in welding comparatively light work, such as mines, bombs, aerial torpedoes and other munitions. This led to its being used for such ship work as tanks, pipe flanges, deck houses and other comparatively light jobs, with a development on heavier plates.

Experimental welding done in one large American research laboratory has been carried out in joining three one-inch plates together by spot welding under heavy pressure and with what is declared to be entire success. Electric welding has an advantage over oxy-acetylene and other gas flame processes in that, by reason of the great speed with which the electric current fuses metal in a small area, hardly affecting surrounding metal, there is freedom from bubbling and warping incident to other processes.

Development of electric welding in shipyards indicates a growing demand for operators in this field, and the industrial training department of the Emergency Fleet Corporation is now establishing a number of training centers for the teaching of electric welding operators.

Yards which have no welding equipment as yet, but contemplate the installation of an outfit can save time in training operators by selecting competent men before their welding equipment is ready, and sending them to one of the training centers for instruction. It is important that the men chosen for such training have an adequate mechanical experience, preferably in metal work. Technical training, such as knowledge of metals, drawing or electricity, will be of advantage. A brief experience in oxy-acetylene welding is an advantage to the student, but a long experience in this work is a hindrance. Good eyes and general good health are also important. Men between the ages of twenty-five and forty years are preferable.

Shipyards Reimbursed

Shipyards sending men to electric welding training centers before June 1 will be reimbursed at the rate of $5 a day for each day's attendance, paid when the course is completed. Shipyards will retain pupils on their pay rolls, paying their wages and necessary expenses during the course of training.

Where shipyards have welding equipment of sufficient size (five or six electrodes or more) they are urged to send a skilled operator to the Newport News training center to be instructed in the teaching of electric welding to others, so that yards may train their own operators in the shortest time. A rigid standard of skill is required of electric welding operators before they can be certified as competent to work on ships. Information concerning such training and the location of the centers may be obtained by addressing the Industrial Training Department, Emergency Fleet Corporation, 136 South 16th Street, Philadelphia, Pa.

MORE LIGHT

The last vestige of lightless nights as a fuel saving measure disappeared on April 22, by action of Fuel Administrator Garfield. On the suggestion of the Liberty Loan Committee he announced that all restrictions on lights, night signs, and street lamps are removed until next September.

The ban on lights was lifted, except in a small number of cases, early in March.

WIN THE WAR CONVENTION

President John W. Lieb, of the National Electric Light Association, has sent the following notice to members:

"The thirty-fourth annual meeting of the National Electric Light Association and its forty-first convention, to be held at the Hotel Traymore, Atlantic City, June 13 and 14, 1918, will be devoted entirely to problems of the war. This will be a strictly business meeting, without entertainment of any kind. It will concern itself entirely with the vital problems of the industry arising out of the war, toward the winning of which the thoughts and energies of every public utility must be consecrated.

No papers will be read. Reports from committees and individuals and discussions will be confined to matters of major importance, and the brief two days will allow no time for the usual helpful discussions on general topics relating to the progress of the art. Everything said and done must be keyed to a victorious conclusion, and an early one, of the great struggle on which our nation has entered and in which our industry is taking a part of continually growing importance.

Our industry, increasingly a permeating factor in the national life, is now subjected to abnormal strains on its personnel and resources. It is the desire at such a vital juncture to devote the time and energies of the association and of those at the convention to only one enterprise which now counts—winning the war."

HOW TO BABBITT A LOOSE PULLEY

To those who know how to do this these directions will seem unnecessary. Those who do not, will do well to remember them. If the pulley is to be babbitted on the shaft it is to be run on, and in the position it is to occupy when done, and the tight pulley is in place and is known to run true, it can easily be set in place by that pulley. If an arbor is to be used, first secure it in a perfectly upright position, put a collar on it for the hub by using any suitable material, such as paper, cardboard, wicking or putty. Cover the shaft or arbor with a thickness of oiled paper held in place by strings wound from ends toward the center in the same direction the pulley is to turn on the shaft when in place. This will give circular oil channels converging toward the centers of the hub, and as the pulley revolves, has a tendency to keep the oil in the bearing, instead of throwing it out at the ends. If the job is such that it cannot be set up on end reverse the operation by levelling the shaft and using a plumb line across the rim of the pulley. In a case of this kind, an extra hole should be drilled through the hub for pouring the metal, so as to save drilling out the holes for the oil cups.

In cold weather, or if the space to be filled is small, the shaft should be heated to insure a good job and in all cases the cavity should remain rough enough to retain the metal in place, as nothing will make more trouble than a loose or broken filling in a pulley. There is no substance more extensively used (except iron) or on which the comfort of an engineer more depends, than on babbitt, or some of the anti-friction metals bearing that name and a knowledge of how to use it should be one of the qualifications of every engineer.

With a good quality of babbitt and a proper kind of ladle—one with a small-pointed snout—there is no necessity for a large hole for pouring. Keeping these few hints in view, it will be easy to secure a satisfactory job at the first time. These directions are embodied in an engineers' handbook published by the Erie Engine Works, of Erie, Pa.

OBJECTIONS TO FEEDING COLD WATER

The practice of feeding cold water into a boiler and delivering it near the shell, cannot be too strongly condemned, says the Engineers' Handbook issued by the Erie Engine Works. Boilers fed in this manner invariably leak at the seams near where the water is delivered, and show other unmistakable signs of distress. If the use of cold water is unavoidable, a "circulating" feed-pipe should always be used. This is a pipe entering horizontally through the front head, near one side, a few inches below the water-level, thence running back to within one or two feet of the back head, then crossing over to the other side of the boiler and projecting downward between the tubes and sides of the shell. The water is thus caused to traverse the entire length, and nearly the whole width of the boiler, and is finally delivered downward into the coolest part of the water. By this means it is heated nearly or quite to the temperature of the main body of the water in the boiler before it can possibly come in contact with any part of the shell, and so the evils of violent contraction are entirely obviated. Of course, where an injector or feed-water heater are used all the time this is not so essential.

The eye is capable of adapting itself to see under illumination intensities which range from a small fraction of a foot-candle to several thousand foot-candles in value. At very low intensities the eye does not receive sufficient light to enable it to distinguish color or detail, and at very high values, a blinding effect which also obliterates detail is experienced.

THE TRADE IN PRINT

What The Industry is Doing in a Literary Way

Motor-Driven, Non-Pulsating Pumps form the subject of an illustrated 16-page catalogue issued by the Luitwieler Pumping Engine Co., of Rochester, N. Y.

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Mueller Electric Co., Cleveland, Ohio, has just issued a 4-page flier describing the construction and operation of the Mueller No. 4 attach plug.

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Pass & Seymour, Inc., Solvay, N. Y., are distributing looseleaf circular 52-A containing cuts and descriptive particulars of P. & S. pull canopy fixture switches.

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Vapor-proof Marine Fittings for the shipbuilding industry are illustrated and described in a three-color folder recently issued by the V. V. Fittings Co., of Philadelphia, Pa.

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Arrow E interchangeable porcelain socket body parts and fixture caps are covered in loose-leaf folder 41-A-D issued last month by the Arrow Electric Co., Hartford, Conn.

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General Electric Co., Schenectady, N. Y., is distributing Bulletins Nos. 44017 and 44678. The first contains data about miniature direct current instruments; drum type controllers for railway service are described in No. 44678.

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Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., is distributing a handsome folder containing illustrated bulletins on elecric cranes and hoists. The cuts used here are unusually good, particularly those showing cranes operating in factories and yards.

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Engineers' Handbook published by the Erie Engine Works, of Erie, Pa., should be on the desk of all operating engineers, both steam and electrical. Containing a wealth of both descriptive and tabular material, it will be found useful as a book of reference.

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Contact for May, 1918, issued by the Westinghouse Electric & Mfg. Co., tells about this year's fan campaign. The campaign will begin in earnest on June 22, when the first advertisement will appear in one of the big popular fiction magazines.

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Stage and Studio Lighting Apparatus and Electric Effects, is the title of a new catalogue issued by the Universal Electric Stage Lighting Co., 240 W. 50th Street, New York. It illustrates and describes the many new developments in stage lighting and effects which have been recently introduced. Among the accessories described are Kliegl spot lights, electric effects, pockets and plugs, connectors, border lights, proscenium lights, disappearing foot lights, act announcers, fire logs, reflectors, electric carriage calls, and Klieglight lilliput, and arc lamps, with accessories, for motion picture photography.

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Electrical Equipment for Cement Mills is the title of the special publication (or circular No. 7174) just issued by the Westinghouse Electric & Mfg. Co. The pamphlet has an attractive art cover, illustrating the interior of a motor driven cement mill, while numerous photographic reproduction are given throughout the publication, showing the application of motors to various types of machinery employed in cement mills. Advantages of motor drive for this class of service, and characteristics required by motors to be specially successful, are given briefly. The publication will be sent to anyone interested in this class of service, by application to the nearest Westinghouse district office.

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Engineering Department National Lamp Works has recently published Bulletin 34, which deals with country home lighting. A very general discussion is given of the generating plant and wiring. Stress is laid upon the fact that satisfactory operation depends to a great extent upon the installation of wire sufficiently large to carry the necessary power without an undesirable voltage drop. A table is given which will facilitate the selection of wire of the proper size. Photographs of actual installations are used to illustrate the lighting of the home. While the discussion of the lighting of the house is thorough, it is not involved with mathematical calculations for which the average owner of a home lighting plant would have small use. With country homes and on farms there are usually several outbuildings to be lighted and a section has been devoted to lighting the horse barn, hog house, garage, and silo. A short descriptive section is given to mazda lamps for country home lighting service. Copies of this bulletin may be obtained, upon request, from the Engineering Department, National Lamp Works, Cleveland, Ohio.

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American Telephone & Telegraph Co. during the 12 months ended December 31 last outdid itself in usefulness to the government and the public generally. The annual report issued serves as a remarkable record of service rendered. The effect of "war conditions" upon the Bell telephone system is clearly brought out by the following analysis: in the years 1909-1915 (inclusive) the average yearly increase in gross revenues amounted to $12,856,420 and the average annual gain in expenses (including taxes) amounted to $10,-311,527. Incidentally during this period taxes increased on the average about $1,000,000. In 1916, the "war stimulus" began to make itself felt and the Bell telephone system increased its gross $30,491,243, or two and a half times the normal business expansion. The accumulating effect of advancing prices as a result of the war came only in part in 1916, but operating expenses increased $21,055,361, or about twice the normal average. Taxes began to reflect the trend of the times by an increase of $1,000,000 above the average. In 1916, therefore, the Bell telephone system had a $9,000,000 spread between gross expansion and increased expenses in favor of the former, as against a normal average of $2,500,000.

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Wheeler Condenser & Engineering Co., of Carteret, N. J., have just published their Bulletin No. 108-B embracing exclusively their line of centrifugal pumps. The bulletin shows the latest Wheeler turbine-driven geared centrifugal pumps; bi-rotor; tri-rotor; electric driven; small belt-driven; small high speed; side, end and bottom suction; vertical shaft; pumps for either series or parallel operation; and special slowspeed engine-driven pumps. Test curves made by both manufacturer and customer are included in the bulletin. These pumps are made for all services and especially for installations where large volumes of water must be pumped economically against low heads.

Nuts for the Knowing Ones

QUERIES AND ANSWERS IN TECHNICS

Please tell me how to construct a lifting magnet that will lift about 100 lb.

Jos. Graziano, Jersey City, N. J.

The question you ask is hard to answer in the limited space at our disposal, assuming you want to know not only what you should do but also why you do it. It involves a serious and prolonged study of that part of electrotechnics which deals with the magnetic circuit. It includes the magnetic properties of iron and steel, flux densities, and working formulas for the magnetic circuit. We suggest that you get a copy of Croft's "Practical Electricity" and give close attention to the matter on pages 150-205.

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We have one light upstairs and one light downstairs to be controlled by one switch upstairs and one switch downstairs. We want the switches to control the lights, upstairs light on by itself, and downstairs light on, then off, and both on, then both off, the lights to be controlled the same way from both switches. Can it be done, and if so, what kind of switches can be used? And of course the lights are to be turned on by the upstair's switch, and turned off from the downstair's switch, or vice versa.

W. J. Cameron, Daytona, Fla.

The two replies to the question asked above in the March issue do not seem to me to meet the specifications. The first answer might be taken as a good, practical solution, but as far as fulfilling the conditions is concerned it does not do so. The second reply requires more than two switches and so does not strictly answer the question.

I have worked out an arrangement that requires two double-deck switches. Whether they are made commercially I do not know but I should like to point out that a well-known electrical concern in New York makes any kind of electrolier switch on order. In the diagram the two decks of one switch are shown

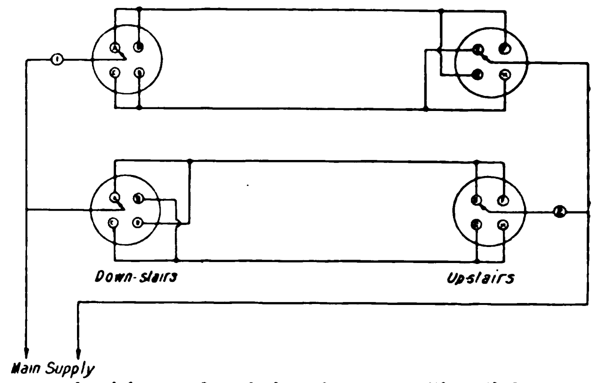

Diagram of wiring and switches for controlling lights upstairs and downstairs.

separated, but it must be understood that both arms are mechanically connected and work together. The table outlines 16

	A	B	C	D
E	2	None	1	1 and 2
F	1 and 2	1	None	2
G	1	1 and 2	2	None
H	None	2	1 and 2	1

possible combinations.

Albert H. Beiler, New York.

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What is babbitt metal?

P. W. Ross, Salisbury, N. C.

This metal is used for bearings. It was invented by Isaac Babbitt, of Massachusetts. It is a soft white anti-friction metal of varying composition. Hardening babbitt contains 4 parts of copper, 8 parts of antimony, and 24 of tin. Lining babbitt contains 4 parts of copper, 8 parts of antimony, and 96 parts of tin.

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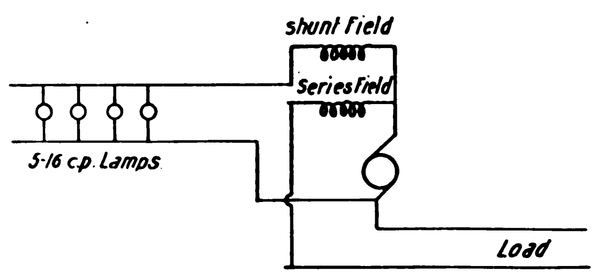
I wish to know if there is any way of using a bank of lamps for a field rheostat on a 15-kw. generator which is self-excited? I connected five 16-cp. 110-volt lamps in multiple and then this group in series with the shunt field. The generator refused to build up, and showed only 2 or 3 volts across the armature terminals. I later connected two 2-gal. jars of salt water in



series and also in series with the shunt field. The generator generated 140-volts with the plates close together in the rheostat. With the plates as far apart as possible it only reduced the voltage about 5 volts and I required 120 volts. Please state if it is possible to operate a water rheostat as a field rheostat on a generator.

A. K. Bowles, Hornell, N. Y.

When a number of lamps are connected in parallel and this group is then put in series with the shunt field winding of the 15-kw. generator, not enough current passes through the shunt field to set up a sufficient number of lines of force to build up the desired voltage. Furthermore, they will not offer a constant resistance. When the filament of a Gem 16-cp. carbon lamp is cold it has a resistance of about 85 ohms; when burning at full candle power, its resistance is 220 ohms. It requires only a very small variation of resistance in the shunt field circuit to produce considerable variation in the voltage.

From the data given in the question it may be assumed that the full line voltage of the generator is 150 volts and the desired voltage 120 volts. The machine being of the self-excited type, it will require about 3 percent. of the full load current for shunt field excitation. At 15 kw. and 150 volts, the full load current will be 100 amperes, $\left(\frac{W}{E}\right)$, and the field current will be 3 amperes. The resistance of the shunt field winding will be equal to $R = \frac{E}{I} = \frac{150}{3} = 50$ ohms; the resistance of the 5 16 cp. carbon lamps connected in parallel will be $\frac{85}{5} = 17$ ohms cold and $\frac{220}{5} = 44$ ohms hot. To connect this amount of resistance in series with the shunt field on starting would prevent the machine from building up, as has been shown by the results obtained by Mr. Bowles.

In the accompanying diagram a lamp bank is arranged so that any number of lamps from 1 to 12 may be connected in parallel and the groups in series with the shunt field winding.

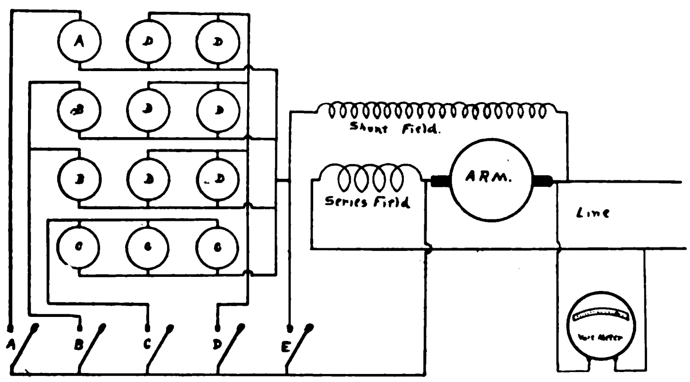


Diagram showing method of using bank of lamps as field rheostat on self-excited 15-k. w. generator.

A, B, C, D, and E are single-pole, single-throw knife switches. Switches A, B, C, and D control the lamps. Switch A controls one lamp; B, two lamps; C, three lamps; D, six lamps, so that any number from 1 to 12 may be cut into the circuit at will. Switch E cuts all lamps out, and should be closed only until the machine is up to full voltage; then by gradually cutting the lamps into the field circuit the voltage may be reduced to the amount desired.

When the machine is to be started, switches A, B, C, and D should be opened and switch E closed; then start the machine and bring the voltage up to the full amount. Then close switch D and open switch E; this will put the 6 lamps connected in parallel in series with the shunt field windings. If this causes the voltage to drop below the desired amount, close some additional switches until the desired reading is shown on the voltmeter. When switch D is closed, should the voltage not be lowered to the desired amount, close switch E, open switch D, and close switches B and C; this will put 5 lamps in parallel and the group in series with the shunt field winding when switch E is opened again. By making various combinations of lamps any desired result may be obtained.

If it is impossible to obtain a desired result by using 12 lamps, more may be used.

A water rheostat may be used in the same manner but the water should be kept at a constant temperature.

The new (Gem) carbon lamps have a metalized filament which has a hot resistance of 2.6 times the cold resistance, while the old style carbon lamps had a much higher resistance when cold than when hot.

If Mr. Bowles is using the old style carbon lamps, I would advise him to get the new (Gem) carbon lamps.

T. Schutter, New York.

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It is possible to use a bank of carbon lamps as a rheostat for a 15-kw., 120-volt generator, but it is not good practice to do so on account of size and cost of such a rheostat. Since the resistance of a carbon lamp when cold is about 460 ohms and since the total amount of resistance required for use in series with the generator field may be about 10 to 20 ohms, it follows that no less than 50, and possibly more, lamps would have to be connected in multiple and then in series with the generator field. Furthermore, provision must be made by means of a suitable switch to short circuit these lamps at the time when the generator is first started up. After the generator voltage is built up to its maximum value the switch may be opened and lamps taken out of the circuit one by one, thus increasing the resistance, until the voltage is adjusted as desired.

The fact that the generator refused to build up when only 5 lamps were used may be explained by referring to Fig. 1.

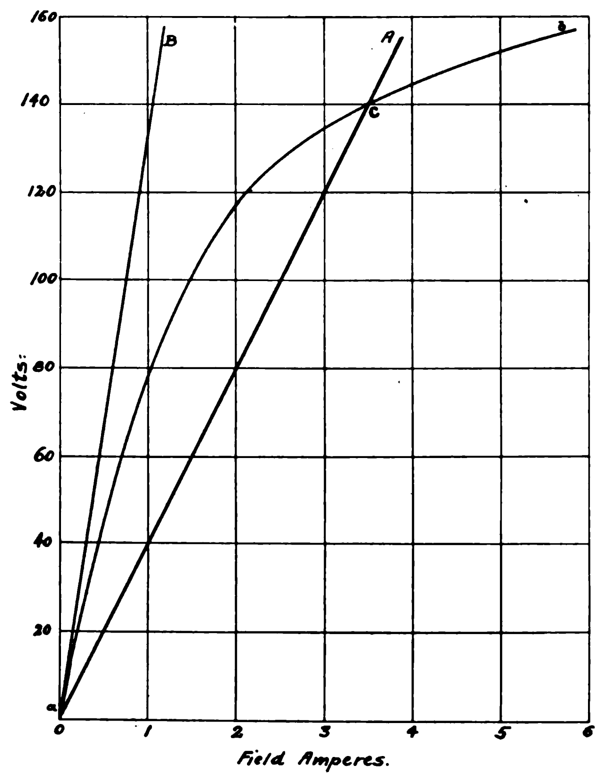


Fig. 1

If *ab* represents the saturation curve of the generator under discussion and its field resistance is, say, 40 ohms, then *OA* represents the field resistance line when no external resistance is connected in the field circuit. Now it is known that when no external resistance is in the field circuit the generator will build up a voltage equal to that indicated by the intersection of *ab* and *OA*, or by point *C*, which in the diagram shows 140 volts. If 5 lamps each of 460 ohms resistance are connected in multiple their equivalent resistance will be $460 \div 5 = 92$ ohms, and if this resistance is connected in series with the 40-ohm field, the total resistance in the field circuit will be $92 + 40 = 132$ ohms, so that line *OB* will represent the new resistance line of the generator. The new resistance line shows by its point of intersection with *ab* that the voltage to which the generator will now build up amounts to only 2 volts.

As to Mr. Bowles' second experiment wherein he used a salt-water rheostat, I would say that here again it is possible to use a rheostat but the operation of it for continued periods of service will obviously prove unsatisfactory. The fact that Mr. Bowles' experiment proved to be a failure may possibly be due to using electrodes which were too large for the purpose and to using a too highly saturated solution for the electrolyte. The curve in Fig. 2 shows the resistance per cubic inch of salt solu-

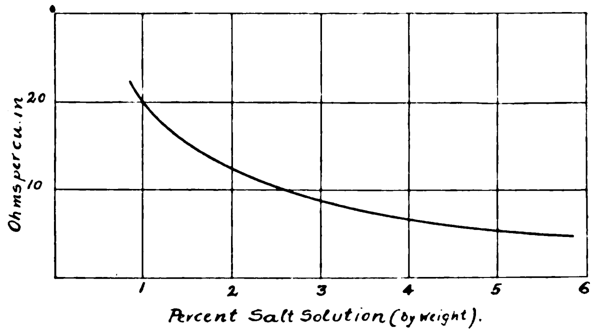
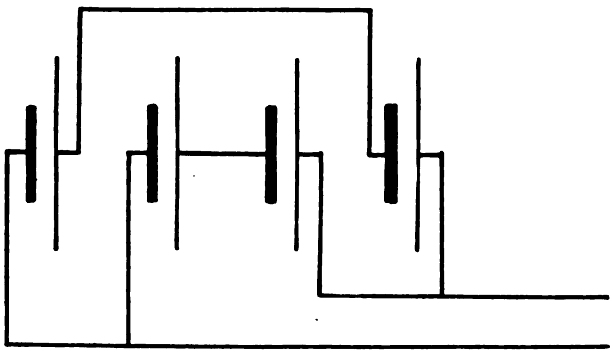


Fig. 2

tion of different concentrations. This curve was derived from data given in the Standard Handbook for Electrical Engineers, page 371. With the aid of Fig. 2 a liquid rheostat for the 15-kw. generator in question may be proportioned approximately as follows: Considering first the requirements which have to be met we find (a) that the resistance of the rheostat should be capable of being adjusted from zero ohms to about 30 ohms, (b) that the current density at the electrodes shall not exceed one ampere per square inch.



4 Cells connected in Series-Multiple.

Fig. 3

To fulfill these requirements a switch to short circuit the rheostat will be needed, also the electrodes must be at least 4 sq. in. in section, and from this it follows that space must be provided to separate the electrodes at least 6 in. to give 30 ohms when a one percent. solution is used. If the available containers do not allow the use of electrodes of 4 sq. in. a sufficient number of them will have to be placed in multiple to give this area, also if the containers do not allow spacing the electrodes 6 in. apart a sufficient number of them has to be connected in series to make up the total required spacing. That is, if the containers allow the use of electrodes of 2 sq. in. and a maximum spacing of 3 in. apart, it follows that four containers will be required. The four cells are then connected in series multiple as shown in Fig. 3.

In conclusion I would say that rheostats like those described above find justifiable use only in an emergency.

H. H. Metzenheim, Ampere, N. J.

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In regard to using a water rheostat with a 15-kw. generator, the trouble can be remedied in the following way:

Procure a vessel that will hold 5 gal. or more of water, preferably a barrel. Put one metal plate about 1 ft. square and 1/4 in. thick in the bottom of the barrel with a wire securely fastened to this plate. This wire should be carried upward and out of the barrel to form one terminal of the rheostat.

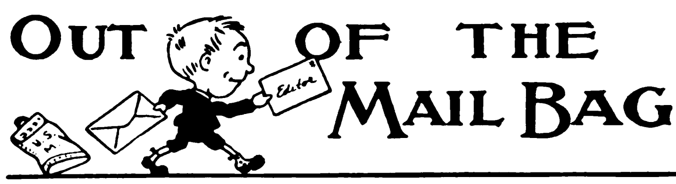
Now take another plate of the same size and suspend it above the barrel by means of a rope and pulley so that it may be raised and lowered, with the rope tied to it in such a way that one corner of the plate will touch the water first when lowered. After fastening a flexible wire to this plate, to form the other terminal of the rheostat, lower the plate until it is within 2 in. of the plate in the bottom of the barrel. Then tie a knot in the rope close to the pulley so that the plate cannot be lowered below this point.

The rheostat is now complete. Referring to the sketch, disconnect the bank of lamps, and connect the rheostat to the two wires leading to the generator.

The next step is to fill the barrel with clear water and start up the engine. If at full speed the voltage does not appear high enough, add a little salt, about one or two pints. Salt should not be added though if the voltage will raise high enough without it. Salt makes water more conductive and consequently raises the voltage.

While a rheostat of this kind will give satisfactory results for temporary work, it should not be recommended as a permanent fixture.

F. P. Miller, Lafayette, La.



FROM OUR CONTRIBUTING EDITORS

KEEP HIM AT SCHOOL

I am a stationary engineer and have a son 16 years old who is now in the high school, second term. He does not seem to care for what he gets there. I want him to learn electrical engineering, and have my heart set on his learning this business from A to Z. What would you advise him to do?

F. W. B., St. Louis, Mo.

We think your boy will regret it later on if he should leave the high school now so as to give all his time to electrical work. If he is to make any progress at all in electricity, he will need the mental discipline he is now getting in the high school. He cannot get too much of mathematics, for engineering is the science of mathematics. Ohm's Law, the fundamental element of electrical engineering, is purely mathematical. No one, however zealous he might be, could advance beyond the journeyman stage if he were unable to comprehend Ohm's Law. We presume your boy is ambitious to be something more than a mere wire stringer. And if he needs the training given by the study of mathematics to comprehend Ohm's Law, he will certainly need it if he is to grasp the fundamentals of alternating current phenomena.

Keep him in the high school until he finishes there, if you can possibly do so. Have him take all the mathematics, physics, and chemistry he can absorb; for without a pretty thorough education in the elementary mathematics and the sciences, he can make little, if any, progress in electrical engineering. Impress upon him that success in electrical engineering requires work by day and study by night; that is, if any one is to make headway with it. It is not an easy subject to learn, nor are its monetary rewards enticing, though it is always fascinating to those whose hearts are in it.

If your boy is content to be a journeyman electrician; is content to string wires and attach fittings without caring anything about why he does it and why he doesn't do something else, then perhaps the sooner he gets out of school and goes to work, the better. This would give him more money to spend just now, no doubt, but if he is as ambitious for himself as you seem to be for him, we think he would live to regret his decision to leave school now.

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FLYWHEEL CALCULATIONS

I am pleased to note that in the April number of ELECTRICAL ENGINEERING, H. H. Metzenheim, Ampere, N. J., is taking an interest in a formula developed by me relatively to the power loss through unlubricated bearings, poorly aligned shafting, and tight belting.

It seems, however, that Mr. Metzenheim forgot to multiply by 2 when determining the power lost in friction while the engine is operating at its normal speed. Thus the formula should have been:

$$\frac{E}{T_b} = \frac{2WV^2}{100\,T_b} \text{ ft. lb. per sec.}$$

This is true for the same reason that in falling bodies, to find the velocity at the end of a given time, we do not merely divide the distance fallen by *t*, for that would merely give the average velocity. To determine the velocity at the end of the fall one must therefore multiply by 2. In the case of a flywheel we have deceleration instead of acceleration, but the laws are the same, assuming the deceleration to be constant, as in falling bodies, which the writer has found to be roughly true in the case of a stopping flywheel.

As for using a radius gyration of 0.8, there doubtless are flywheels in which the radius of gyration is so close to the center. This is a matter that the writer thus far been unable to verify, as there seems to be but little matter published on that subject.

Generally in making flywheel calculations, the weight of the arms is neglected and the peripheral radius of the rim is used. The weight of the arms is considered sufficient to make this assumption close enough for most practical purposes. Of course where great refinement is required in the calculations, the exact weight and form of the rim, and the distance of every elemental mass from the center of rotation must be taken into consideration.

More comments from readers of ELECTRICAL ENGINEERING on this interesting subject would be appreciated, and if anybody knows of a quicker or easier way to measure the approximate friction absorbed internally by an engine, by a bearing, or even by a machine driven by an engine, we would like to know about it.

W. F. Schaphorst, New York.

DID YOU KNOW THAT-

BITS OF GOSSIP FROM THE TRADE

Automatic Fire Detector Co., Inc. is now located at 46 West 33rd Street, New York.

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Bryant Electric Co., in Bridgeport, Conn., announces the following changes in its sales department: Frank V. Burton who has been connected with the company for 16 years, and has been Eastern sales manager for the last 11 years, is now general sales manager. William A. Stacey becomes Western manager, succeeding Edward K. Patton, deceased. John R. Topping continues as assistant manager of the Chicago office. Harold E. Sanderson continues as Pacific Coast manager at San Francisco. Robert M. Eames is appointed export manager, with headquarters at Bridgeport.

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Frankel solderless connectors are now a Westinghouse product, the Westinghouse Electric & Mfg. Co. having acquired the sole marketing of this device in the United States.

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Hotpoint Division of the Edison Electric Appliance Co., of New York, Chicago and Ontario, Calif., will carry on an intensive campaign this spring to increase the use of electric heating appliances.

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Bell Telephone System in the United States for the three months ending March 31, 1918, reports total operating revenues of $76,300,000, and a surplus of $2,935,000. The system owns 22,770,582 miles of wire. There are 10,603,878 stations.

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The William F. Wolff Co., 563 West 145th Street, New York, has appointed the S. W. Electric Co., 144 East 34th Street, New York, as sole distributors of the Anywhere lamp bracket. The S. W. Electric Co. intends to appoint sole agents in the principal cities of the United States for the wholesale and retail distribution of these brackets, and will give prompt attention to all requests for such agencies.

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The Binghamton Light, Heat & Power Co. has again started the preparation of its war garden for the benefit of the employees of the company, and the ground is being plowed and harrowed in readiness for staking out. This year there will be approximately 20 acres of land under cultivation. The demand for land this year is greater than it was last, due to the fact that the proposition proved so successful then, about $1,200 worth of produce being grown.

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Bosch Magneto Company, of Plainfield, N. J., and Springfield, Mass., with property valued at $5,000,000, was taken over on April 19, by Alien Property Custodian Palmer. Investigation revealed that instead of most of the stock being owned by residents of this country, as had been reported by its officers, ownership was in reality vested in Robert Bosch and other residents of Germany. The entire product of the company, whose plants are among the best equipped in the country, will now be turned over to the Government for the army and navy.

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Westinghouse Electric Products Co.—On April 1, the Copeman Electric Stove Co. was merged in the new concern named above and located at Mansfield, Ohio. This factory will be devoted to the manufacture of heating appliances previously made at the Newark works of the Westinghouse company, and the Flint, Mich., works of the Copeman Electric Stove Company. The general operations of the Westinghouse Electric Products Company will be directed by W. K. Dunlap, as general manager. Mr. Dunlap is also assistant to the vice-president of the Westinghouse Electric & Mfg. Company.

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Sprague Electric Works of General Electric Co. has just put up a new building in Bloomfield, N. J., at the intersection of the D. L. & W. and Erie Railroads. This building will provide increased capacity for the manufacture of generators, motors and controllers, dynamometers, hoists, ozonators, and electric fans. It is of reinforced concrete, 75 by 550 ft., with an ell 75 by 175 ft., six stories in height, walls and columns being designed for the addition of another story should it be necessary at some time. To provide abundant light for manufacturing purposes and to eliminate dark corners, about 60 percent. of the wall area is devoted to window space, counterbalanced steel sash being used throughout the building. In addition, the ceilings are painted with mill white flat finish to reflect the light to the best possible advantage.

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The Southwestern Minnesota division of the Northern States Power Company has completed the transmission line between Franklin and Bird Island.

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Northern States Power Company reports a difficult year without loss in net earnings. While the company materially increased its business, increased coal and labor costs and higher taxes made serious inroads on its gross earnings last year.

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The sales department of the Minneapolis General Electric Co. early in April accepted 530 electric contracts covering 282 kilowatts of lighting and 123 hp. in motors. Orders were taken for wiring 58 already built houses. The net connected load for the week shows a loss of 48 customers but a gain of 43 kw. lighting business and 118 hp. in motors. Electric energy output for the week was 11.9 percent. greater than for the corresponding week of last year.

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PURELY PERSONAL

W. H. Dow, acting purchasing agent, H. M. Byllesby & Company, Chicago, has joined the 37th Engineers at Columbus Barracks, and expects to go to Ft. Meyer, Virginia.

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N. J. Neall, consulting engineer, Boston, has received an appointment as major in the Quartermaster's Corps and is closing his office for the duration of the war.

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H. C. Cummins, assistant to the president, H. M. Byllesby & Company, Chicago, has joined the Ground Aviation Department as a private and will be stationed at Camp Dick, Dallas, Texas.

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Jerome L. Cheney, of Syracuse, N. Y., has been appointed a member of the Public Service Commission for the Second District of New York State, to fill the vacancy caused by the death of William Temple Emmet.

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E. Kilburn Scott, consulting engineer of London, England, who is now in this country on a business trip, recently lectured before the Engineers' Club of Trenton, N. J., on "Nitrogen from Air for Explosives.

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R. J. Kaylor, formerly advertising manager of the Western Conduit Co., of Youngstown, Ohio, is now advertising manager of the Youngstown Sheet & Tube Co., of that place, with offices at 1008 Stambough Building, Youngstown. As already announced in this column, the Western Conduit Co. has been taken over by the Youngstown Sheet & Tube Co.

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F. A. C. Tocque, formerly new business manager of the Fort Smith Light & Traction Company, Fort Smith, Ark., has passed the necessary examinations for entrance into the Canadian Officers' Training Camp and will shortly sail for England. He expects to receive a commission in the Royal Engineers.

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R. W. Spofford, general manager of the Augusta-Aiken Railway & Electric Corporation, Augusta, Ga., who is a retired officer of the United States Navy, has been called to active service. W. C. Collaghan succeeds him as general manager. Mr. Callaghan has been with The J. G. White Management organization, New York City, the operators of the Augusta company, since 1913.

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A. A. Gray, of the firm of Gray & Benjamin, advertising specialists, Chicago, has been commissioned major in the Ordnance Reserve Corps and will have charge of a new publicity bureau that will endeavor to co-ordinate the activities of the Ordnance Department and the industries through the medium of the technical and trade press. Formerly he was vice-president and general manager of the Electrical Review Publishing Company.

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L. C. Davis, Shreveport, La., agent for the Domestic Engineering Co., of Dayton, Ohio, is the chief figure in a half-column story in the Shreveport Times of March 21. This story contains an account of the recent annual convention at Dayton, Ohio, of the manufacturers, dealers, and distributors of Delco-Light apparatus. There will be a sub-convention of Delco-Light representatives in Shreveport next July.

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J. C. Rockwell has been promoted from manager of the light and power department to general manager of the Manila (P. I.) Electric Railroad & Light Company. Mr. Rockwell was graduated in 1907 from Cornell University with the degree of mechanical engineer. Following his graduation he engaged in track construction work. In 1911 he joined the operating organization of The J. G. White Management Corporation, New York, and was assigned to the Manila Electric Railroad & Light Company as manager of the light and power department.

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C. R. Dooley, manager of the educational department of the Westinghouse Electric & Mfg. Co., has been granted leave of absence to accept an appointment by the Government as director of the vocational educational project for army needs, now being developed by the War Department committee on educational and special training. He will be located in the War Department at Washington, D. C. With the assembling of the first drafted at Camp Sherman, Mr. Dooley was given the task to select from the men in the cantonment the one best fitted for any particular class of service. The efficient manner in which this system was installed is largely responsible for Mr. Dooley's second call from the Government.

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OBITUARY

George J. Jackson, president of the National Conduit & Cable Company, died in New York last month, aged 57 years. Mr. Jackson had been prominently identified with the cable industry for many years.

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Lieut. George A. Ward, formerly in the test room of the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., recently died in the service of the country. He became ill of diphtheria while aboard the transport en route to France and died after being removed to Liverpool.

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Jame A. Scrymser, president of the Mexican and the Central & South American Telegraph Companies, died at his home in New York on April 21, aged 79. After serving through the Civil War, at one time as aide-de-camp to Major General "Baldy" Smith with the army of the Potomac, Mr. Scrymser organized in 1865 the International Ocean Telegraph Company, operating a cable line between the United States and Cuba, West Indies and South America. A few years later he also organized the two telegraph companies, of which he was president at the time of his death. These companies established 14,300 miles of cable and 2,500 miles of land wires, connecting the United States with Latin America.

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Capt. Henry N. Brooks, a member of the United States Engineers Reserve Corps, is dead in France of pneumonia. Before enlisting he was electrical engineer with James N. Hatch, consulting engineer, Chicago. He went to France last December. He was a graduate of Cornell University in the class of 1888, and was one of the pioneers in the electrical railway engineering field.

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ASSOCIATION NEWS

Electrical Club of Detroit invites visitors to its luncheons, which are held at 12.30 p. m. every Saturday in the Flemish room of the Hotel Cadillac.

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A Joint Annual Meeting of the American Association of Engineers and the Committee on Engineering Co-operation will be held at the City Club, Chicago, 315 Plymouth Court, on May 14, 1918.

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The Society for Electrical Development, Inc., will hold its annual meeting at 29 West 39th Street, New York, on Tuesday, May 14, at 11 a. m. All members are invited to attend and take part in the meeting.

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Fourth Annual Convention of the American Association of Engineers will be held in Chicago, May 14, 1918. National extension of the association makes it necessary to amend the by-laws. National officers and directors are to be elected for the ensuing year. Edmund T. Perkins, consulting engineer, Chicago, is the retiring president.

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New York Electrical Society announces that with a margin of nearly two months to spare it has closed its membership campaign, the 500 new members having been secured. At the meeting of the Executive Committee held April 4, the results of the drive were formally disclosed. The chairman of the membership committee stated that although the ambition of his committee had been realized, the encouragement of new enrolments would not cease.

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New York Electrical Society held a meeting in the auditorium of the Engineers' Society Building, 29 West 39th Street, New York, on April 18. Majors O. O. Ellis and E. B. Garey, of the United States Army, talked on "Using the Motion Picture to Train Officers and Enlisted Men of the Army." The handling of the Browning, and other modern guns, and their operation in action was explained and illustrated on the screen. Hudson Maxim spoke on "High Explosives in Modern Warfare."

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In the 1918 Edition of the Year Book of the American Institute of Electrical Engineers the names of members who are in the army or navy of the United States or allied nations, of which the secretary had been notified, have been designated by a special entry. The total number of members in the uniformed service, including those of which notice was received by the secretary after the Year Book went to press and up to April 1, is 760, which is over 8 percent. of the total membership, now in excess of 9,200.

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National Electric Light Association will hold its annual meeting at Atlantic City, N. J., on June 13-14. Headquarters will be in the Hotel Traymore. But one subject will be discussed—war problems.

The convention committee is composed of Messrs. W. Neumuller, New York; T. C. Martin, New York; H. C. Abell, New York; J. L. Bailey, Baltimore; R. H. Ballard, Los Angeles; M. R. Bump, New York; J. E. Davidson, Omaha; Leavitt Edgar, Boston; E. A. Edkins, Chicago; Dudley Farrand, Newark; Martin Insull, Chicago; W. H. Johnson, Philadelphia; A. W. Leonard, Seattle; Robert Lindsay, Cleveland; S. J. Lisberger, San Francisco; R. J. McClelland, New York; E. S. Mansfield, Boston; C. S. Ruffner, St. Louis; Frank W. Smith, New York; S. B. Way, Milwaukee; W. F. Wells, Brooklyn.

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American Chamber of Commerce in Paris says that the disappearance of German competiton has greatly favored the expansion of the American electrical industry. Owing to the export restrictions in rigor in both France and England, the United States is about the only country, at present, in a position to replace Germany in the worlds market. The following figures will show the great development made by the United States in the exportation of electrical goods since the war.

Fiscal Year Ending	Value of Exports
June 30, 1914	Frs. 133,000,000
June 30, 1915	Frs. 105,000,000
June 30, 1916	Frs. 160,000,000
June 30, 1917	Frs. 275,000,000

As shown above the value of exports for the year 1917 was 70 percent. superior to those of 1916 and 105 percent. superior to those of the year 1914.

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National Electric Light Association announces that at a recent meeting of its executive committee it was decided that a committee of three members should be appointed to co-operate with similar committees of the electric railway and gas industries in the formation of a conference or joint committee to advise in regard to such utility problems of national interest as may be specifically assigned for consideration. This suggestion arises from the desire to give specific direction and authority to the work which is being done now by the National Committee on Public Utility Conditions, representing the N. E. L. A., American Electric Railway Association, American Gas Institute and National Commercial Gas Association. President J. W. Lieb reported at the meeting that the association, in the referendum of the Chamber of Commerce of the United States on water power development, has given its affirmative vote for the proposed legislation by Congress. The committee approved the action of the officers.

Twenty-seven additional central stations have been admitted as members, also 773 Class B members, 13 Class D members, 76 Class E members, and 3 foreign members.

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At a meeting of the executive committee of the National Association of Manufacturers at the general offices, 30 Church street, New York, on April 19, it was voted to apply to the purchase of Liberty Bonds, instead of a banquet on the third day of this year's convention to be held at the Waldorf-Astoria Hotel, May 20, 21 and 22, a sum of money equivalent to that which has usually been expended in peace times on the closing feature of the convention.

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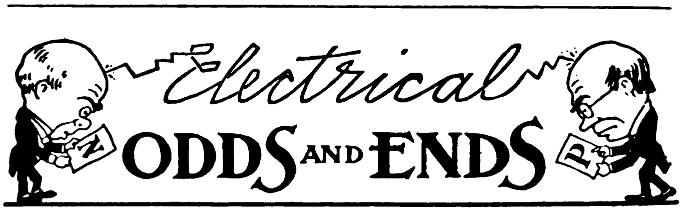
NEW BOOKS

Direct-Current Machinery

A book that succeeds in covering the theory and operation of direct-current generators and motors without exhibiting the mathematical prowess of the author is a book worth having. Here it is. A few formulas are used, to be sure, but these are so simple that anyone who knows anything about elementary arithmetic and algebra can readily comprehend them. The first nine chapters are given over to electromagnetism, induction, units of measurement, transformation of energy, armature winding, and uses of electrical energy. Types of generators, commutation, operating characteristics of both generators and motors, operation of three-wire systems, and the selection and operation of generators take up the other seven chapters.

In several places in the text the author makes a distinction between generators and dynamos, but for some reason which is not clear to us, this distinction is not followed in the table of contents, while in other parts of the text dynamo and generator are used synonomously. And, too, there is a touch of German grammar in the fifth line of the preface that would better be obliterated in future editions. This book contains 285 pages, is illustrated by 214 cuts, and sells for $2.50. It is published by McGraw-Hill Book Co., Inc., New York.



BRIEF TIDINGS FOR THE BUSY MAN

The problem of manufacturing and supplying machinery and tools sufficient for the carrying out of the Government program for the production of ships, shells, guns, and aircraft will be the subject considered at the War Convention of the machinery, tool, and supply industry of the country to be held in Cleveland the week of May 13. "No industry has a greater responsibilty at this moment than the machinery men," says H. W. Strong, president of the National Supply & Machinery Dealers' Association. "We must have men, but behind the men must be ships and munitions, and behind the ships and munitions, machinery—more machinery—still more machinery. We are in this fight to a finish. The Germans have convinced us that the only way out of the war is straight through, and the American machinery industry is ready to carry on to a knock-out."

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Perhaps you feel that your income tax is heavy and that in paying it you are doing your share. You may have been more or less unhappy over what the Government has taken from your income this year Think over the following figures and be thankful.

	In England	In America
On $1,000	$ 45.00	Nothing
On $1,500 if married	101.25	Nothing
On $1,500 if unmarried	101.25	$10.00
On $2,000 if married	157.50	Nothing
On $2,000 if unmarried	157.50	$20.00

The average tax on income from $3,000 up to $25,000 is approximately six times greater in England than in America.

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"In my annual report of last year," says the Secretary of War, "I pointed out the inadequacy of the engineering school maintained at the Washington Barracks and expressed the hope that the attention of Congress could at some suitable time be called to the wisdom of providing facilities for original research and continuous and fundamental training for our body of engineers. The experience of this war emphasizes the suggestion then made. The engineer is the bridge over which discoveries of science pass into the practical uses of everyday life. There should therefore be a school for army engineers which would keep constantly engaged in devising modes and appliances for the application of scientific discoveries in military matters. In the present war, as doubtless in all wars, the inventive faculty is aroused to unwonted activity; not only do our own scientists and inventors produce discoveries and inventions which can be adapted to immediate military use, but our adversaries are likewise fertile and appear on the battlefield with new agencies and appliances which must be met defensively and surpassed offensively. These observations, of course, are equally applicable to the work of the Ordnance Department, and beginnings have been made at the proving ground by that Department, which will continue the practical education received by the young ordnance officer."

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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 April 1, 1918.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and County aforesaid, personally appeared Chas. B. Thompson, who, having been duly sworn according to law, deposes and says that he is the Business Manager 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, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Technical Journal Co., 233 Broadway, New York City.

Editor, Geo. A. Wardlaw, 233 Broadway, New York City.

Managing Editor, George A. Wardlaw, 233 Broadway, New York City.

Business Manager, Charles B. Thompson, 233 Broadway, New York City.

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 percent. or more of the total amount of stock.)

Technical Journal Co., 233 Broadway, New York City; Charles B. Thompson, 233 Broadway, New York City.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 percent. 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 holder 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.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is—(This information is required from daily publications only). CHAS. B. THOMPSON, Business Manager.

Sworn to and subscribed before me this 29th day of March. 1918.

(Seal) G. H. RAYMOND.
(My commission expires March 30, 1920.)

NOTE.—Since the above statement, the publishers are the Wm. R. Gregory Co.

✦ ✦ ✦

The first group of telephone operators trained by the Bell System for our army in France has reached the goal toward which every girl in it has been working and striving for many weeks. Behind the lines, in the American camp in France, they are taking their places and adapting themselves to the needs of the war machine.

VIA THE SHEARS AND PASTE-POT ROUTE

Items of Interest Gleaned From Various Sources

NOTCE 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.

Germany thinks that America cannot build ships. Berlin says there are not enough men in America who have actually worked on ships to build one-tenth the number we need if we are going to do any fighting worth while. Here is where American workmen can fool the Kaiser. There may not have been one-tenth enough shipbuilders in America last year, but it is the determination of the Government and the American people that this year there shall be, not only one-tenth enough, but more than enough necessary to beat Germany. It calls for determination, for perseverance, for imagination. It is a challenge to the manhood of the nation. And it comes direct from the enemy. We cannot, must not, fail to answer the challenge in the only manner that a true American ever replies to the taunt of an enemy.

A "Bridge of Ships to France" is the answer.

✣ ✣ ✣

Four of the largest single phase transformers ever built were recently shipped by the Westinghouse Electric & Mfg. Co., to a southern power company. These units are rated at 14,000 kva., 60 cycles, and since they have a 25% overload rating they are practically 17,500 kva. maximum rated transformers. These transformers will operate at the highest transmission voltage used to-day, that is, 150,000 volts. These transformer units will form one 42,000 kva. bank, which, together with a spare unit will make the preliminary installation to step up the voltage from 13,200—that of the water-wheel generator. Power will be transmitted about 25 miles to an industrial plant where it will be stepped down by means of a number of 7,000 kva. single phase transformers of similar characteristics, ten of which have recently been built by the Westinghouse Company.

✣ ✣ ✣

The demands upon the public utility companies caused by the war are illustrated by the experience of Northern States Power Company in 1917. This company, under the management of H. M. Byllesby & Co., serves Minneapolis, Saint Paul and a large number of other cities in the central northwest, none of which was engaged in munitions production to a large extent. Eighty-seven percent. of the gross earnings and 95 percent. of the net earnings of this company are derived from the sale of electrical energy. In 1917 the company was called upon to supply 306,714,706 kw-hr. or 27 percent more electricity from its water power and steam sources than in 1916. Although a considerable number of small communities were added to the lines during the year, the great bulk of this unprecedented increase in demand came from factories, flour mills and other diversified industries requiring power. At the close of 1916 the company served a total of 102,247 horsepower in motors. During the succeeding 12 months additional power business connected to the lines aggregated 25,442 hp., an increase of nearly one-fourth. Early in 1918 the company had under contract and about to be connected 21,200 horsepower, which added to that gained in 1917 totals 46,642, a gain equivalent to 45 percent. of the total business served only 15 months before.

✣ ✣ ✣

The War Trade Board announces that various individuals, firms and corporations have been advertising their services to be rendered in the matter of securing export and import licenses. The Board suggests that it is not necessary for exporters or importers to consult such agencies. The various bureaus of the War Trade Board will supply all the information desired on receipt of requests therefor. The Board desires to place as little inconvenience and expense upon importers and exporters as possible, and, therefore, this suggestion is made in order that they may not be put to the expense of employing such agencies to obtain licenses, unless they so desire.

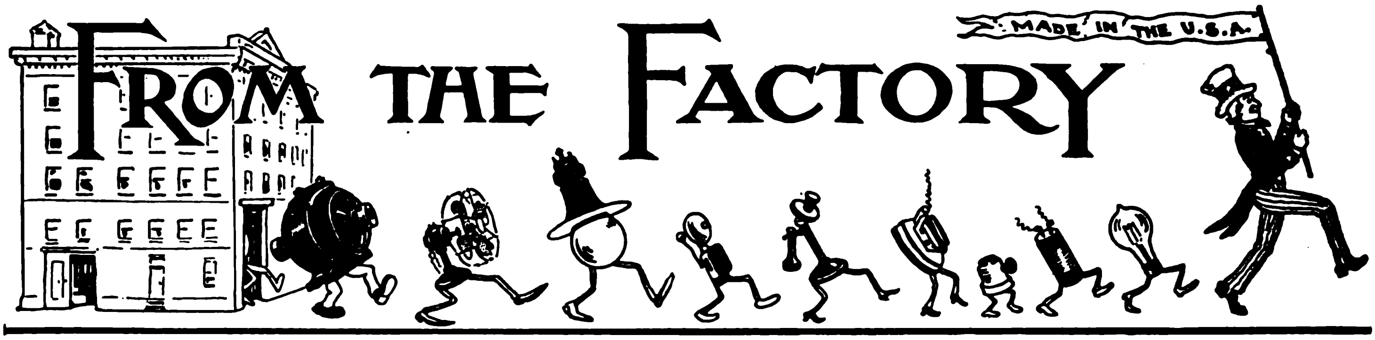
✣ ✣ ✣

Standard Gas & Electric Company earned a surplus of $111,207 for the year 1917 after the payment of interest charges, 6 percent. preferred stock dividends and amortization, according to the annual report just issued. Net income for the year was $1,566,051, compared with $1,664,199 in 1916. In addition to these earnings, which are from returns on securities owned, the company had $100,000 income from other sources in 1917 compared with a profit of $311,857 on bonds called for redemption in 1916. The report as customary analyzes the company's affairs in detail. Regarding the company's dividend policy the report says:

"The uncertainty of the times makes it increasingly difficult to forecast dividend distributions. It is unlikely that the conditions produced by the war will permit any increase in the preferred stock rate during the current year over the six percent. now being paid. Construction requirements of all of your subsidiaries have been reduced to a minimum in accordance with the general request of the government to conserve materials and money for war purposes. It is impossible, however, to cut off construction entirely. Should it become impossible to finance necessary improvements and extensions, your company may find itself compelled to apply its earnings to such purposes, even to the extent of reducing its dividends. At this time it seems improbable that an emergency measure of this nature will have to be resorted to."

✣ ✣ ✣

An optimist is a man who doesn't care what happens—so long as it dosn't happen to him.



Short Stories About Electrical Goods Offered By Manufacturers

MUELLER ATTACHO PLUG

That versatile and enterprising electrical manufacturer, the Mueller Electric Co., 423 High Avenue, Cleveland, Ohio, has just developed an attachment plug that consists of only four parts instead of the usual ten or more. In appearance and operation it is the simplest plug yet devised. No soldering is necessary, as all connections are made by means of screws; and there is adequate cord strain relief without the need of knots. When the threaded shell is off the inside of the plug is fully exposed, thus doing away with the process of fishing for holes with lead-in wires.

No. 4.—Attacho plug. Mueller Electric Co., 423 High Avenue, Cleveland, Ohio.

To connect this plug to the cord, cut one leg of the cord about ¼ in. shorter than the other and skin both legs about ½ in. Then remove the threaded shell. Hold the length-wise groove toward you and thread both legs of the cord through the central hole in the body of the plug and steer the longer leg into the hole leading to the end contact. Feed the shorter leg out until the insulation comes nearly to the outer edge of the groove and then lay the skinned end around the shank.

Now screw on the brass shell, binding the skinned end between the bottom composition thread and the shoulder of the shell. With the blade of a screw driver, key the shell to the body by indenting it at the top edge, over the groove.

The other wire is secured under the end contact screw in the usual manner, the undercut head of the screw completely concealing the wire.

⁂

CORNIMIT INSULATING MATERIAL

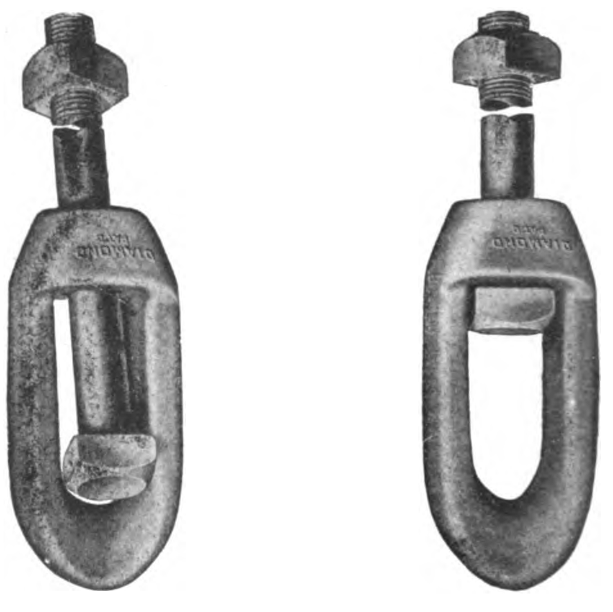
A new Danish process by which certain by-products, valuable for electrical insulation, may be made out of fish offal is soon to be put to practical test in Skagen, Denmark. The most important of the new products is called "Cornimit," and a factory known by that name is now being erected. It is thought that an application of the process might prove profitable along the eastern coast of the United States, where there is such a large supply of menhaden, the offal of which already has proven valuable as a fertilizer and an oil yielder.

It is claimed for the product Cornimit that it excels galalith as an electrical insulating material. It is said to have less water-absorbing ability as well as a larger insulating resistance. Cornimit can also be used in the manufacture of other things, such as brushes, combs, telephone apparatus, door handles, cane handles, furniture ornaments, and rollers for typewriting machines.

⁂

WELDLESS GUY-ROD HEAD

The Diamond Expansion Bolt Company, 90 West Street, New York, is in the market a new guy-rod head. It consists of a weldless loop constructed so that a square-headed rod can be slipped through it and held in position against turning. The weldless eye is shaped so that the wire looped through it will not be bent in too small radius. There are no screw threads above the ground level to deteriorate from atmospheric conditions.

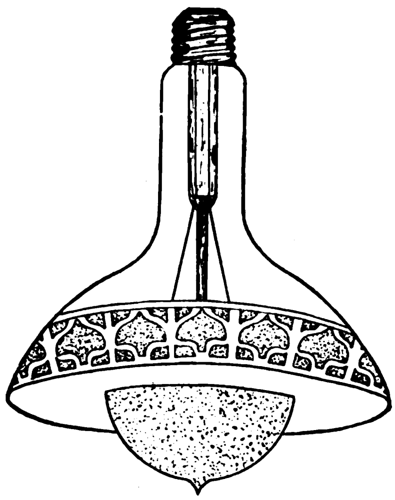


Weldless guy-rod head. Diamond Expansion Bolt Co., 90 West St., New York.

The guy head is made from high quality malleable iron. In the ⅝-in. size, it is stated to be capable of sustaining a breaking load of 30,000 lb., or more than double the ultimate tensile strength of the ⅝-in. rod. Diamond guy rod heads are furnished separately or complete with the bolts. Those who are interested in the working of this device are invited to visit the company's office.

LIBERTY LAMP

A new and novel form of gas-filled incandescent lamp is shown in the annexed cut. Unlike any other make of incandescent lamp, the bulb and the shade form a complete unit, and these are combined in such a way as to make the



Liberty Lamp. Victoria Lamp Works, Union Hill, N. J.

Liberty an indirect, non-glare lamp. It is manufactured by the Victoria Lamp Works, 507 Union Place, Union Hill, N. J. It is made of plain white glass with ornamental decorations in green, gold, blue, and other shades selected to harmonize with chandeliers or room decorations.

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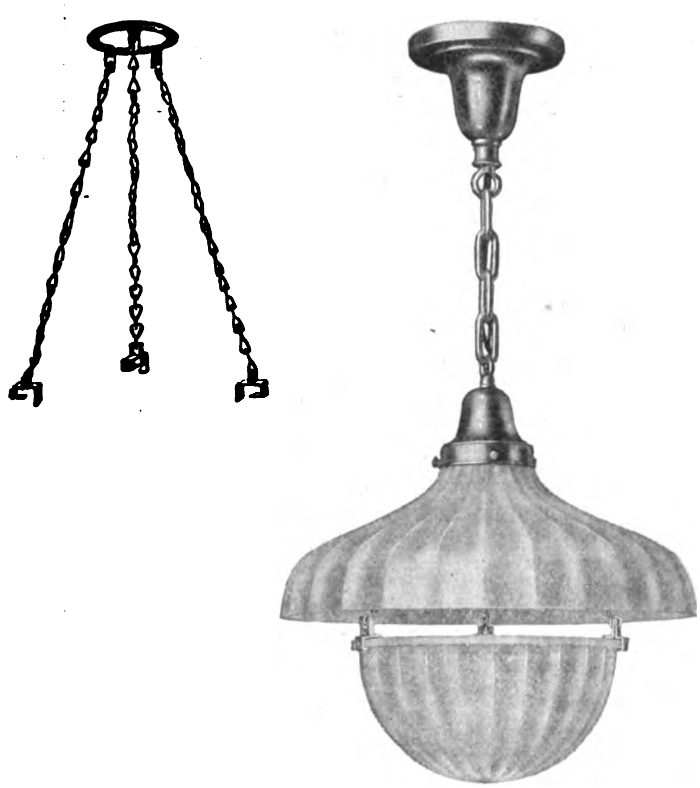
DORIC-LITE

The Doric-Lite is a lighting unit consisting of the usual arrangement of reflecting and diffusing bowls, supplemented by an adapter that allows the bowl to be taken off and cleaned without trouble. This adapter consists merely of three chains



Direct-indirect lighting fixture adapter. Lighting Studios Co., 220 West 42nd St., New York.

with spring clips at the lower end and a shade fitting at the upper end. The upper end is attached to the shade holder of the original unit and the lower spring clips are attached to the diffusing bowl. By means of it old direct lighting units can be modified to suit indirect lighting requirements. The spring clips can be easily attached to the bowl but cannot slip off accidentally. By using these adapters an even pull is exerted on the diffusing-bowl rim and the bowl does not have to be bored and thus weakened. This device is manufactured by the Lighting Studios Company, 220 West 42nd Street, New York. The accompanying cuts show the adapter and how it is applied to change a direct into an indirect lighting unit. It will fit any 2¼ or 3¼ in. holder.

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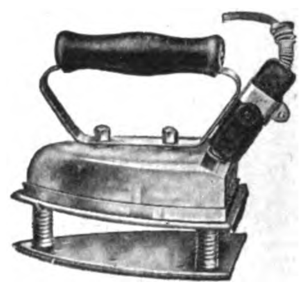
ELECTRIC IRON WITH SWITCH PLUG

Landers, Frary & Clark, of New Britain, Conn., are marketing two 8-lb. electric iron models equipped with permanently attached push-button switches. These switches are conveniently arranged on the iron so that they can be controlled without moving the hands from the iron handle. A quick double-break switch is inclosed in a heavy split casing held



Switch plug electric iron. Landers, Frary & Clark, New Britain, Conn.

together by a steel clamp which also serves to attach the plug to the handle bracket. It is claimed that the use of this switch lengthens the life of the cord, saves energy, and is advantageous because it eliminates the arc which would ordinarily occur when the commonly used plug is removed from the iron.

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WESTINGHOUSE WARMING PAD

To fill the demand for an electric warming pad of moderate price, the Westinghouse Electric & Mfg. Co. has placed upon the market one which measures 9 x 12 in. and sells for less than five dollars. It is equipped with 15 ft. of cord, with at-

Warming pad. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

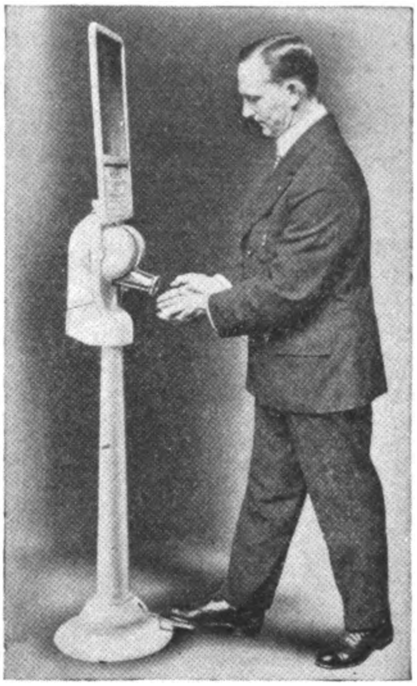
tachment plug. No switch is provided, the current being turned on and off at the lamp socket, or by separating the attachment plug. To prevent overheating, two thermostats are enclosed in the pad. These are connected in series and should the temperature rise to a point near the maximum safe value, one or the other will open the circuit. Upon a fall in temperature, the thermostat will reclose the circuit, thus maintaining the heat at a uniform temperature.

It is manufactured in one style only, for a voltage range of 95 to 125, with a consumption of 38 watts at 110 volts.

AIRDRY

Airdry, as implied by the name, is a device to supersede linen and paper towels for drying the face and hands. It consists of white enamel iron standard containing a motor, a fan, a heating element, and an adjustable nozzel for directing the flow of air. As an additional convenience, a plate-glass mirror is mounted on the casing.

Connected up to an ordinary lighting circuit, this device is set in operation by means of a foot-switch or lever in the base of the standard. Pressing down the lever causes warm



Airdry. Groton Electrical Devices, Inc., Groton, N. Y.

air to discharge through the nozzle. It is instantly adjustable to any position so that a child or grown person can use it in comfort.

After washing the face and hands, stand in front of Airdry, turn on the current by pressing the pedal, and stand where the warm air from the nozzle will evaporate the moisture. It is made by the Groton Electrical Devices, Inc., Groton, N. Y. The motor is of fractional horsepower and with current on a basis of 10 cents per kilowatt hour, 120 people can use this device for drying face and hands at a total expense of less than 10 cents.

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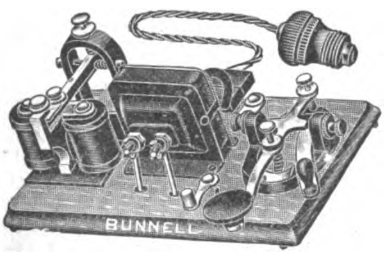
ALTERNATING CURRENT TELEGRAPH INSTRUMENT

This device consists of an alternating-current sounder, a steel lever key, and a transformer—all mounted on a base as shown in the illustration, and equipped with 6 ft. of cord and attachment plug. It is designed for use in telegraph schools, home practice, and private lines. It can be used on the 110-volt, 60-cycle alternating current lighting circuit by screwing the at-



Alternating current combination instrument. J. H. Bunnell & Co., Inc., 20 Park Place, New York.

tachment plug into a lamp socket. It works as perfectly as from a battery and never requires changes of adjustment.

Two or more instruments may be connected in series just the same as instruments with battery, by attaching the primaries of the transformers in multiple to the 110-volt, 60-cycle lighting circuit with the secondaries and the sounders—all in series. This is done by simply screwing the attachment plugs into lamp sockets, and connecting the instruments in the usual way, through their binding screws or terminals. Two terminals or binding posts and a single switch are mounted on base of each instrument.

When it is desired to operate two or more instruments on a line the terminals are used for connecting the instruments in series. When used this way, the single-point switches should be left open. Closing a switch localizes the instrument so that it can be used for practice without interfering or being interfered with by other instruments on the line.

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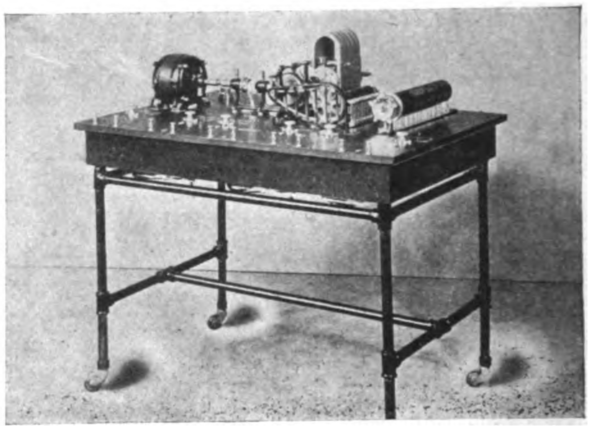
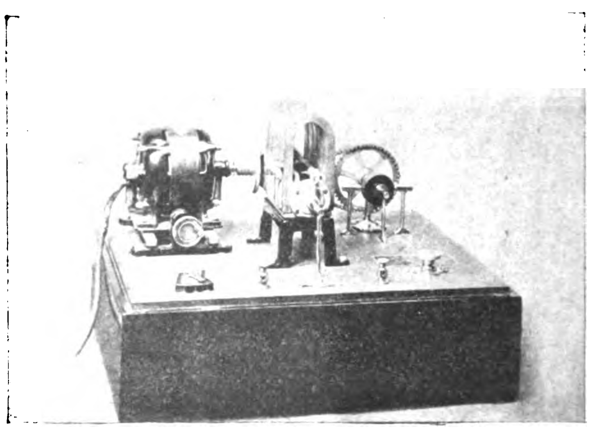
MOTOR OPERATED THERAPEUTIC MACHINE

The Sanitarium Equipment Company, of Battle Creek, Mich., has developed a motor operated magneto which produces alternating current for medical purposes, including hydroelectric baths and automatic exercise.

The equipment consists of an insulated table on which are mounted the driving motor, the magneto which generates the



Motor operated magneto for therapeutic purposes. Operated by General Electric motor.



Sinusoidal machine, operated by General Electric motor.

sinusoidal current, the interrupter, the speed and current controls, and the connection posts.

A motor suitable for the particular current from the lamp socket is supplied. It is a fractional horsepower machine and made by the General Electric Company. This drives the magneto through a leather insulated friction disc. Speed is regulated and controlled by a hand screw which moves the motor on sliding base rails to change the relative position of the friction disc on the motor shaft to the friction wheel on the generator or magneto shaft. The nearer the center of the disc to the point of contact of the wheel the slower the speed of the magneto.

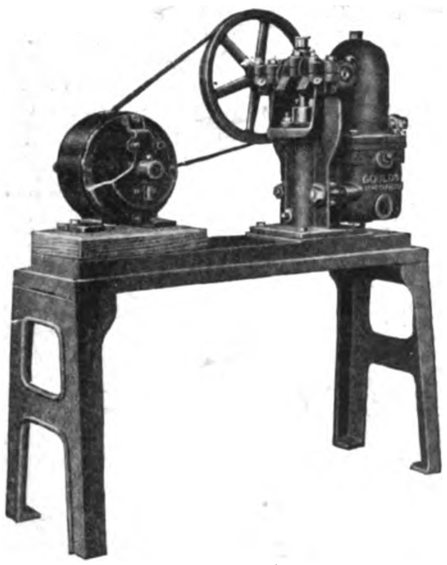
Alternating current is generated by the magneto. It is made and broken by a silent chain drive interrupter which always acts at the same point in the wave in order to make the current painless. By the addition of a rotary converter on the magneto the cycles of the sinusoidal current all flow in the same direction producing its characteristic waves.

This current is insulated from that supplied to the motor via the lamp socket, and there is complete insulation to prevent the current supplied to the motor from reaching the patient.

SMALL CAPACITY ELECTRIC-DRIVEN MOTOR

The Goulds Mfg. Co., Seneca Falls, N. Y., has recently developed a new pump for service in homes, summer cottages, camps, dairies, and small hotels. This pump is known as the "Hi-Speed." Its chief feature is a speed of 500 rev. per min. which allows the pump to be belt connected to the motor with only a small reduction and consequently with a small pump pulley instead of the larger diameter pulley commonly used.

The pump is of the vertical reciprocating type and is suitable for pressures up to 43 lb. or 100 ft. elevation. It is made



Motor driven pump for small capacity service. Goulds Manufacturing Co., Seneca Falls, N. Y.

in two sizes 1¼ in. diameter with 1⅛ in. stroke, and 2 in. diameter with 1⅛ in. stroke. The former has a capacity of 3 gal. and the latter a capacity of 6 gal. per min.

All gears have been eliminated in the pump to insure quiet operation. The crankshaft is counter balanced to insure smooth operation at the high speed of the outfit.

The outfits come complete with pump and motor mounted on a heavy oak plank or iron base plate with removable legs, as desired. They are operated by ¼ hp., 1750 rev. per min. Robbins & Myers motors.

DANDY BUZZER-LIGHT SET

A percentage of soldiers in every company should be capable of receiving and sending light and buzzer signals before they become eligible to go "over the top."

In order to meet this need, J. H. Bunnell & Co., Inc., 20 Park Place, New York City, have developed the Dandy Buzzer-Light set. The buzzer is of the watch case pattern, especially adjusted to give a high pitch note. A lamp stand similar to those used on automobile dash boards is mounted on the board and equipped with a hood so that the flashes are not diffused but sent only in the direction desired. The Dandy key without circuit closer, a two-point switch, and the necessary binding posts complete the equipment.

The frame of the key is finished in lustrous black enamel with the lever of nickeled steel; while the buzzer, lamp stand,

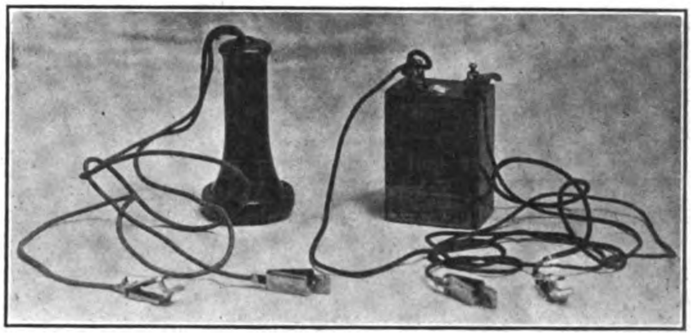
Dandy buzzer-lighting set. J. H. Bunnell & Co., Inc., 20 Park Place, New York.

and switch are of brush brass finish. All parts are mounted on a polished cherry base.

The switch is so arranged that upon throwing it on one contact the buzzer is connected in, and signals can be practised with or without a head set; but if the switch is thrown over to the other point, the buzzer is disconnected and light flashes can be sent. This set operates on one dry cell.

MOORE TROUBLE FINDER

This device is designed to aid the trouble man in locating short circuits and grounds on magneto telephone lines. It measures 2 x 2¾ x 3⅞ in. and weighs 1¼ lb. It is easily operated. The trouble man puts the set in his pocket, runs the cords and clips out and on the line, and then pushes the but-



Moore's trouble finder. Economy Manufacturing Co., Bad-Axe, Mich.

ton. The indicator tells him which way to look for the line disturbance. On test it has given satisfactory results on short circuits on No. 12 iron wire up to about 4 miles, and on grounds to about 8 miles. It is manufactured by the Economy Mfg. Co., of Bad Axe, Mich.

COMBINED FUSE AND DISCONNECTING SWITCH FOR OUTDOOR SERVICE

In connection with operation of small outdoor substations the combined fuse and disconnecting switch here shown is used primarily for the protection of transformer banks where no primary switches are required. The fuse is suitable for opening the exciting current of transformer banks not exceeding 300 kva. Secondary switches should be provided so that the load can be removed in case it should become necessary to open the primary side with the fuses.

The fuse holder has petticoats so spaced as to provide ample creepage surface. The contact parts at the ends of the fuse holder are of brass, and when the holder is in normal operating or closed position they engage with the stationary contacts on the supporting insulators.

The contacts are protected against the effects of ice, sleet, and snow, by the method of mounting and by means of a punched hood attached to the top of each supporting insulator.

The fuse passes through the center of a treated fibre tube within the porcelain fuse holder and is attached to the upper or

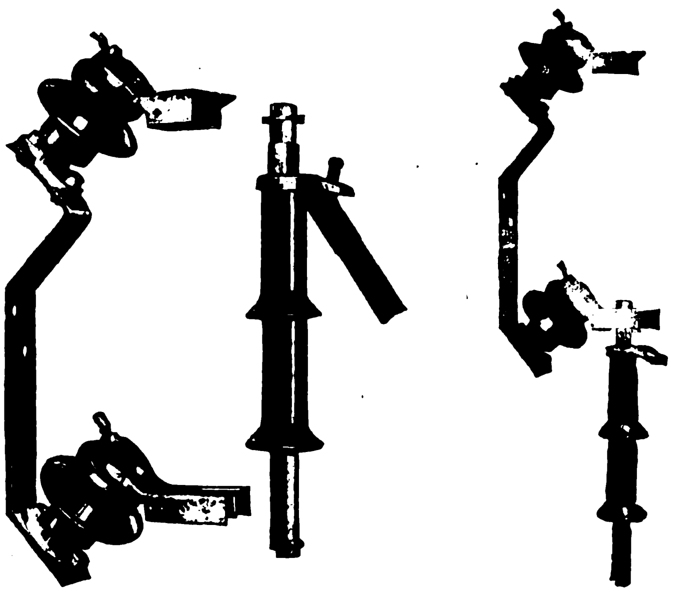


Fig. 1.—15,000 volt combined fuse and disconnecting switch showing fuse holder being removed by the fuse hook.
Fig. 2—Same as above, except fuse holder is suspended from lower contact clips.

closed end of the fuse holder by means of an adjustable clamp, and to the lower or open end of the fuse holder by a circular ring, which, when tightened, holds the fuse firmly in place without a tendency to shear off, when the fuse blows. The explosion consequent upon the expansion of the gases formed effectively expels the arc through the open end of the holder downward and instantaneously opens the circuit. New fuses may be inserted readily.

This combined fuse and disconnecting switch, made by the General Electric Co., Schenectady, N. Y., and known as the type TD-127, is made in single-pole units for vertical mounting on flat surfaces. It can be obtained for use at 15,000, 22,000, 35,000 and 45,000 volts. The maximum current rating is 50 amperes.

No special arrangements are needed for mounting. The supporting bracket is bolted to the cross arm.

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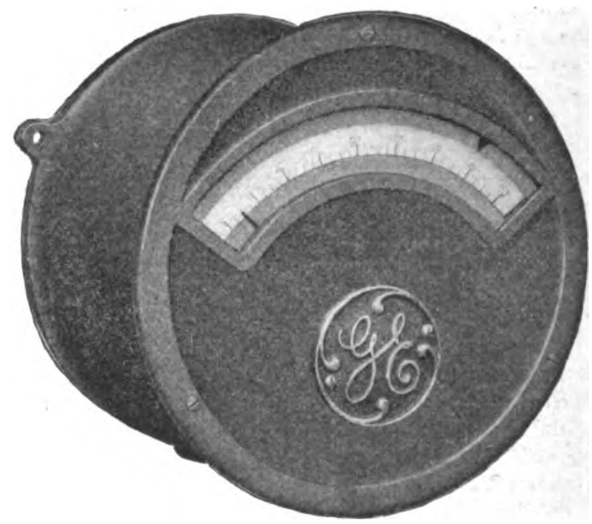
PRESSURE GOVERNOR FOR GAS AND LIQUID SYSTEMS

A new pressure governor to control standard self-starters for motor operated pumps and compressors has been developed by the General Electric Co., Schenectady, N. Y. The governor maintains a pressure between predetermined limits on any gas or liquid systems that will not corrode the Bourdon tube.

This governor is called the CR 2922 and can be used on any standard alternating or direct current circuit. It is rated for pressures of 60, 100, 160, 300, or 500 lb. and operates within settings of from 3 to 12 lb. between high and low pressures. Governors for high pressures can be supplied if desired.

The governor consists of a Bourden tube, an indicating needle, a graduated pressure scale, adjustable high and low pressure stops to determine the desired pressure range, and a relay which actuates the contacts in the control circuit of the self-starter—all enclosed within a dust proof case easily opened for inspection.

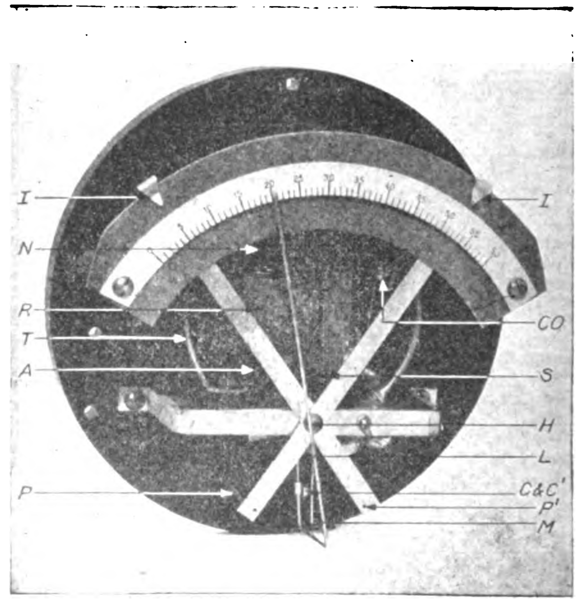
Assuming that the pressure is at the low value, as indicated by the left hand indicator, I, the contact, C, on the needle, N, completes the circuit through the contact, C', on the movable arm, M, which at the low-pressure point rests against the stop, P'. When this contact is made, the circuit is completed through the relay coil, R, causing the armature, A, to close. Attached



Pressure governor for gas and liquid systems. General Electric Co., Schenectady, N. Y.

to this is the contact, CO, which, upon closing, completes the control circuit to the self-starter, causing the motor to start. The armature is also attached to the spring, S, which holds the contact, C', firmly against C until contact is broken at P.

As the pressure increases, the needle pointer moves to the right, but its lower part to which the contact, C, is attached moves to the left, and is followed by the movable arm, M. When the high pressure point is reached, the movable arm is



Operating mechanism of pressure governor for gas and liquid systems.

prevented from traveling further by stop, P, and the needle continues its course, breaking the circuit by separating contacts, C and C'. The instant the circuit is broken, the relay, R, is deenergized, its armature falls, releasing the tension on the spring, S, and because the movable arm, M, is counterweighted it returns to the stop post, P'.

When the pressure is decreased to the minimum value, the contact, C, again completes the relay coil circuit by engaging contact, C[1], and the cycle of operation is repeated.

The case is tapped and drilled at the bottom for the pressure pipe and electrical conduit connections.

COMPRESSION CHAMBER ARRESTER FOR 10,000 AND 13,200 VOLT CIRCUITS

To protect pole transformers on 10,000- and 13,200-volt distributing lines, the General Electric Co., Schenectady, N. Y., has developed a form of compression chamber, multigap lightning arrester in which is embodied the shunt resistance principles. See Fig. 1.

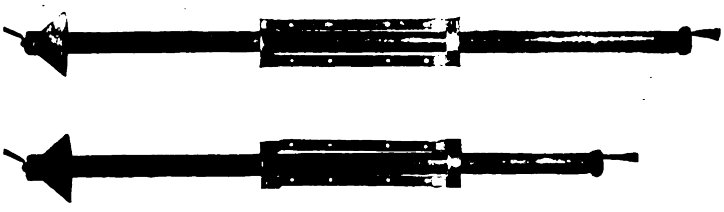


Fig. 1. Compression chamber lightning arrester for 6600, 11,000, 13,200 volt service. General Electric Co., Schenectady, N. Y.

In the usual form of multigap shunt resistance arrester, the resistance shunts the gaps. In this form, the gaps shunt the resistance. The gaps are mounted on and insulated from the resistance rods. The arrangement of the gaps and resistances is shown in Figs. 2 and 3.

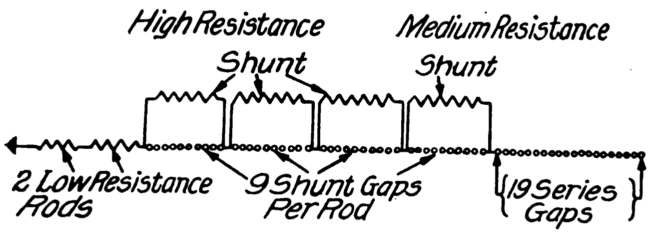


Fig. 2. Connections of Form GS lightning arrester for outdoor service, 7500, 11,900 volts.

Sensitiveness to lightning disturbances is obtained by this combination of gaps and resistance rods used as shunts—all mounted in a porcelain tube.

By reason of this combination of gaps and resistances the arrester will discharge at low rises in potential, is sensitive to lightning over a wide range of frequency, and, following the lightning discharge, quickly cuts off the generator current and prevents grounds or shorts.

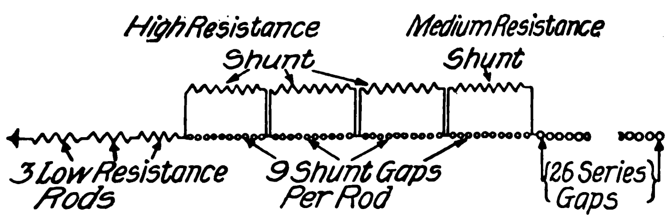


Fig. 2a. Connections of Form GS lightning arrester for outdoor service, 11,900-15,000 volts.

A number of paths for the lightning discharge through the arrester are offered by the four units of shunting resistance used. As the resistance rod in contact with the series gap is grounded through the other resistances, the initial discharge is made easy, because the ground potential is brought up to the bottom of the series gaps. The path which the discharge takes after passing through the series gaps depends on the frequency and quantity. Very high frequency will discharge straight across all the gaps; discharges of lower frequency will take place through one of the shunt paths. The generator current which follows the lightning discharge will shunt to the resistance rods. This limits it to an amount that can be extinguished readily by the gaps.

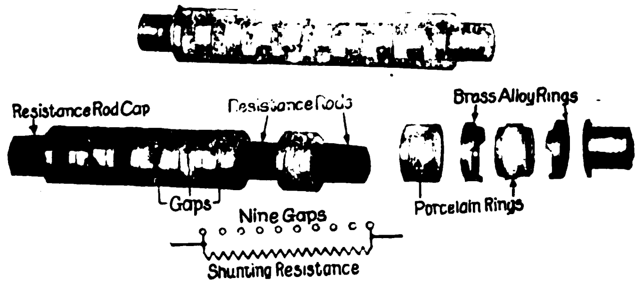
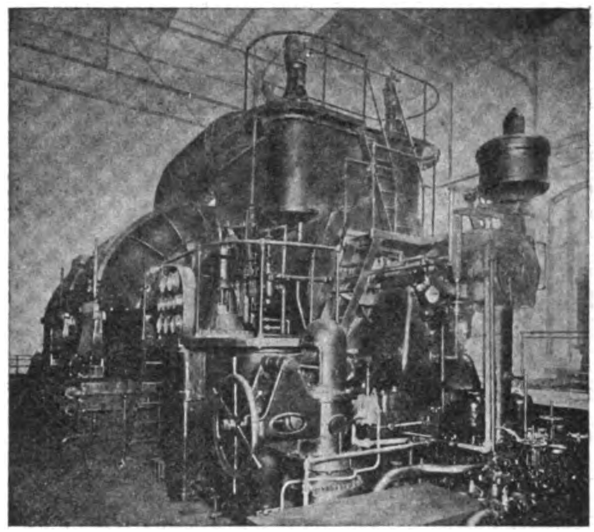


Fig. 3. Shunted resistance units used with Form GS compression chamber arrester.

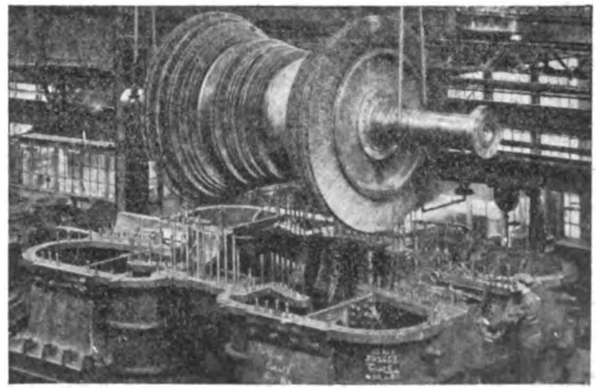
The arrester is said to afford complete protection and is light, efficient, compact, and proof against fire and weather.

COMMONWEALTH EDISON 35,000-KW. TURBO GENERATOR

For service in its Northwest station, the Commonwealth Edison Company of Chicago has ordered two 35,000-kw. tandem compound, turbo-generators from the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa. One of these machines has been in regular operation since early in October of last year. The second one is now being erected. A third



Turbine generator recently installed for the Commonwealth Edison Co., of Chicago, by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.



Essembling Commonwealth turbine generator.

unit of the same capacity is under construction for the Fisk Street station, Chicago.

The two units for the Northwest station are identical. Each consists of a high-pressure turbine element, a low-pressure turbine element, and a 35,000-kva. alternating-current generator.

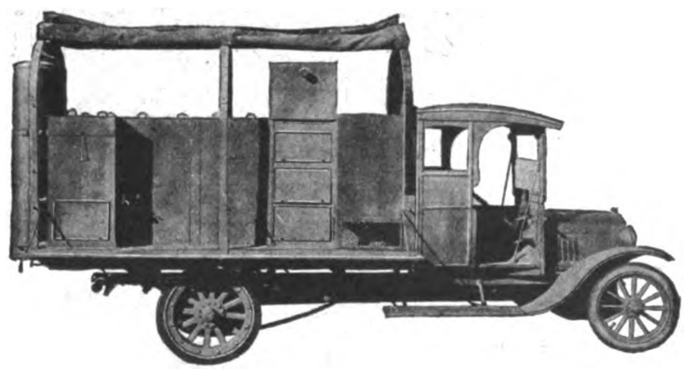
The condensing outfit comprises two shells of 28,000 sq. ft. each, making a total of 56,000 sq. ft. In the upper portion of each condenser, 1200 sq. ft. of tubing is used for heating condensate; that is, the condensate from the bottom of the condenser is pumped through this portion of the tubes so that the condensate is heated to substantially the temperature of the exhaust steam. Each of the shells is equipped with hot-well and air pumps, interconnected so that one or both sets may be used. One set, under normal operating conditions, is sufficient. A single circulating pump, driven by an induction motor, furnishes circulating water for both condensers, the pump having a capacity of 60,000 gal. per min.

The generator is of standard construction, being designed for 1200 rev. per. min., 60 cycles, three phase, 12,000 volts. Its rated capacity is 35,300 kva. and 85 per cent power factor.

AUTOMOBILE ELECTRIC KITCHEN

A new automobile electric kitchen has been designed and built by the Duparquet, Huot & Moneuse Co., primarily for army use. It consists of a standard Ford touring car and Smith Form-A-Truck attachment on which are mounted a small direct-current generator and a number of insulated cooking compartments. The cooking compartments are fitted with electric heating units and provided with passages for the exhaust gases from the engine, the heat of which materially assists in the cooking operations.

The vehicle body is 10 ft. long and 4 ft. wide, and is fitted with a canvas top of the regulation army type, with sides extending to protect the operator from the weather. Eighteen-



Automobile electric kitchen, General Electric Co., Schenectady, N. Y.

inch hinged side platforms are fitted which, when in position, provide access to all cooking departments, and when closed lie within the clearance line of the vehicle.

The generator is of standard General Electric construction totally enclosed, and is rated 6½ kw., 125 volts, 1800 rev. per min., and is designed for continuous operation at rated load. The generator is driven from the transmission shaft of the automobile by silent chain. Voltage is judged by pilot lamp and regulated by the speed engine, no instruments being necessary. Protection against short circuit and overload is provided by an overload circuit breaker and fuses. A larger, and for many purposes more desirable, equipment employing a 12-kw. generator, could be mounted on a 2-ton truck.

Water for cooling the engine is contained in a heavy galvanized steel tank located in an insulated compartment at the rear of the vehicle. The water is circulated through the engine and radiator by means of a centrifugal pump mounted on the engine. This cooling water may be used for culinary purposes, if the pipes, radiator, etc., are occasionally flushed out and cleaned.

All methods of cooking, with the exception of broiling, have been provided for. Broiling can be done by installing an electric broiler in the top of the oven.

Underneath the oven, and heated by it, is a warming closet large enough to hold roasting pans. This closet is fitted with drop doors on both sides for serving purposes. Under the warming closet are located the switches, circuit breaker, and all fuses for heati g circuits.

The are four fireless cooker compartments, each having a capacity of 30 gal. The insulation, which is 2 in. thick, is fireproof, self-supporting, light in weight.

The electric generator can also be used to supply light or power for any purpose within its capacity. For instance, the 6½-kw. generator could supply current for 246 25-watt lamps or 650 10-watt lamps, or power for the electrical equipment of a field hospital for X-ray work and sterilizing.

THRIFT BANK

These new minature thrift banks will soon be found wherever Thrift Stamps are sold by authorized agents, for they save time in selling and accounting and actually increase the sale of stamps. They require no attention other than to keep them filled with the special roll form of United States Thrift Stamps, that may be had in amounts of 50 or 100 stamps.

Simply deposit a quarter, turn the crank and a 25 cent Thrift Stamp is delivered in clean sanitary form and the trans-

United States Thrift Bank. National War Savings Committee, 51 Chambers Street, New York.

action is recorded. All coins, other than quarters, are returned to the user and will not operate the bank.

These banks are loaned at a cost to you of less than four cents per day. Orders for one or more of the banks may be placed direct with the National War Savings Committee, 51 Chambers Street New York; or with the general distributors, The Schermack Corporation, 16th floor, Kresge Bldg., Detroit, Mich.

MOTOR OPERATED RUBBING MACHINE

The Mattison Machine Works, of Beloit, Wis., has developed a motor operated rubbing machine for wood surface finishing. It operates from the electric light socket with a current consumption approximating 5/16 cp carbon incandescent lamps.

A fractional horsepower motor made by the General Electric Company is supplied for the prevailing current. This motor moves the rubbing blocks together and apart at an even speed governed by the regulator which is set according to the class of work in process.

The machine which is enclosed in a dust proof aluminum case, weighs about 35 lb. and additional pressure can be applied by the operator. It can be used for rubbing surfaces 15 in. long and over and of practically any width. All wearing parts are of bronze or hardened steel and friction is eliminated practically by the use of ball bearings.

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EMERSON MOTOR GENERATOR SETS

Three new styles of motor-generator sets are now being offered by the Emerson Electric Mfg. Co., 2024 Washington Avenue, St. Louis, Mo. These sets are of small capacity, suitable for charging ignition, lighting and starting batteries of one or two cars at a time.

A definite additional field for these 80-watt and 150-watt sets will be found among private garages and small public garages and service stations with only occasional charging requirements. Each set consists of a split-phase motor for 110 volts, 60 cycles, enclosed in a field ring also containing a direct current generator. A single shaft carries the armatures of motor and generator. The enclosing frames provide protection from dirt and moisture, while definite ventilation is insured by means of a fan carried on the armature shaft.

The 80-watt generator set is designed to charge a single 6-volt battery of 120 ampere hours or less rating. No rheostat or resistance is necessary. The generator windings are designed to give what is known as a boosting or tapered charge, starting at a high rate and finishing at a low rate. This form of charge is recognized as the most efficient to give a run-down battery a maximum charge in the shortest possible time.

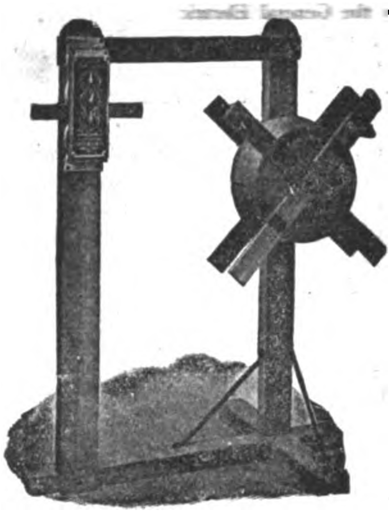
A wooden sub-base is provided to avoid damage to the finish of the car in case the set is used on the running board The equipment includes 10 ft. of extra heavy cord with plug at the motor end and 8 ft. of cord with heavy spring clips at the generator end. A handle is provided for conveniently carrying the set, which has a net weight of 43 lb.

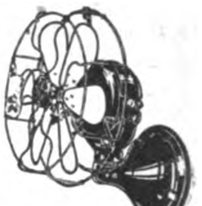
The 150-watt generating set with switchboard, is designed to charge two 6-volt batteries in series or one 12-volt battery, and may be used for charging one 6-volt battery by introducing resistance by means of the rheostat furnished.

A similar 150-watt generator set without switchboard, but with rheostat, can be furnished at a somewhat lower price.

◆ ◆ ◆

For their respective first three months the American War-Savings Campaign is running ahead of the English campaign America is pouring into the Treasury at the rate of about $2,000,000 a day—over $75,000,000 up to date. The $75,944,417 of spending money put at the service of the Government by the buyers of War-Savings Securities has transferred from millions of patriotic, saving citizens to the National Treasury command of the labor and materials to build a fleet of about one hundred 5,000-ton ships.





THE CLEARING HOUSE

Advertisements on this page 5 cents a word. No advertisement accepted for less than $1.00. Electrical Engineering reserves the right to open all letters addressed in its care and agrees to forward only answers that are germane to the product or subject advertised.

FOR SALE

FOR SALE—Steam Engine for sale: 200 to 380 hp. Harrisburg cross compound automatic engine on sub-base. Cylinder 14 in. x 26 in. x 18 in. Wheel 72 in. x 30 in. face. First-class operating condition. Dimensions 8 ft. x 12 ft. Sell right for quick sale. Address: J. F. Foster, 294 Washington St., Boston, Mass.

FOR SALE—Second-hand central energy lamp telephone system, with Kellogg switchboard, now wired for 40 phones, ultimate capacity 100 phones; 5 wall and 25 desk telephone instruments. Ideal for a factory. Fish & Horton, 133 Mill Street, Rochester, N. Y.

GOOD PAYING BUSINESS—Electric retail and contracting, in Western Michigan for sale. Stock runs about three thousand ($3000). Can reduce to one thousand dollars ($1000) in three months. One competitor. Must make change on account of son's health. Will consider any opening in the Southwest in the electrical business. I am 42 years old. I have spent 12 years in my present location, 3 in the office of Power Co., and 9 in a plant where I filled positions from oiler to first assistant engineer. Address: C. N. care of ELECTRICAL ENGINEERING, 1642 Woolworth Bldg., New York City. Miscellaneous

HELP WANTED

ELECTRICAL testers wanted for A.C. and D.C. machines. Must have some electrical experience. Technical or trade school graduate preferred. No age limit. Salary $16 per week and up, depending upon capability. Address: Employment Department, Diehl Manufacturing Company, Elizabeth, N. J.

MISCELLANEOUS

DEBTS collected everywhere, quickly! Established 25 years, same address. William H. Dodd, 87 Nassau St., New York City.

STEAM APPARATUS FOR SALE—1 30 in. Cochrane Oil Separator. 2 Westinghouse Machine Co.'s 6½ x 6 Vertical Engines complete with governors and direct connected to size 8 Alberger Centrifugal pumps both mounted on common bedplate.

1 Ideal Engine 15¼ in. bore and 14 in. stroke, double fly wheel 14½ in. face on eccentric end of crank shaft, 12 in. face on opposite side.

1 American Blower No. 8 with pulley 9 in. diameter, 7 in. width.

Can make immediate delivery. Price upon application. Wisconsin-Minnesota Light and Power Company, La Crosse, Wis.

STEAM MATERIALS FOR SALE—Large quantity of new standard cast iron flanged fittings including tees, crosses or four way tees, elbows, side outlet elbows, off-set, taper reducers, short sections of pipe-gate valves, check valves in 2-3-4-5-6-8-10 and 12 in. sizes.

Can make immediate delivery. Price upon application. Wisconsin-Minnesota Light and Power Company, La Crosse, Wis.

ELECTRICAL MATERIALS FOR SALE:

140 ft. 4 in. Iron Conduit (New)

40 ft. 1½ in. Iron Conduit (New).

250 ft. 1¼ in. Iron Conduit (New).

250 ft. 1 in. Iron Conduit (New).

Can make immediate delivery. Price upon application. Wisconsin-Minnesota Light and Power Company, La Crosse, Wis.

FOR SALE

40-K.W. Generator Garwood Type 3-Wire System. 125-250 Volts Speed 275 Revolutions.

Switch Board 1-panel with instruments marble type.

All in first class condition

Address:

THE PASTIME AMUSEMENT CO.,

17 S. High St., Columbus, Ohio

FOR SALE

GAS ENGINES

For Natural Gas—Illuminating Gas or Distillate

1 100 H. P. Weber Engine

2 150 H.P. Rathbun Jones Engines

For Producer Gas

2 100 H.P. Rathbun Jones Engines

Smith Gas Producers

All machines perfect condition

A. H. COX & CO., Inc.

307-309 First Ave. So. Seattle, Wash.

FOR SALE

REFRIGERATOR PLANT

18-ton complete plant consisting of Wolf compressor, 3000 ft. of 2 and 2½" coils, and engine.

P. R. LINKER

LA CROSSE WISCONSIN

Immediate Delivery

50 KW. 125 volt, G.E. generator, 6 pole 280 RPM. direct connected to a 13 x 12 G.E. ideal engine.

10 KW. 125 volt, G.E. generator, direct connected to an 18 HP. Metz & Weiss kerosene engine.

400 KVA. 3 phase, 60 cycle, 480 volts, Westinghouse alternator. 400 RPM.

125 KW. 3 phase 60 cycle, 2300 volts, G.E. alternator.

75 KW. 3 phase, 60 cycle, 440 volts Westinghouse alternator.

2-100 HP. 110 volt, Holtzer-Cabot D.C. motors.

Large stock of smaller sizes.

JOSEPH MYERSON

270 Commercial Street

BOSTON, MASS.

ENGINE AND DYNAMO FOR SALE

Nash 30 hp. Gas Engine, with General Electric double generator, 160 volts direct, 60 cycle, alternating switchboard, air compressor, air tanks. Excellent condition, suitable for testing purposes or isolated plant.

S. S. HEPWORTH CO.,

2 Rector St., New York City.

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Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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General Electric Co., Schenectady, N. Y.

GRAPHITE
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Standard Underground Cable Co., Pittsburgh, Pa.

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Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Inst. Co., Newark

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Erdle Perforating Co., Rochester, N. Y

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National Metal Molding Co., Pittsburgh, Pa.

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Galena Signal Oil Co., Franklin, Pa.

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Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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Southern Exchange Co., The, N. Y. C.

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Baker & Co., Newark, N. J.

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Adam Electric Co., Frank, St. Louis
Benjamin Elec. Mfg. Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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Brady Elec. & Mfg. Co., New Britain, Conn.

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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Oil
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General Electric Co., Schenectady, N. Y.
Leffel & Co., James, Springfield, O.
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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WASHING MACHINES, Electric
Western Electric Co., New York City

WASHERS, Iron, Steel and Mica
Erdle Perforating Co., Rochester, N. Y.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Leffel & Co., James, Springfield, O.

WATTMETERS
" See Instruments, Electrical

WIRES AND CABLES
American Platinum Works, Newark
American Steel & Wire Co., N. Y. C.
Detroit Insulated Wire Co., Detroit
General Electric Co., Schenectady, N. Y.
Lowell Ins. Wire Co., Lowell, Mass.
Moore, Alfred F. Philadelphia, Pa.
Okonite Co., The, New York City
Roebling's Sons Co., John A., Trenton, N. J.
Phillips Insulated Wire Co., Pawtucket, R. I.
Rome Wire Co., Rome, N. Y.
Southern Electric Co., Baltimore, Md.
Simplex Wire & Cable Co., Boston
Standard Underground Cable Co., Pittsburgh, Pa.
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ectrical Engineering

VG/1

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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

Volume 51 | **JUNE 1918** | **Number 6**

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This flat surface is an exclusive Flexsteel feature. Flexsteel fishes easily, is flexible and is easy to cut and strip.

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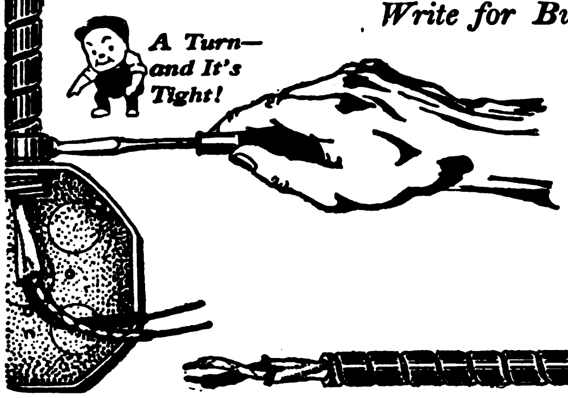

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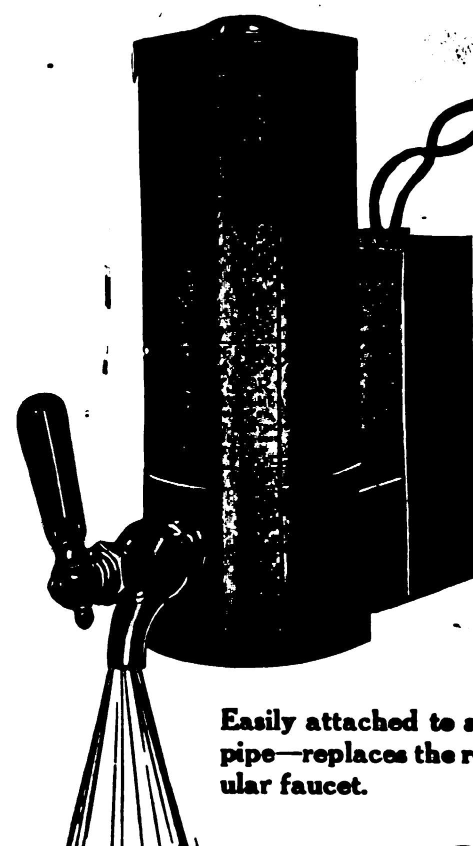

Easily attached to any pipe—replaces the regular faucet.

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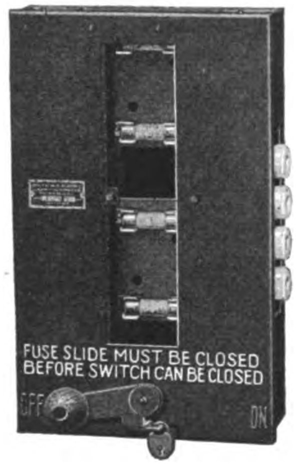

The *distinctive* feature of the

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Let Us Tell You The Story Of A Real Safety Switch

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Our experience of 27 years in manufacturing electrical equipment and repair parts qualifies us to assert that the durability and strength of a motor depend on the careful attention given to every detail. The largest mining, street railway and electric companies have long ago discovered that "the best" only is worth while, so they specify

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The care which we take in the selection of materials, in insulating and baking and the extremely practical tests which we insist on is your assurance of efficient motor service. Write today for complete details and you will be better qualified to select dependable motor equipment.

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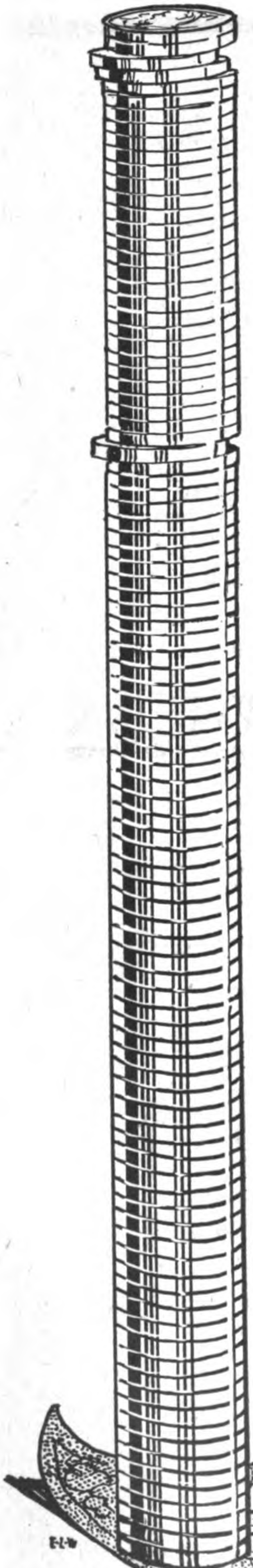
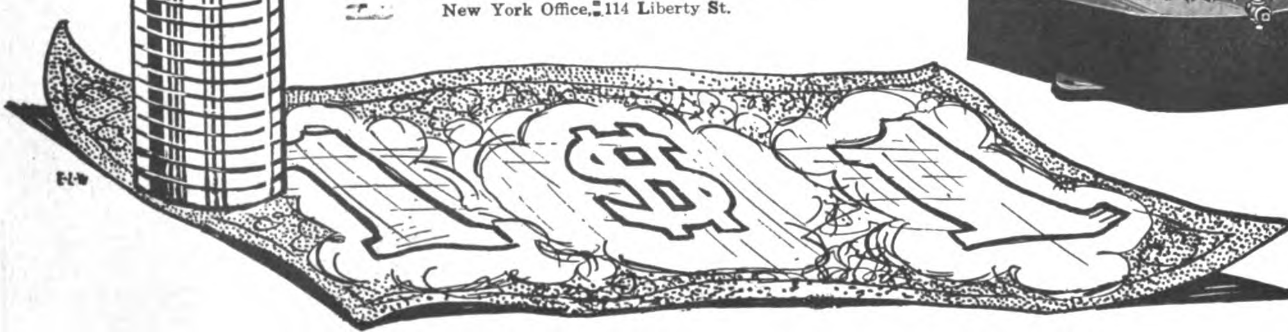
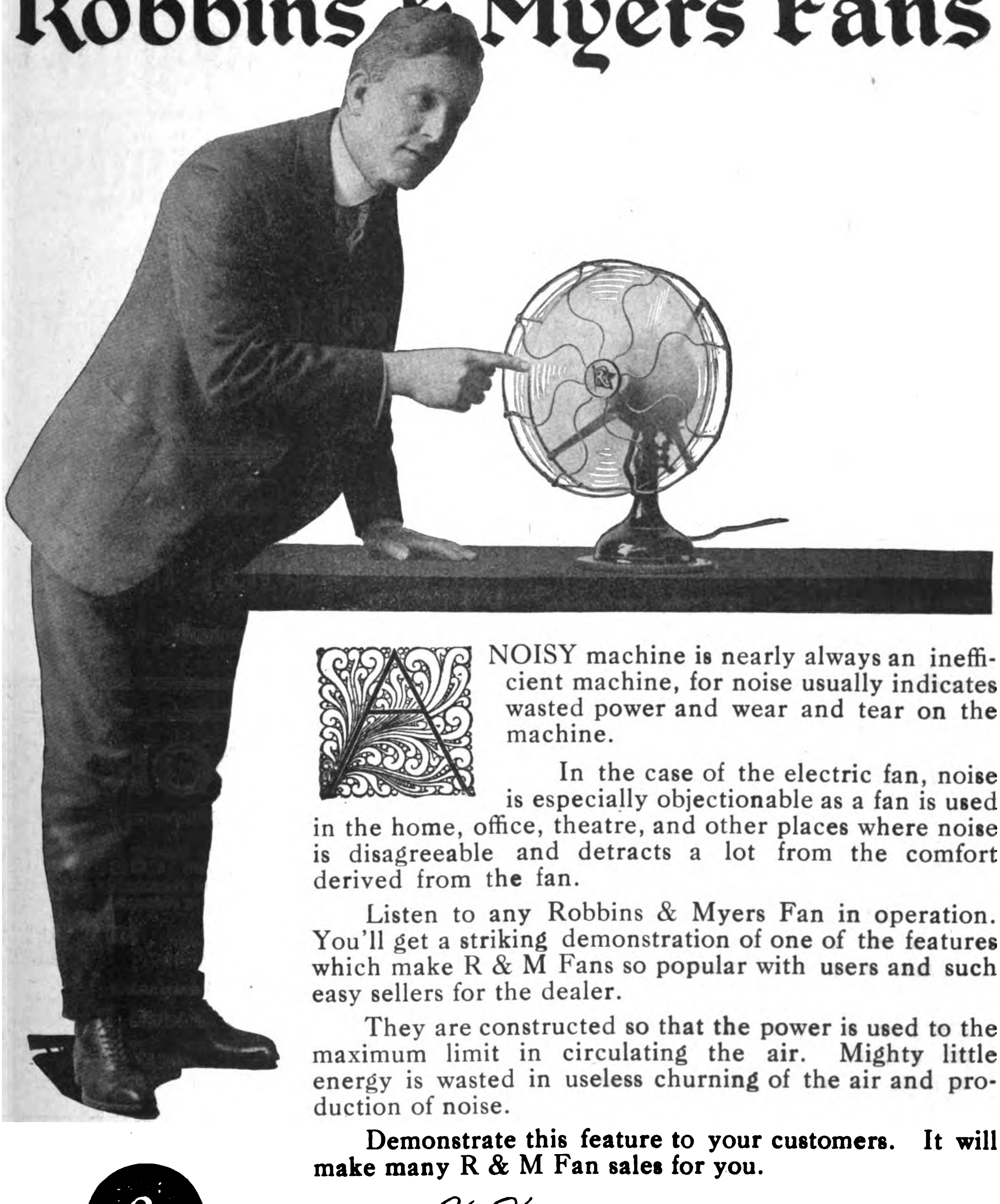




Robbins & Myers Fans



A NOISY machine is nearly always an inefficient machine, for noise usually indicates wasted power and wear and tear on the machine.

In the case of the electric fan, noise is especially objectionable as a fan is used in the home, office, theatre, and other places where noise is disagreeable and detracts a lot from the comfort derived from the fan.

Listen to any Robbins & Myers Fan in operation. You'll get a striking demonstration of one of the features which make R & M Fans so popular with users and such easy sellers for the dealer.

They are constructed so that the power is used to the maximum limit in circulating the air. Mighty little energy is wasted in useless churning of the air and production of noise.

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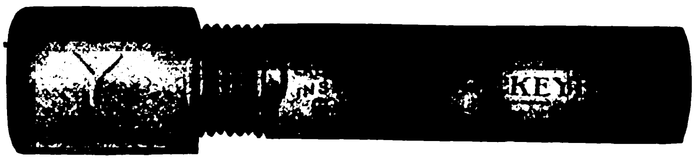

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For Direct or Alternating-Current Circuits

Capacities up to 24,000 Amp. 750 Volt, Direct Current, 2500 Amp. 1500 Volt, Direct Current

The type CA carbon circuit breaker is the development of 35 years' experience by Westinghouse engineers, beginning with the type A circuit breaker, which was the first carbon breaker ever put on the market. The type A breaker for lighting service, and the type C breaker developed later for railway service, passed through many years as the standards of the company; and large numbers of both kinds are still giving honorable service.

The type CA carbon breaker, with its laminated butt brush contact, its auxiliary arcing contacts, its simple toggle mechanism, and other numerous advantageous points, gives satisfactory service under conditions requiring the greatest carrying capacity, and greatest interrupting capacity, developed so far.

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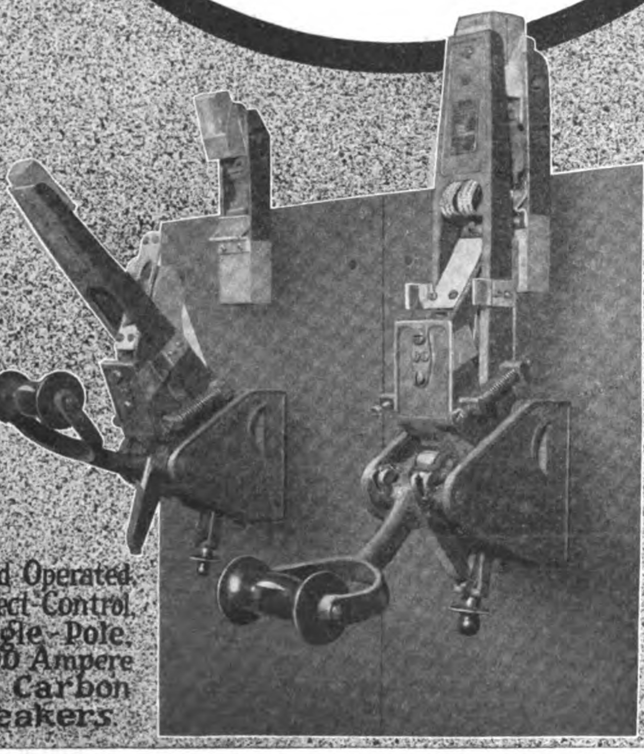
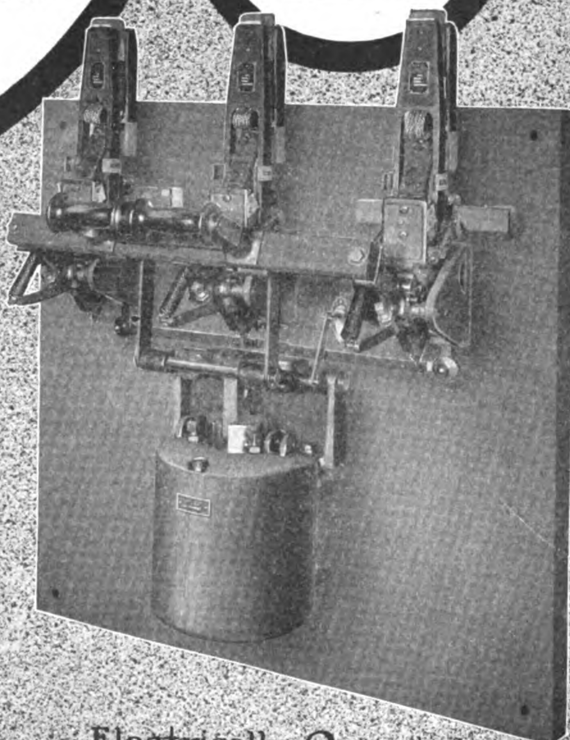


Hand Operated Direct Control Single-Pole 2000 Ampere CA Carbon Breakers



Electrically Operated Three-Pole 3000 Ampere CA Carbon Breaker with Equalizer Contacts

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. 51 **JUNE, 1918** **No. 6**

ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

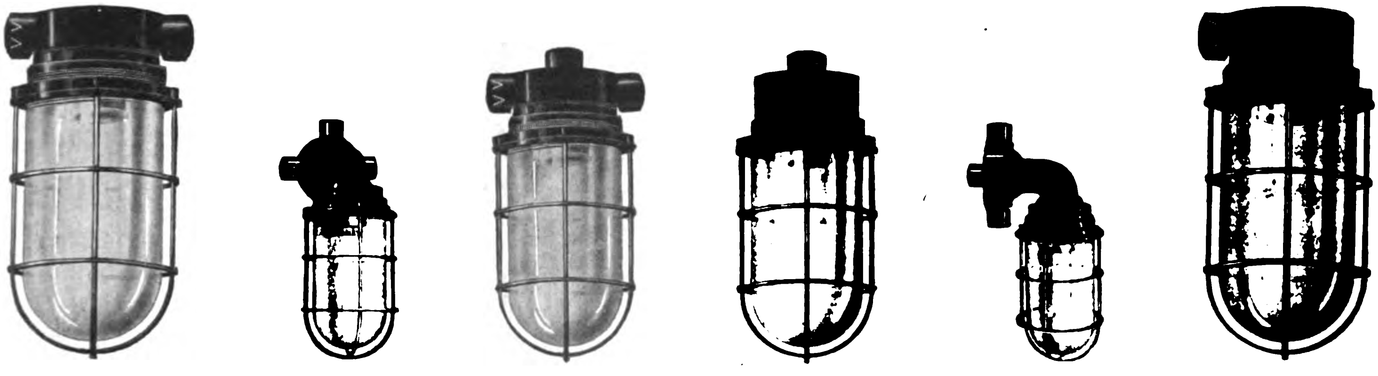
By H. A. Hornor

(*Continued from page* 17, *May issue*)

This expensive renewal of fixtures has introduced lately in this country, but used for sometime in European practice, a line of marine fixtures made of china. Frosted lamps of low wattage are used thus eliminating the glass or porcelain globe avoiding breakage and cost of renewals. The fixtures need only be occasionally dusted or washed with soap and water. They are manufactured in this country by the Lenox, Incorporated of Trenton, New Jersey, who describe them as follows:

"China electrical fixtures of this type have been made for some years, mostly in cheap German chinas and heavy domestic ware. The former were of a porous body, easily glazed and cracked by moisture and salt air. The latter were heavy and of a cold white color exactly on the order of bath room fixtures. The Lenox fixtures are made in the famous Lenox Belleek china, exactly the same body as their most expensive service plates and table china. It is a vitrified body of a beautiful cream tint covered with a rich, luscious glaze adaptable to any style of surroundings. Special shapes are designed to go with any style of architecture and decorated to harmonize with interior color schemes. Moisture and salt air have no effect on this china, eliminating the cost of upkeep."

The Belleek fixture is also adaytable as a non-watertight receptacle and when so used makes the quarters of the vessel entirely free of metal except for joiner hardware. For watertight applications the Navy standard switches and receptacles are generally used on merchant work. There is only one good watertight receptacle on the market. This is known as the Conlen receptacle but its cost is higher than the Navy standard. This must not be construed to mean that its cost prohibits its use. On the contrary it is well worth the money invested, as some owners now appreciate. For the non-watertight spaces ordinary commercial switches and sockets are installed.



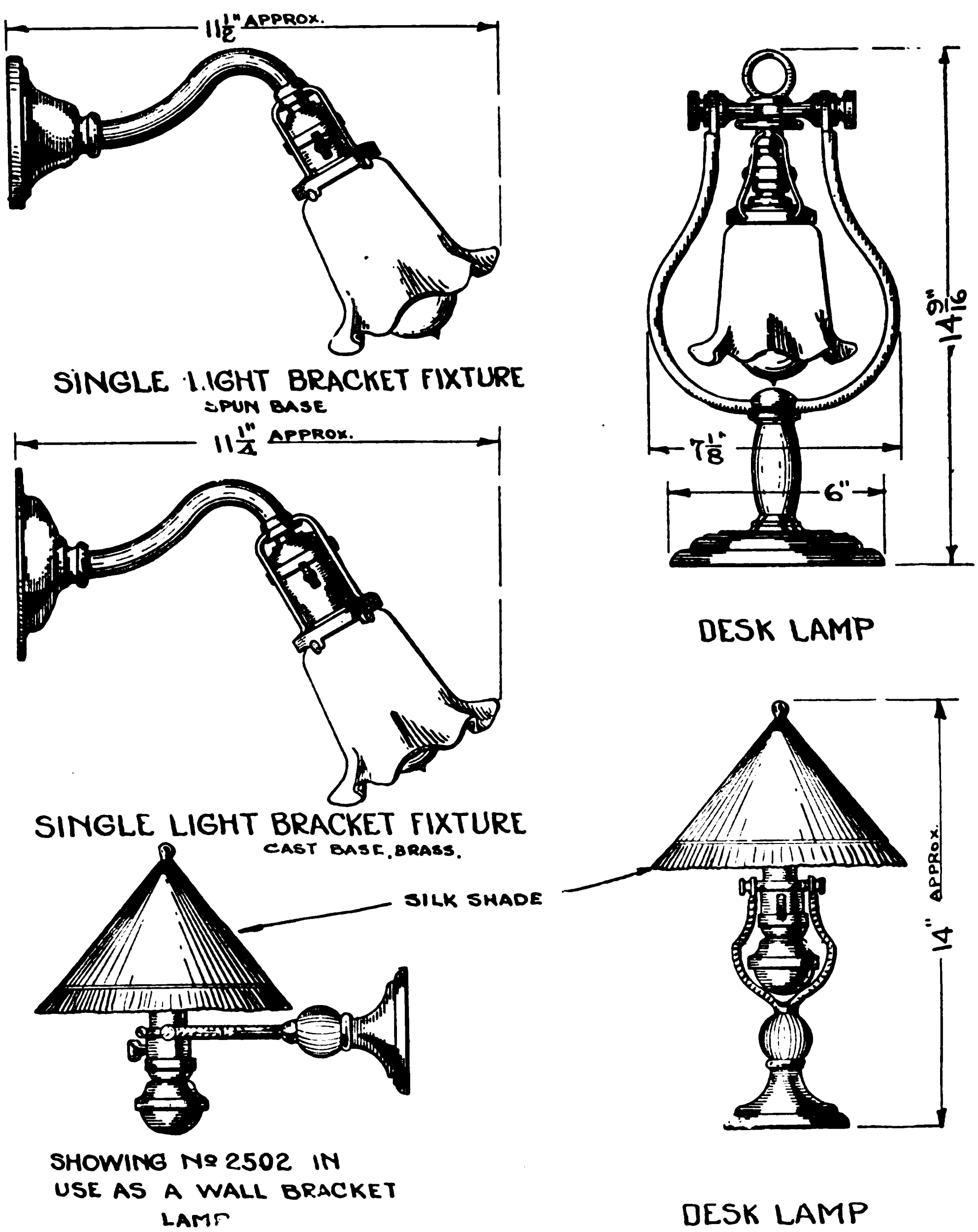
Watertight marine fittings for use on shipboard. V. V. Fittings Co., 1910 *North 6th Street, Philadelphia, Pa.*

It is customary to provide the captain and chief engineer with a receptacle for a portable desk lamp and another for an electric fan. A switch is installed at the cabin door for the purpose of controlling the single lighting unit used for general illumination. As stated previously, in moulding work the taps are made in the moulding but for watertight work, either conduit or steel-armored conductors, a round iron box is used. This branch box is so arranged that it may be tapped on each quarter. The practice in the established shipyards differs on the point of purchasing these branch boxes tapped or untapped. If the layout of the electrical installation is sufficiently clear at an early enough period to give this information to the manufacturer, both the branch boxes and steamtight fixtures may be ordered tapped; but the chances are very great that interferences on the ship or changes made desirable by the development of the work will cause useless delay by a deficiency in the number of boxes will cause useless delay by a deficiency in the number of boxes tapped in a certain way. The unforseen is as potent in this work as in the moral development of man.

Searchlight

The freight vessel carries at least one searchlight, and the large passenger vessel for coastwise service may carry double ting power is secured and objections are only made on the basis of unreliable service due to intermittent use.

The accepted lamp consists of a steadying adjustable resistance which is usually located near the main switchboard, and connected in series with the arc. The lamp mechanism consists of electromagnets operating through a ratchet on a screw spindle, the changes in the electrical circuit automatically varying the distance between the carbons which in turn controls or steadies the arc.



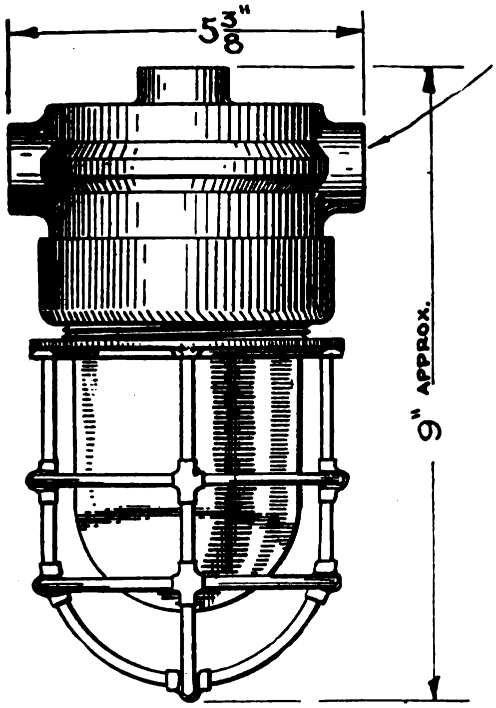
Some of the marine lighting fixtures made by Chas. Cory & Son, 290 Hudson St., New York.

this number. They are a necessity of navigation, both for picking up buoys when entering a harbor at night or for signalling purposes. They are a further convenience in docking or undocking a vessel at night. They are classified by the diameter in inches, but the mirror reflector and the 18-in. searchlight generally satisfies the requirements of the merchant vessel. Excursion river steamers make it a practice to illuminate the shores for the amusement of their patrons and may in certain cases find it advantageous to increase the size so as to obtain a broader beam.

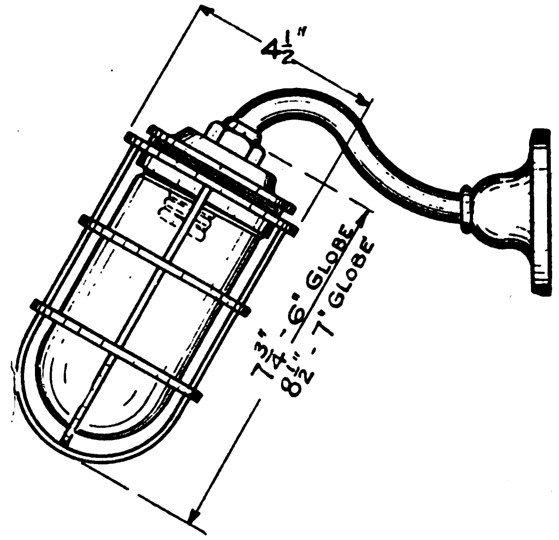
The arc lamp projector has been employed for many years and the incandescent projector is now approaching introduction. Of the arc lamp apparatus it must be said that greater illumina-

The searchlight is usually located on the bridge or top of the pilot house and is thus exposed to all conditions of weather. It may not be needed for days but, when the captain does require it, he expects upon closing the switch in the pilot house that the searchlight will immediately respond. If it does not he sends for the chief-engineer. If the latter cannot fix it, the reputation of the searchlight manufacturer is expressed in sea terms not comprehensible to the land lubber.

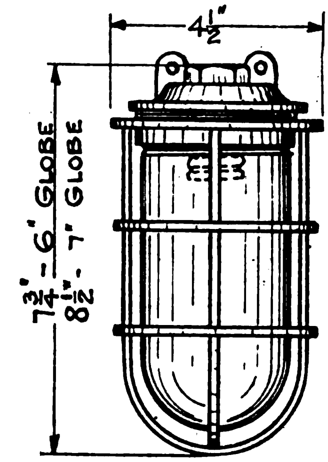
Although the 500-watt tungsten incandescent projector may not equal in penetrating light rays the arc lamp searchlight, yet it is believed that for all work on a radius of from one-half to three-quarters of a mile it will be found successful. Certainly it will always be ready for service, no matter how long it may



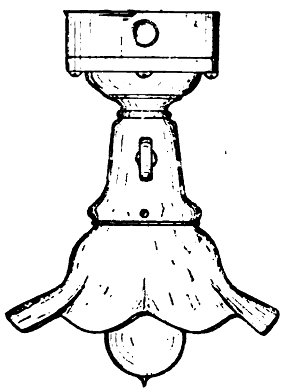
VAPOR PROOF CONDUIT FIXTURE



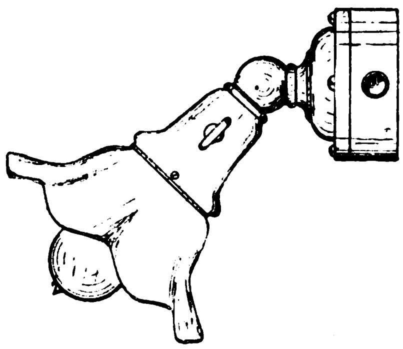
STEAM TIGHT BULKHEAD ANGLE FIXTURE



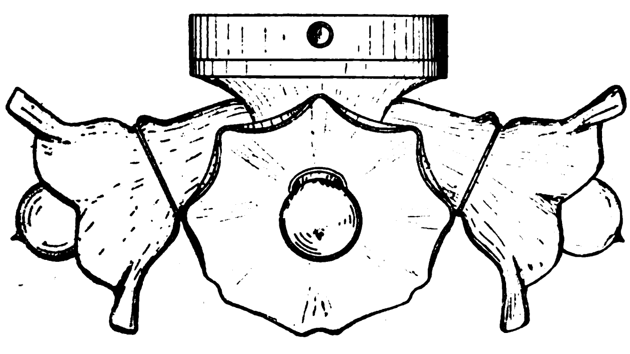
STEAM TIGHT DROP FIXTURE



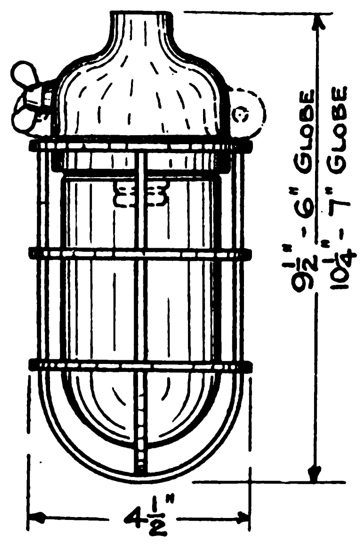
I-LIGHT CEILING FIXTURE



WALL BRACKET FIXTURE



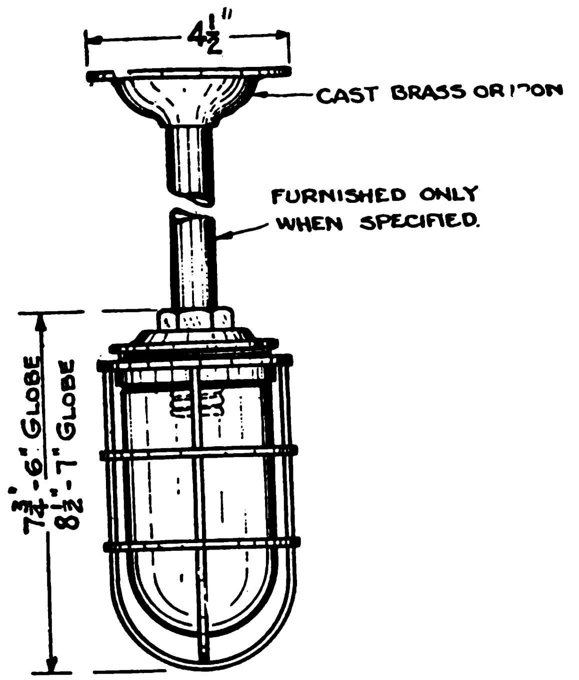
4-LIGHT CLUSTER CEILING FIXTURE



STEAM TIGHT DROP FIXTURE

More marine lighting fixtures made by Chas. Cary & Son, 290 Hudson, Street New York.

stand in disuse. The most serious danger, namely, the breaking of the lamp, can be quickly remedied by carrying a few spare lamps. The installation will be so greatly simplified that the impecunious owner may carry many searchlights for the cost of one of the arc lamp pattern. This is more clearly seen when comparing the current required to operate the two types of apparatus. The arc lamp consumes 35 amperes, and the incandescent approximately 4½ amperes.

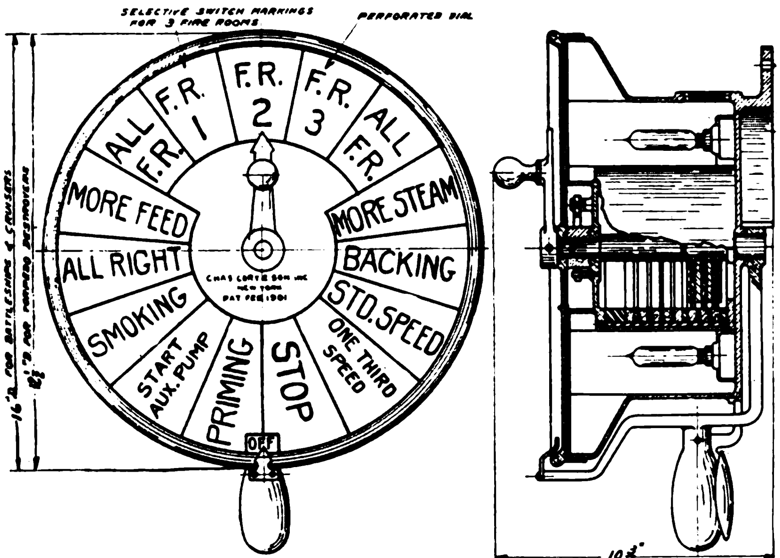


STEAM TIGHT DROP FIXTURE

It is essential for the operation and the preservation of either type that the leading wires be carefully wrapped with steel wires, or other protective covering, which must be well grounded to the hull. This is to prevent the action of the inductive disturbances of the wireless telegraph.

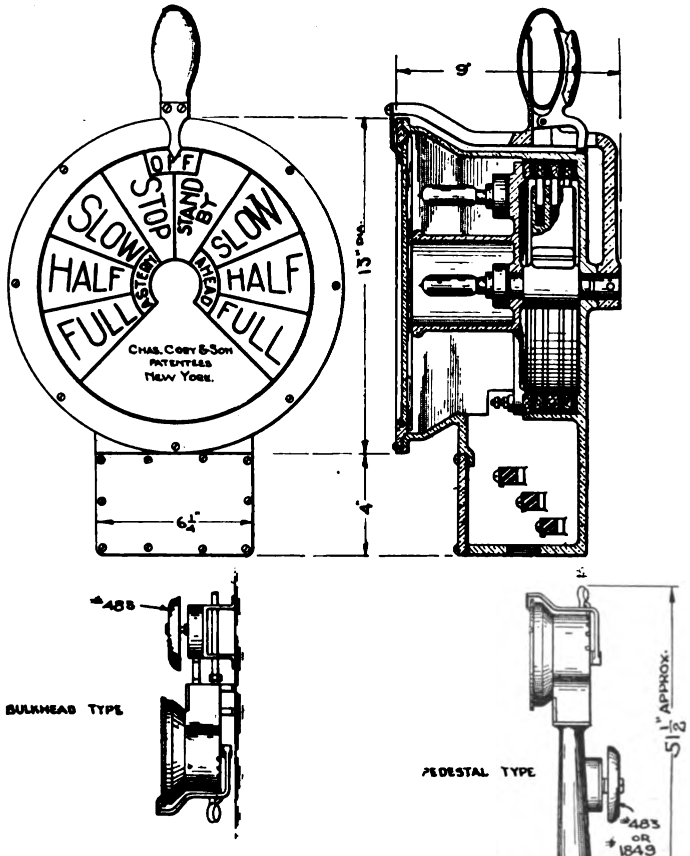
Interior Communication Systems

Engineering compromise makes necessary a separation of those who control the movements of the ship and those who govern the motions of the machinery. The latter are located below the water line; the former keep constant watch on the



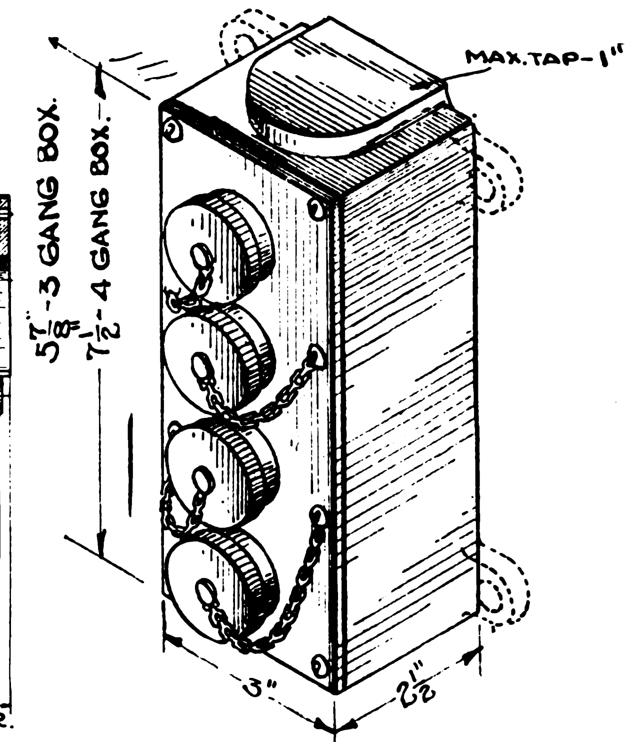
COMBINED ELECTRIC FIRE ROOM TELEGRAPH TRANSM. & INDICATOR.

bridge or in the pilot house. The means of communication between these two principal parties to the safe navigation of



ELECTRIC ENGINE ORDER TELEGRAPH
LAMP TYPE

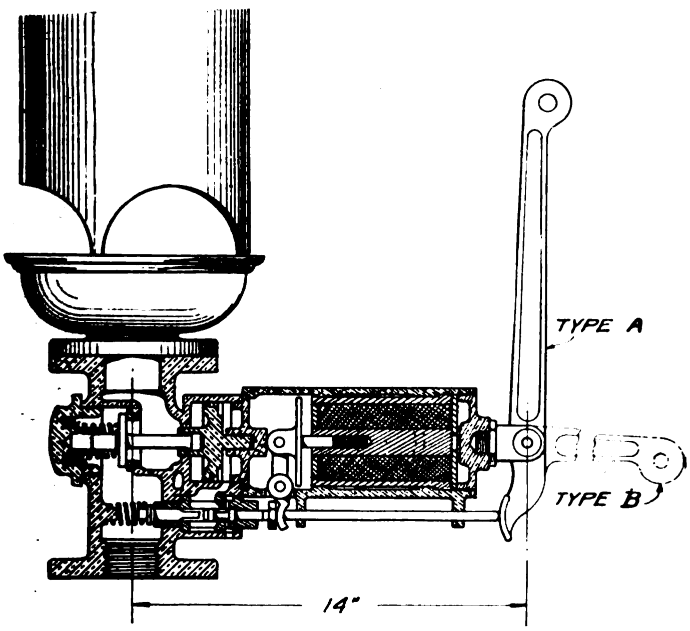
the vessel is a serious and a vital matter. So great has been the danger of a misleading or incorrect signal that for many years reliance has been uninterruptedly placed on the employment of mechanical telegraphs. These instruments are made of brass and take two forms, one applicable to mounting on the bridge or pilot house, pedestal type, the other similar in all



W.T. 3 GANG RECEPTACLE

respects but suitable for mounting on a bulkhead or stanchion in the engine room. This latter, called the engine room receiver, is usually located at the starting platform of the main engine. The instruments are circular in shape with white translucent glass dial for the transmitters, used by the captain, and brass dial for the engineer. The markings on the dial are so arranged that by moving the operating handle forward the orders for ahead movement of the ship are given and the reverse for stern movement.

The telegraph handle actuates a wheel over which runs a triple link brass chain which in turn is attached to a low brass wire. This type of chain is used over small pulleys when it is necessary to make a turn in the circuit. In the same instrument is contained another wheel on the end of whose shaft is placed an arrow. This wheel is actuated through chain and low brass wire by a duplicate handle on the engine room receiver. In this manner a reply signal is given so that the captain is advised



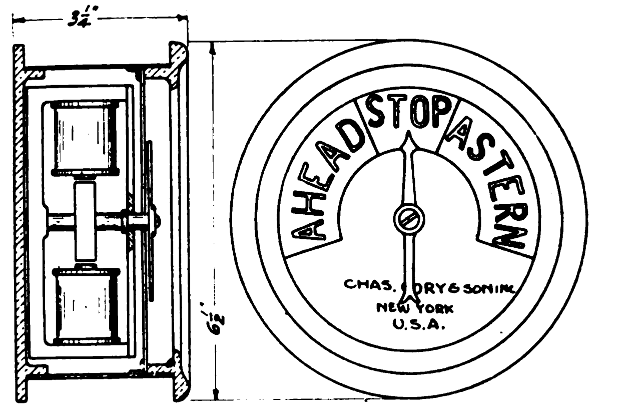
STEAM WHISTLE VALVE
ELECTRICALLY OPERATED.

that the engineer has actually carried out the orders sent. In certain cautious installations an electrical attachment is added between the engine room receiver and the main engine so that an alarm is given if the engine direction for some reason does not correspond with the signal when repeated. Based upon this same general method there are other instruments exactly like the engine telegraph, except changes on the dial markings, for the purpose of docking or steering the vessel, or for observing constantly the motion of the rudder.

As an auxiliary to the engine telegraphs some owners require a gong and a jingle bell. The bell and gong are placed in the engine room and above them a sounding hood and tube leading back to the pilot house. In this manner the captain can hear distinctly the sounding of the signal in the engine room.

Excellent electrical telegraphs are also manufactured to perform the same functions as these mechanical instruments, but broadly stated they are too expensive for the consideration of the owners of merchant vessels. They are also expensive to install, and require careful overhauling and upkeep. Of the two types of electrical instruments, a motor type and a lamp type, the latter is more satisfactory for the merchant service than the former. It is rare to find their use on a merchant ship, either freighter or passenger, and installations that have been made are now replaced or abandoned altogether.

The main steam whistle is always provided with a mechanical pull in addition to any other means. Lately a very good electrical whistle operator has been introduced and many freight vessels carry such an outfit. The steam valve is opened and closed by means of an electromagnet and automatic or "at-will" signals may be given. The automatic features are accomplished by two methods, one employing a motor, another a clock mechanism. The clock movement carries a contact dial, or dials, and

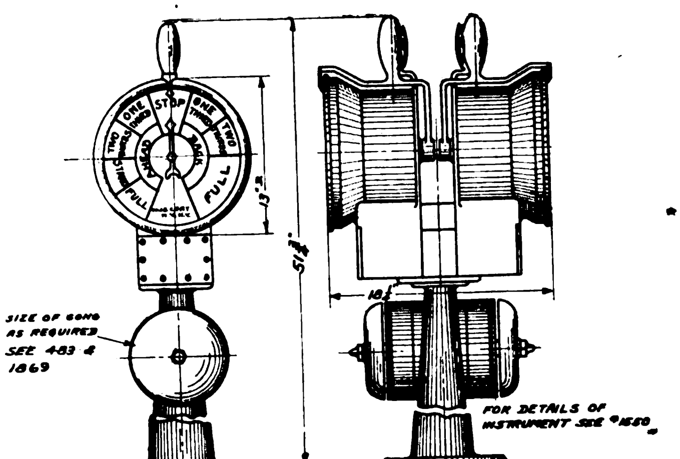


ELECTRICAL ENGINE DIRECTION INDICATOR

the blasts may be regulated so as to sound the whistle as required by law when the vessel is enshrouded in fog and also when it is towing or being towed by another vessel.

Voice tubes are required between the bridge, engine room, captain's cabin, and wireless room. If, however, the ship is planned so that the distance between the pilot house or bridge and the engine room is more than 150 ft., the navigation laws require a telephone instead of the voice tube. Only spasmodic attempts have been made to solve the riddle of the marine telephone.

The owner has been tried beyond patience by various experiments with ordinary land phones. The price of marine tele-



DOUBLE ENGINE ORDER ELEC. TELEGRAPH TRANS. INDICATOR-TWIN SCREW

phones is very high, but much less than the repairing and finally tearing out of land phones. The best practice seems to be a loud-speaking watertight set between the bridge and engine room, arranged with watch case receivers or head sets, and flat speaking transmitters for interior intercommunicating purposes. The flexible head sets permit free action and, what is more valuable, makes the human body act as a cushion for the ship vibrations.

Much of the trouble connected with the application of land phones is the use of corrosive parts and the packing of the carbon granules in the transmitter, this latter being due either to the ingress of dampness or the continual vibrations of the ship when the instrument is not in use.

(To be continued)

UTILIZING SECOND-HAND LINE MATERIALS

With the increased cost of all raw materials, a careful study of scrap, that is, material which can be disposed of only as junk, should be instituted by all central stations. Metals, alloys, scrap rubber, etc., should be carefully segregated as to quality, so that the highest price may be obtained for each.. This is the gist of an article written by L. M. Klauber, superintendent of the Electrical Department of the San Diego Consolidated Gas and Electric Co., appearing in a recent issue of the N. E. L. A. Bulletin.

Never before has there been such need for increased economy of operation and for more efficient utilization of labor and material. Of course, economy must not be allowed to interfere with maintaining a high standard for service; but, in attempting to decrease expenses by the standardization of equipment and the adoption of more efficient or durable apparatus, sight should not be lost of the economy of utilizing discarded material and equipment. Here is where the construction department, which acts in the capacity of contractor to the operating department, has an opportunity to determine how this so-called scrap material can be utilized to best advantage.

The degree of segregation which should be practised will depend upon the specific conditions in each case, the quantity of each class of scrap accumulated, and proximity to markets for raw material. Disposal direct to junk dealers will save much trouble, but in any case a certain segregation is advisable. A miscellaneous scrap heap is the junk man's picnic; he pays a skim-milk price, based on the least valued metal in the pile, and then separates the cream in the privacy of the junk yard.

Utilizing Old Poles

Other material and equipment can be renovated and used for a new service which is not so exacting. Poles form the greatest bulk of distribution plant removed. Poles of adequate length and size can be retreated and used again, if not too badly deteriorated; others may be too light or too worn.

Retired poles must first be carefully examined for soundness. The butt can usually be sawed off about 6 in. above the old ground line if weakened by decay. In fact, it usually pays to discard the butt if decay has advanced beyond a surface sap rot. Sometimes about 3 ft. of the butt can be removed so that when the pole is reset the deteriorated portion falls so far below the surface that it will not be subject to rot. In any case the pole should be carefully treated to arrest further decay, otherwise the life after reinstallation will be short. Brush treatment is better than nothing, but an opentank treatment is much to be preferred.

In these days of greater strength of construction and wider clearances, the 30-ft. poles with 5-in. tops, commonly referred to by linemen as "toothpicks," have little place. In a rapidly growing community they accumulate in considerable quantities. Installation on rural branch lines often solves the problem of their disposal. In some locations villa lots are so large that a special service pole is required between the main lead and each house. An old 30-ft. or 25-ft. pole serves well for this purpose. Short poles can sometimes be used in rolling country on long-span work, where necessary clearances can be secured by taking advantage of the hilltops. A short pole as a push brace will often solve a difficult problem where anchor rights cannot be obtained. One avenue of disposal of light poles which must not be overlooked is to communication companies. Telephone and telegraph construction, especially in rural districts, is ordinarily of lighter quality than that of supply lines, and often a lot of light second-hand poles in sound condition can be disposed of to such companies at a price well above scrap value.

If a pole is no longer fit to use as such, good service may be had from it as a guy stub, an anchor slug or for crib-bracing unguyed poles under strain. Light pieces may be sold to farmers for fence posts. Poles are useful in all heavy construction work and can be disposed of to contractors, house movers and the like. Square redwood poles were once used considerably in some parts of the country before the price become prohibitive. They may be sawed up and put to a variety of uses, particularly in rough building work. They are also valuable in the construction of mudsills, bog shoes or crow-feet, for holding poles in marshy ground, owing to the durability of redwood in the presence of moisture. A piece of redwood makes an especially good anchor slug.

Failing in all other uses, poles may be cut up for firewood. Yet they are not so well adapted to this use as might be thought. Cedar soon chars in the ordinary fireplace and burns with difficulty. It is a fact testified to by many operators that a pole which catches fire from a defective insulator will easily burn down at 2 a. m. in a heavy rainstorm, but when cut and dry will stubbornly refuse to burn up in a perfectly good fireplace.

Use of Discarded Cross-Arms

Non-standard cross-arms, even though in good condition, are difficult to place, since they will not match with new material and are especially bothersome when doube-arm pairs are desired. Older cross-arms are liable to be small in every dimension —shorter, of smaller cross-section or with less clearance between pinholes. The clearance between the pins next to the pole is often less than permitted by law or good practice. A solution of the difficulty as to second-hand arms lies in their use as service buck-arms. Though more expensive than brackets, the buck-arm has advantages as to clearances, making a neat and safe installation, especially where a number of services leave a pole in a variety of directions.

One company which utilizes retired non-standard arms for buck-arms placed an average of 2000 arms per year in such service, thereby utilizing the entire non-standard accumulation. If these second-hand arms are found to have a "pole-pin" separation too narrow to comply with standard practice, it is a good plan to fill one of the pole-pin holes with a 1½-in. wooden plug which can be nailed in place. A new through-bolt hole can then be drilled about 4 in. off center toward the plugged hole and the arm mounted off center. This increases the clearance between the remaining pole pin and the pole by 4 in. Three pin positions remain available for use, these being all that are required for a lighting service. The offset buck-arm does not look bad on a pole, and, besides the advantage of increase clearance, it permits the use of one short or non-standard cross-arm brace with each arm, thus utilizing an additional second-hand item.

Other uses to which old cross-arms may be put are those which might be filled by any number of similar size, such as fence posts for wire fences, blocking for the storage of poles, cross-arms and other materials, cross-pieces for pole-hole covers, and, in general, rough construction work.

Reinstalling Old Wire

Weatherproof copper wire removed from the lines, should be carefully examined before it is reinstalled. If the impregnating compounds has been tried out, it will be better to skin it at once and use it where bare wire is permissible. Many places will be found in suburban and agricultural districts where bare wire is as useful as weatherproof, provided it has retained its strength.

Short lengths of good quality, either weatherproof or bare, should be saved for ties. Annealed wire makes a better tie than medium hard-drawn, particularly when tying bar wire with bare wire.

One use to which larger sizes of copper wire can be put after the insulation has worn off, and even after the wire has crystalized, is for grounded neutrals in underground secondaries. Where secondaries are well grounded at transformers and where practically every service conduit is likewise grounded and tied to the neutral, insulated neutrals would appear an unnecessary expense. Such systems are in operation, using bare neutrals entirely from the transformers to the various branch terminals at customers' entrance fuses, and no difficulties have been experienced due to loading and heating of adjacent cable coverings by leakage current.

Places for Retired Insulators

Insulators, especially pin-type insulators, present a different problem. They are more likely to be unsuitable because of inadequancy than because of deterioration. Some companies serving extensive territories in which a variety of service conditions are encountered find that insulators which have become inadequate in one district may be utilized for lines of similar voltage in sections where conditions are less severe. For instance, companies with lines along the seacoast may find that insulators which have proved to be inadequate under fog and spray conditions will give perfect service on the same kinds of line in interior valleys.

Glass insulators, even of obsolete type, will ordinarily be found useful on secondary systems, provided they have standard pin holes. Sizes smaller than those now standard for line construction should be used on service brackets.

It pays to have a few old types available for emergency connections and testing about any plant, for insulating tools and staging and for temporary service during construction work.

Strain insulators are more flexible devices, and if in good condition use may be found for most obsolete types. Glass "bobs," formerly used in large quantities in guys, are being abandoned for more dependable porcelain, but they will be found quite adequate for the house ends of service loops. They may also be used in the lighter types of guys, such as arm and bridle guys, and in dead-ending light secondaries. Two-bolt and small obsolete three-bolt guy clamps should also be used up on these guys.

Some prototypes of the modern clevis cap suspension insulator which are useful in dead-ending 11-kv. to 22-kv. lines are with difficulty made up into strings, as they have an eye at each end. These may be made up into neat pairs by using one new clevis cap unit at the line end of each pair, thus eliminating connecting links.

Uses for Old Pins and Space Bolts

The lead bushing is an exceedingly useful device in remodeling metal pins. Combination pins having a steel through bolt, porcelain base and wood thimble are becoming obsolete with most companies in high-voltage work, owing to the rapid digesting or destruction of the wood. The wood thimbles may be readily split off, and by means of plaster-of-paris molds, these may be replaced by new lead thimbles, resulting in a pin actually superior in strength and durability to the original article.

A secondary dead-end of the strain type, readily attachable to the end of any space or through-bolt and having all metal parts galvanized, may be cheaply made up with a porcelain strain insulator, a short piece of arc chain, a lap link and a dead-ending clevis.

Disposing of Other Materials

Transformers and meters when retired are generally returned to the manufacturers for credit on new goods. When this is not done, some parts may be saved from the scrap pile to advantage. Transformer cases with leads intact make excellent waterproof cases for the installation of meters, instrument transformers or relays in the open. Occasionally a transformer case is needed in camouflaging a check meter on the service of a suspected customer.

Linemen's gloves after breakdown on test are useful where acids or other corrosive substances are employed, as for instance in handling materials in the lye solution in gas-meter shops and packing plants.

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EFFICIENCY *of* CARBON *and* GEM LAMPS

The criterion by which other lamps are judged at this time is the mazda lamp, says Frank W. Smith, chairman of the N. E. L. A. Committee. In comparison, carbon and gem lamps are very inefficient. To produce a given quantity of light they require more electrical energy and a greater consumption of coal than do the mazda lamps. Stated otherwise, for a given consumption of watts and a given quantity of coal they produce too little light. While the relative efficiencies of these lamps are well known, it will serve in order to bring home the facts which are significant in this connection, to present the statistics once more.

Relative Quantities of Carbon, Gem and Madza Lamps

	Carbon	Gem	Mazda
Watts	50	50	50
Candlepower (mean horizontal)	16.8	20.0	48.1
Corresponding lumens	174	207	476
Watts per candle	2.97	2.50	1.04
Lumens per watt	3.48	4.14	9.52

In addition it is well known that the mazda lamp is much brighter than are the gem and carbon lamps. It is more fragile than the gem lamp, and much more fragile than the carbon lamp, the most rugged of all incandescent lamps.

Reasons Why Gem or Carbon Lamps May Prove Desirable in Certain Installations

Considering first the few reasons which exist for using gem and carbon lamps, it may be said that where lamps are subjected to hard usage the greater ruggedness of these two is an advantage. Thus when a lamp is used on the end of a flexible cord, as in store-rooms, garages, etc., it may be necessary to use them because of the excessive breakage which might be encountered if mazda lamps were used. In some installations considerable loss of lamps is suffered through theft. Gem and carbon lamps being inefficient and relatively undesirable and not so likely to be stolen, their use in such installations somtimes, offers the simplest projection against loss by theft.

The use of diffusing or concealing accessories to soften light and prevent glare is almost imperative when lamps are used, and, although desirable, is not quite as essential when gem and carbon lamps are used. On this account, when lamps are exposed to view and when either carbon or gem lamps will produce enough light for the purpose, it may be desirable to use one of them. Where lamps are used only occasionally and but little light is required, as for example in closets, it may make little difference what lamp is used, and the cheaper gem lamp will serve well enough, particularly if breakage is to be anticipated.

These are the only reasons which have been advanced against the wholesale and complete substitution of mazda for gem and carbon lamps.

Wastefulness of Carbon and Gem Lamps

Except in installations of the kind described, the use of carbon and gem lamps involves waste. The waste is either in human energy by reason of the inadequacy of illumination produced by these inefficient light sources, or it is in electrical energy by reason of the greater consumption necessary to produce the required light. It is difficult to say which form of waste is the more serious. Probably in the long run the waste of human energy through inadequate illumination is a greater impairment of the resources of the country, although in times of fuel shortage, when attention is directed particularly to coal conservation, the waste of electrical energy commands greater attention.

Waste Through Inadequate Illumination

In the industries ample illumination is influential in increasing output, diminishing shrinkage and avoiding accidents. In commercial lines it makes for good working conditions and expeditious work. To fail to profit by these advantages is to waste human energy.

Waste of Electrical Energy

To use electricity needlessly means the employment of generating capacity which otherwise might be put to advantageous use, and as a result waste of coal. While the amount of coal involved in electric lighting waste or in non-essential use of lighting current is relatively small, it is none the less incumbent upon every one involved to effect savings wherever this may be possible. There are few ways in which this can be accomplished with less disadvantage than by the substitution of small mazda lamps for carbon and gem lamps, in those installations where but little light is needed and where no peculiar conditions necessitate the use of the inefficient illuminants. In such installations, if the carbon or gem lamps have provided sufficient light, small mazda lamps consuming less energy will serve.

Concretely, the extent of the advantage obtained in conserving electrical energy through reduced consumption or in providing better illumination with which to conserve human energy is stated in the following table:

		Mazda Lamps			
		For Usual Conditions		Where but Little Light is Needed	
Lamp	Candlepower	Candlepower Change	Watts	Candlepower Change	Watts
50-watt carbon	16.8	+186%	50	−24% +35%	15 25
50-watt gem	20 00	+140%	50	+13½%	25

Where practicable, therefore, mazda lamps should be substituted for gem and carbon lamps, usually to obtain the indicated increase in candlepower, amounting to 140 or 186 percent., and in the less usual conditions where but little light is needed, to reduce the watts and thereby consumption of coal. These measures would be advisable in time of peace and are even more to be urged in time of war, when elimination of waste and speeding up of industry are so essential.

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WESTINGHOUSE ANNUAL REPORT

On May 23, the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa., issued a report of the operations of the home and proprietary companies (except the New England Westinghouse Company) for the fiscal year ended March 31, 1918. This report shows:

Gross earnings	$95,735,406.75
Cost of sales, including all taxes	80,225,936.91
Net manufacturing profit	15,509,469.84
Other income	1,325,263.52
Gross income from all sources	16,834,733.36
Deductions, interest	1,429,052.47
Net income for dividends, etc	15,405,680.89

As of April 1, 1918, the value of unfilled orders in hand was $147,857,580, of which $110,185,007 was for the regular products of the company. No facilities heretofore employed on regular products are engaged on munition work.

Income and Profit and Loss Account

The surplus as of March 31, 1917, $18,105,298.66, was increased by the net income of $15,405,680.89 for the year, making the gross surplus $33,510,979.55.

In addition to the regular quarterly dividends at the rate of 7% per annum on the preferred and common stocks, a special "Red Cross" dividend was paid, making a total of $5,610,848.11 for all dividends paid during the year.

Special appropriations were made for the protection of inventory book values and to establish a research and development fund. After deducting these appropriations and other miscellaneous adjustments the net surplus as of March 31, 1918, is $26,404,694.73 an increase of $8,299,396.07 over the net surplus as of March 31, 1917.

Assets

The property and plant account includes expenditures during the year in connection with the new plant known as the Essington Works, located near Philadelphia, Pa., to which reference was made in the report for last year. This plant, which is now completed and nearly equipped, is operating with a force of about 3,000 men, which it is expected will be increased to approximately 5,000 during the year. Contracts with the United States Government for equipment for cargo ships will occupy the capacity of this plant for approximately two years.

Another important improvment completed during the year is a factory at Trenton, N. J., for the manufacture of incandescent lamps. This factory has been in operation for some months.

The increase in investments includes a subscription for Liberty Loan Bonds of the second issue, the only other important additions being the capital stocks of other companies acquired under the merger of The Westinghouse Machine Company and the Electric Company.

New England Westinghouse Company

The report for last year advised of a modified agreement made with the British Government with respect to the contracts for the manufacture of Russian rifles. The New England Company under this modified agreement was regularly producing rifles in excess of the originally estimated capacity of its plant, but when slightly more than 1,000,000 rifles had been delivered and probably because of the conditions arising in Russia resulting in the withdrawal of that country from the war, the British Government in December, 1917, exercised its privilege of cancellation of the undelivered part of the contracts. However, almost simultaneously with the receipt of this notice of cancellation inquiries were received from the United States Government as to the manufacture by the New England Company of heavy Browning Machine Guns. Negotiations resulted in the receipt of orders from the United States Government, thus enabling the New England Company to retain its organization, not only to its own advantage, but especially to the advantage of our Government in having available for immediate use both manufacturing facilities and a trained organization for the production of Machine Guns. Deliveries began in April and are in advance of the schedule fixed by the contract.

The cancellation of the Russian rifle contracts resulted in the company sustaining the full loss of $5,000,000 against which a reserve in that amount was set aside last year. The Directors therefore authorized the absorption of this amount in said reserve.

Net income available for Dividends and other purposes, as detailed in income account		$15,405,680.89
Profit and loss credits:		
Profit and loss—Surplus, March 31, 1917		18,105,298.66
Gross surplus		$33,510,979.55
Profit and loss charges:		
Preferred dividends	299,902.50	
Common Dividends	5,310,945.61	
Appropriation to reserve accounts	1,360,036.19	
Miscellaneous (net)	135,400.52	7,106,284.82
Surplus, March 31, 1918, per balance Sheet		$26,404,694.73

ELEMENTS OF ILLUMINATING ENGINEERING

The proper lighting of buildings, both interior and exterior, and public highways has developed into a science during the last fifteen years. It is now agreed that in a factory or office the correct disposition of the lighting units, as well as the design of the units themselves, has much to do with the working ability and capacity of all those who are compelled to labor under artificial light. During the development period the essential fundamentals have not received the attention demanded by the importance of the subject. The primer 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. This primer forms the subject of an illustrated story in a recent issue of the General Electric Review. It is republished here for the benefit of our readers who do not happen to have access to that journal.

A mastery of principles of illumination can be gained only by studying the subject from the ground up. In this, as in other scientific subjects, it is necessary at the outset for us to familiarize ourselves with the various terms used in the art, especially those terms which designate units of measurement, for these terms constitute the foundation work upon which the final structure is to be built. Basic definitions have a very academic and sometimes a very technical sound, although the units themselves, once their definitions have been assimilated and not merely learned by rote, are comparatively simple. The definitions which appar from time to time in this paper, need not, therefore, be committed to memory, but should be thoroughly digested so that the reader will grasp the distinction between the different units, and obtain a working knowledge of what each stands for and the quantity it represents. In illumination it is of more practical value to have a conception of the quantity of light represented by one lumen—to know that, for example, 75 of these units represent the quantity of light given off by a 10-watt lamp—than it is to be able to tell precisely what a lumen is. If the unit of length which we call a mile were arbitrarily made shorter, the distance between New York and Chicago would still be the same, or if the day were divided into ten equal parts instead of 24 hours, the planets would not change their speed of travel or rate of rotation. Obviously, it is of advantage to standardize certain units so that relations of magnitude can be expressed and understood with precision, although the value we arbitrarily assign as a standard is of little importance except from this standpoint.

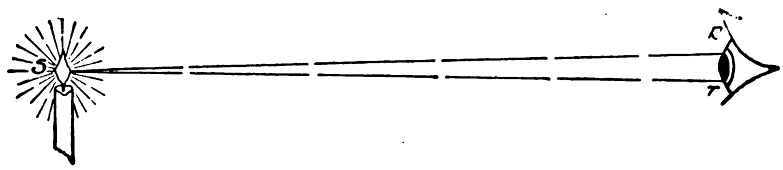

Fig. 1. Only a slender cone of light reaches the eye

Units of Measurement

The Candle

A generation or two ago when new light sources began to supersede the candle, it was most natural that the illuminating power of these new sources should be expressed in terms of the candle familiar to all. It is probable that the very first comparisons of two light sources were made by setting up the two lamps in the line of vision and gauging them by means of the eye, the most natural direction in which to look at the sources being the horizontal. A glance at Fig. 1 shows that the eye (an extremely fallible instrument of light measurement at its best) is capable of measuring only a very slender cone of light at one time; in fact, if the eye is an appreciable distance from the source, the cone *RST* becomes virtually a single line. While there are an indefinite number of directions from which the eye might look at the source, the light-giving power in a horizontal direction was made the basis of comparisons, and the strength of the light in this direction from a candle made according to certain definite specifications, was arbitrarily chosen as the unit of intensity and called a *candle.* The newer illuminants appearing on the scene were rated according to their strength in this same direction and were stated to give so many candles, so that when we say a lamp gives 10 candles, we really mean that its intensity or strength in a horizontal direction is equal to that of a group of ten standard candles. This rating of a lamp is made by means of an instrument known as a photometer, a description of which will be given later. One essential point to remember in this connection is that the candle-power of a lamp represents the intensity in one direction only. In practice it has been customary for years to rotate the lamp about a vertical axis while the candle-power was being determined and the result was known as the mean or average horizontal candle-power, but even this determination gives an average value of the intensity in the horizontal direction only. It should be stated, however, that in comparing lamps on the basis of their horizontal candle-power, the light in directions other than the horizontal was not really ignored, for it was taken into consideration that most sources

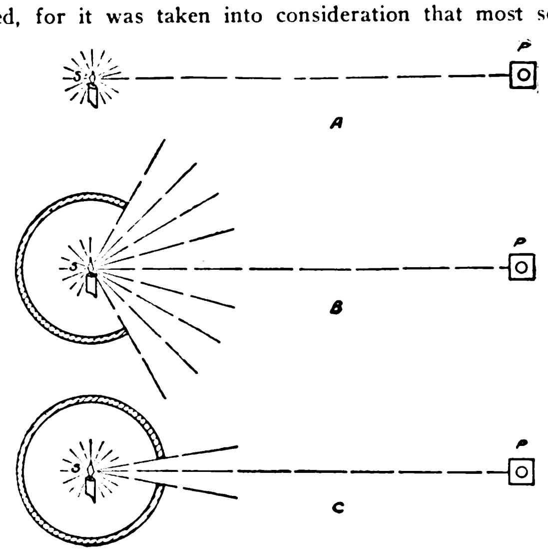

Fig. 2. The candle-power in the direction of the photometer is not changed by partially surrounding the light source with a non-reflecting surface.

of light then in use gave off their light in about the same proportions in the different directions and that for this reason the candle-power in a single direction furnished a criterion sufficiently accurate for the needs of the time.

To carry our conception of candle-power a little further, let us assume the conditions existing in Fig. 2. In Case A we have on the left a standard candle and on the right a photometer pointed toward the candle. From what has already been stated, it is obvious that when the photometer is balanced it will indicate an intensity of one candle. In Case B we have surrounded the same candle with a sphere having a moderately large opening. The inside of the sphere, we will say, has been painted a dead black so that none of the rays striking it are reflected but are absorbed and cease to be light—in other words, are thrown away as far as our experiment is concerned. In this case the photometer will still indicate an intensity of one candle in spite of the fact that a great deal of light has been thrown away. In Case C, we have used a sphere with a much smaller opening and are therefore wasting still more of the light, but even in this case our photometer will indicate an intensity of one candle. In fact, our reading will be one candle regardless of the size of the opening, that is, regardless of the quantity of light we allow to be emitted, provided the direct rays from the candle to the photometer are not obstructed. The proverbial candle hidden under a bushel will still give an intensity of one candle if there is a small hole in the bushel for a beam to escape, although as far as its illuminating value is concerned, it is still "hidden under a bushel." This leads us to the important conclusion that the candle-power of a source gives no indication of the total quantity of light emitted by that source. Candle-power, we may say, is analogous to a measurement of the depth of a pool of water at a certain point on its surface—a measurement which is useful for certain purposes but in itself gives no indication of the quantity of water in the pool.

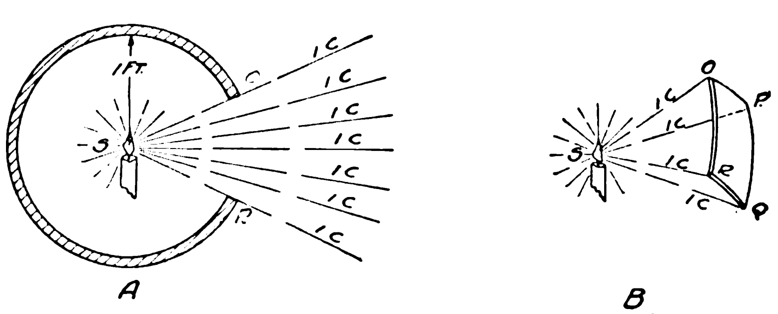

Fig. 3. A—Opening OR has area of one square foot and emits one lumen. B—One lumen falls on surface OPQR

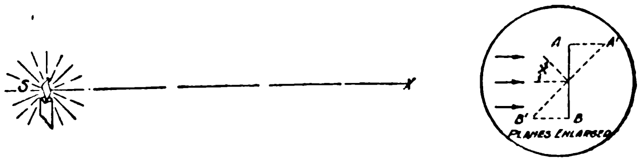

Fig. 5. The illumination is less on A'B' than on AB (See footnote)

The first fundamental concept we have to deal with in illumination, then, is candle-power, which is the measure of strength of a source to produce illumination in a given direction, and the power in a horizontal direction of a candle made according to certain specifications and burning under certain conditions has been arbitrarily chosen as the unit for measuring this strength.

Closely related to candle-powr is ***mean spherical candle-power.*** The mean spherical candle-power of a lamp is simply the average of all the candle-powers in all directions about that lamp. A source giving one candle in every direction would have a mean spherical candle-power of 1, or if a source gave off various candle-powers in different directions but if the average of all these candle-powers were 1, this source would have a mean spherical candle-power of 1. We must remember, however, that the infinite number of directions in which a source ordinarily emits light do not all lie in the same plane, but extend into space on all sides about the source, like the pricks of a chestnut burr.

The Lumen

We have seen from Fig. 2 that candle-power alone gives no indication of quantity* of light. It is necessary, therefore, for us to develop a unit whereby we can measure the quantity of total flux of light emitted by a source. For this purpose, let us assume a source giving one candle in every direction, and that this source is placed at the center of a sphere painted black on the inside and having a radius of, say, 1 foot, as shown in A, Fig. 3. *OR* represents an opening in the sphere through which some of the light may escape. The quantity of light allowed to escape may be varied by varying the size of the opening, with the candle-power of the source and the radius of the sphere

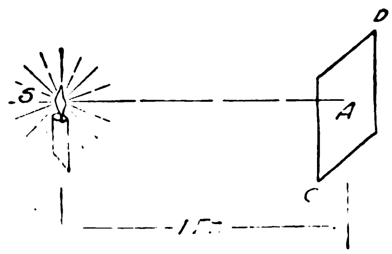

Fig. 4. The illumination at A is one foot-candle

remaining fixed; if we decide on some definite size of opening at *OR* we shall have a definite quantity of light which we can use as our unit for measuring quantity. The simplest area or unit to assume for OR is 1 square foot and if we make this opening of an area of 1 square foot, the amount of light that escapes is considered to be the unit of quantity, and is called a *lumen*.† Thus we have established a permanent unit for the measurement of quantity of light; the mathematical relations used to fix it serve only the same purpose as two scratches on a platinum iridium bar in the International Bureau of Weights and Measures, the distance between which at a definite temperature is called a meter.

If the area of OR is made ¼ square foot, the light escaping will amount to ¼ lumen; if the area of *OR* is doubled, the light escaping will be 2 lumens. On the other hand, if we have a uniform source of 2 candles instead of 1, 2 lumens will be emitted through an opening of 1 square foot in this particular sphere. We know by arithmetic that the total surface of the sphere having a radius of 1 foot is 12.57 square feet.‡ In other words, removing the sphere entirely, we would have the equivalent of 12.57 openings the size of *OR*; that is, if the candle gives 1 candle in every direction, with the sphere removed it would give 12.57 lumens. This means that if we know the mean spherical candle-power of a lamp, by multiplying this value by 12.57 we obtain the number of lumens emitted by that lamp. A value of 12½ is sufficiently accurate for most practical purposes and is somewhat more convenient for calculation inasmuch as it is necessary only to divide the mean spherical candle-power by 8, with proper regard to the decimal point, to arrive at the lumen rating. A lumen may also be defined as being equivalent to the quantity of light intercepted by a surface of 1 square foot every point of which is at a distance of 1 foot from a source of 1 candle. (Fig. 3, Sketch B.)

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*Quantity is here used in the sense that it indicates only a summation of flux as throughout a given solid angle about the source, and over a given area illuminated to some average value. Quality in a more precise sense is a summation over a period of time and is measured in lumen-hours.

†We could choose a sphere of any radius we cared to, as long as we kept the proportion the same by making the size of the opening such that its area would be equal to the square of the radius. The quantity would still be one lumen.

‡The surface of a sphere is equal to the radius squared multiplied by 4 by 3.1416.

While the foregoing definitions establish definitely the quantity of light that we use as our basic unit, it must be remembered that a lumen, in order to be a lumen, need not necessarily conform with these specifications if the quantity of light represented is equivalent to that prescribed by the definition. A bushel might be defined as the quantity of any commodity contained in a cylindrical measure having a diameter of 18½ inches and a height of 8 inches; however, a bushel of potatoes spread out in the field is just as much a bushel as though the shape of the pile conformed in every respect to the dimensions just mentioned.

The Foot-Candle

Light is a cause and illumination the effect or result. Both the lumen and the candle are used to measure the cause, these units applying to the light source itself and not to the point where the light is utilized. To measure the illumination on a newspaper, desk, or other working plane, we employ a unit called the *foot-candle*. A foot-candle represents an intensity of illumination equal to that produced at a point on a plane which is 1 foot distant from a source of 1 candle and which is perpendicular to the light rays at that point. In Fig. 4, if the source *S* gives an intensity of 1 candle along the line *SA* and if *A* is 1 foot distant from the source, the intensity of illumination on the plane *CD* at the point *A* is 1 foot-candle.* The intensity of illumination, measured in foot-candles, is the unit of measurement most

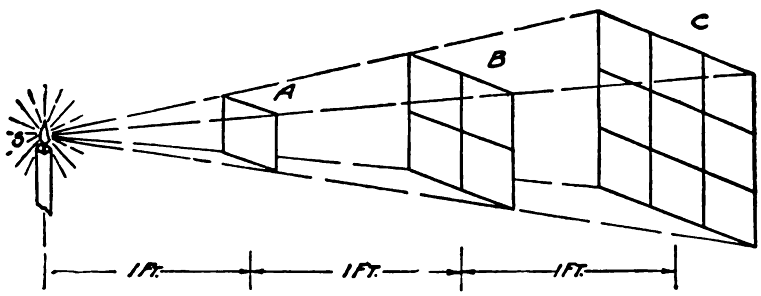


Fig. 6 The illumination on a surface varies inversely as the square of the distance from the source to the surface.

intimately associated with our everyday use of light, and a measurement which the eye either consciously or unconsciously is making whenever the faculty of vision is being employed, for the number of foot-candles we have on the working plane, other things being equal, determines directly whether or not there is sufficient light. A working idea of a foot-candle of illumination can be obtained by considering the intensity on a newspaper read by the light of a candle, the paper being held approximately one foot away from the candle. The foot-candle is a unit applying to a point on a surface; by averaging the foot-candles as a number of points on a plane, we get the average intensity of illumination on that plane.

Care should be taken to avoid confusing the intensity of illumination on a surface as indicated by the foot-candles with the appearance as regards brightness of the surface. A grey surface lighted to an intensity of one-candle will not appear so bright as a white one, for a greater proportion of the light falling upon the plane is absorbed and lost. The brightness of an object depends upon both the intensity of illumination on it and the percentage of light that it reflects.

Having defined the foot-candle as a unit of intensity of illumination, we are naturally interested in seeing how the intensity of illumination varies as the candle-power of the source varies, and also as the distance of the plane from the source varies. It is obvious that if in Fig. 4. instead of an intensity of 1 candle along the line *SA* we have an intensity of 2 candles the illumination at *A* would be twice as great, and that if we have an intensity of 5 candles the illumination of *A* will be five times as great. Now, if we consider a source of 1 candle as shown in Fig. 6, we know that the intensity of illumination on *A* which is 1 foot distant is 1 foot-candle. If, however, we remove the plane *A* and allow the same beam of light that formerly was intercepted by *A* to pass on to the plane *B*, 2 feet away, we

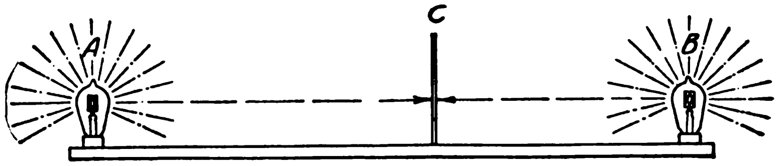


Fig. 7. Essential parts of horizontal photometer

find as shown in the diagram that this same beam of light would have to cover four times the area of *A*; and, inasmuch as we cannot get something for nothing, we would find that the average intensity on B, 2 feet away would be ¼ as high as that on A, 1 foot away, or ¼ of a foot-candle. In the same way, if *B* also is removed and the same beam allowed to fall upon plane C, 3 feet away from the source, it will be spread over an area nine times as great as *A*, and so on; at a distance of 5 feet we would have only 1/25 of a foot-candle. From this we deduce that the intensity of illumination falls off not in proportion to the distance, but in proportion to the square of the distance. This relation is commonly known as the inverse square law.

Important Relation Between Foot-Candle and Lumen

If we refer back to Fig. 3B we see that the surface *OPQR* is illuminated at every point to an intensity of 1 foot-candle. We also know by definition that the quantity of light falling on the plane *OPQR* is 1 lumen. This gives us the important law that if 1 lumen is so utilized that all of the light is spread over a surface of 1 square foot, that surface will be lighted to an average intensity of 1 foot-candle. This relation greatly simplifies the designing of a lighting installation, for once the number of square feet to be lighted and the intensity of illumination which it is desired to provide are known, it is a simple matter to find how many lumens must fall on the working plane. If, for example, it is desired to illuminate a surface of 100 square feet to an average intensity of 5-foot candles, 500 lumens must be utilized. The designing of a lighting installation is taken up more in detail in a succeeding issue.

Photometry
Candle-power and Light-output Measurements

Photometry is a specialized branch of the science of illumination which in itself may be made the subject of an extended study. The man doing field work in illumination has no need for an intimate knowledge of all the details that enter into this branch of the art. In the following discussion, photometers are treated in a broad, general way, and for more detailed description of these instruments the reader is referred to standard works on the subject of illumination and photometry.

A sketch of the simplest type of photometer is given in Fig. 7. The essential part of this photometer is a vertical paper screen between the lamps to be compared, at the center of which is a grease spot. When the illumination on one side of the screen is greater than that on the other, the spot on this side will appear darker and on the other side lighter than the sur-

*If, instead of being perpendicular to the beam, the plane *A B* is tilted at an angle, as shown in Fig. 5, it will be seen that the light of this beam is spread over a greater area than if the plane is perpendicular, so that the intensity of illumination on the plane is less in proportion to the ratio of the length of *A B* to the length of *A'B'* or to the cosine of the angle between a perpendicular to *A' B'* and the axis of the beam, which is the angle *X*. If with the plane in the position *A B* the illumintion is 1 foot-candle and the cosine of the angle *X* is 0.7, the average illumination on the plane in position *A' B'* will be only 0.7 of a foot-candle.

*That the above condition is true can be proved mathematically, but it is believed that a discussion of this proof, important as it is in simplifying the operation of determining total light output, would be beyond the scope of this publication.

rounding paper. By sliding the screen back and forth on the bar, a position can be found where the outlines of the spot will vanish and the spot itself will disappear. When this condition obtains, the illumination on both sides of the screen is the same.

In order that both sides of the screen may be seen simultaneously, mirrors are mounted obliquely behind the screen. In Fig. 8, Case A, it will be noted that the spot as viewed in the left-hand mirror is darker than its surroundings and as viewed in the right-hand mirror is lighter than its surroundings, which indicates that the left-hand sides of the screen is illuminated to a higher intensity than the right. In Case B of the same figure, it will be noted that the conditions are reversed; therefore, in this case the illumination on the right side of the screen is greater

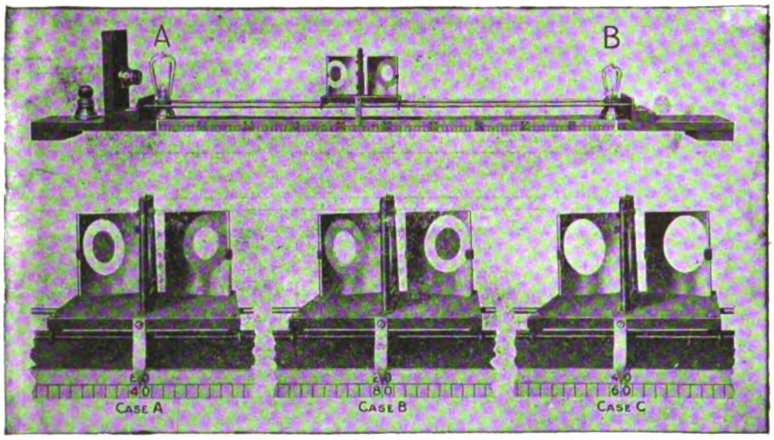


Fig. 8. Photometer and Screens
Case A—Screen at left of balance point
Case B—Screen at right of balance point
Case C—Screen at balance point

than that on the left. Somewhere between these two positions is a position at which the spot will cease to be visible, as shown in Case C of Fig. 8.

From what has been said above, the intensities of illumination on both sides of the screen in Case C are equal. Now, since we have a relation between the intensities of illumination that the two lamps being compared produce, we can reason back as to the relation between the candle-powers given, respectively, by lamps *A* and *B* (see Fig. 8). The scale of the photometer shows us that at a distance of 60 inches the lamp *A* produces an illumination equal to that which the lamp *B* can produce at a distance of 40 inches. At first thought we might say that *A* must give 3/2 as great a candle-power as *B*, recalling the inverse square law previously referred to which states that the intensity of illumination varies inversely as the square of the distance, or, what is the same thing, that the candle-power necessary to produce a given illumination varies as the square of the distance from the source to the plane, we see that the ratio of the candle-power of A to that of B instead of being 3 to 2 is 3^2 to 2^2 or 9 to 4. The horizontal candle-power of *A*, therefore, is $2\frac{1}{4}$ times that of *B*. If *B* is a lamp of some known candle-power, the candle-power of *A* is determined by multiplying the candle-power of *B* by $2\frac{1}{4}$. The general rule, then, is that the candle-powers of two lamps on a photometer are to each other as the squares of the distances from each to the screen are to each other. For accurate photometry, the grease spot screen is no longer in use, but the newer and more accurate photometers are the same in principle.

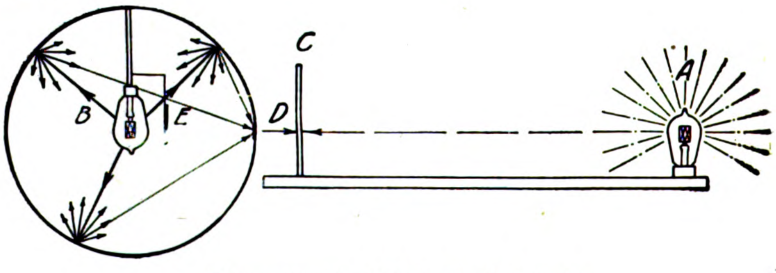
The simple bar photometer measures candle-power in one direction only. If the lamp being measured is rotated about its vertical axis, its means horizontal candle-power is obtained. In like manner, if the vertical axis of the lamp being measured is tipped and the lamp rotated on this axis, the average candle-power at any angle can be determined.

Another form of photometer known as the sphere photometer, or Ulbricht sphere, is shown in Fig. 9. In this photometer the lamp to be measured is placed at the center of a large sphere the inside of which is painted flat white. In this sphere is a small window of milk glass. The candle-power emitted by this window is compared with the candle-power of a standard lamp. The candle-power of the window computed as above is directly proportional to the mean spherical candle-power or the total lumen output of the lamp in the sphere, so that multiplying this candle-power by a constant factor which has been determined for this particular sphere gives the total lumen output direct. Thus at one reading the mean spherical candle-power of the total lumen output of a lamp can be determined.

Foot-candle Measurements

It will be noted that in measuring the *candle-power* of light sources as discussed above, we balance the *illumination* on opposite sides of a screen. Often, however, we are interested in the illumination itself, that is the foot-candle intensity which is being supplied any given area, and care very little about the candle-power of the sources which supply the illumination. If we calculate the different foot-candle intensities to which one side of the screen of a photometer is illuminated when the distance between the screen and the standard lamp is varied, and then place the screen so that the illumination we wish to measure falls upon the opposite side of the screen, the balance of the photometer will give us a measurement of the foot-candle intensity. The differences between photometers used for measuring candle-power and those used for measuring foot-candles are chiefly ones of form and calibration.

An instrument called the foot-candle meter has recently been designed to measure foot-candle intensities quickly and with a fair degree of accuracy. It is very simple in operation, so light that it can be easily carried about, and so small that readings can be taken in very restricted spaces. The instrument is shown in Fig. 10. In operation, it is placed upon or adjacent to the surface on which a measurement of the foot-candle intensity is desired. A lamp within the box illuminates the under side of the screen to a much higher intensity at one end than at the other. The illumination which it is desired to measure is, of course, practically uniform over the entire scale. Closely spaced translucent dots, which serve the same purpose as the grease



Diagrammatic sketch of photometer

spot in the simple bar photometer, line the scale from end to end. If the illumination on the scale from the outside falls within the measuring limits of the meter (0.5—25 foot-candles) the spots will appear brighter at one end of the scale than at the other, and at the point where the spots are neither brighter nor darker than the white paper scale the illuminations from within and from without are equal. The scale is accurately calibrated with the lamp within the box burning at a certain definite voltage. A voltmeter and rheostat permits the operator to adjust the lamp voltage to that at which the instrument was originally calibrated. The energy is supplied from small dry cells.

This instrument is proving very serviceable for "checking up" installations to insure, for example, that the illumination is ample when the lighting equipment is in first-class shape and to see that it is not allowed to fall below a desirable value due to improper care and attention being given to the lighting system. Those who by reason of their experience are enabled to plan an illumination layout without direct reference to spacing tables, formulas, etc., should find this instrument of special

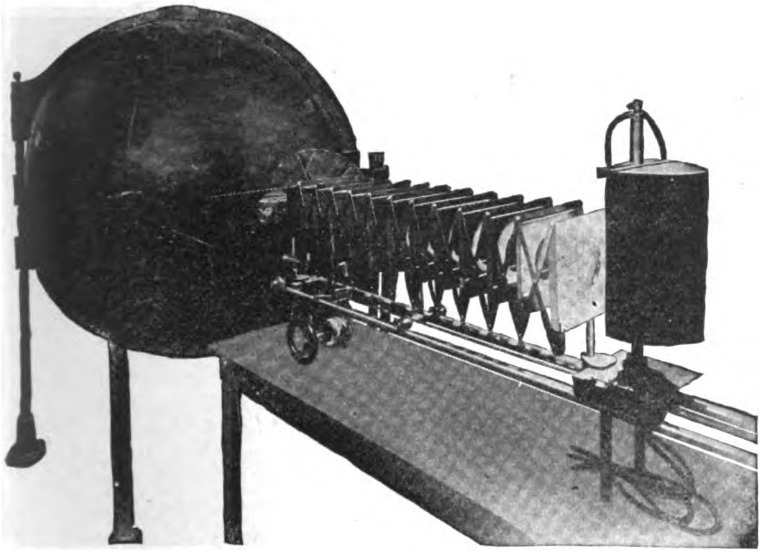


Fig. 9. Sphere photometer

value in securing data which can be applied in the designing and future installations.

The Candle-power Distribution Curve

The candle-power distribution curve of a lamp or unit was at one time widely used in calculating illumination intensities, but the greater simplicity and accuracy of the lumen method of computing illumination has resulted in the former method falling into disuse. Distribution curves are now used principally for comparing the suitability of reflectors for use in a given location from the standpoints, particularly, of light distribution and light absorption.

Figure 11 presents three methods of showing the manner in which the candle-power of a unit measured at different angles can be recorded. The value at any angle represents the average candle-power of the source at that angle as the source rotates about its vertical axis. At the left of the figure the data are given in tabular form; at the center and the right they are plotted to polar co-ordinates. Distribution curves are used simply as a graphical method for presenting the data given in the table on the left. All have exactly the same meaning. A distribution curve is a graphical—not a pictorial—representation of the light distribution from a source, although its general shape might convey the wrong impression. It is simply a convenient engineering method of presenting tabulated data graphically.

The area of a distribution curve is not a criterion of the total amount of light emitted by a source. In Fig. 12, both curves, shown are taken from units giving exactly the same total lumens with different distributions of candle-power; although Curve B appears from the distribution curve to represent much more light than A, the amount of light given off is the same in each case.

Another common error in regard to distribution curves is to assume that simply taking the arithmetical average of the candle-powers at different angles, as shown on the distribution curve, will give the mean spherical candle-power of the unit represented. To make the true relation clear, it us assume a May Pole set up at the middle of a hemispherical hollow and that one girl carries a streamer making an angle of 45 degrees with the vertical and another carries one making an angle of 15 degrees with the vertical. Due to the contour of the ground about the pole, both ribbons will be of the same length. Now, keeping our candle-power distribution curves in mind, let us assume that the tip of the pole is the light source under consideration and that the length of each streamer represents the candle-power in its particular drection. It is obvious that in order to make one revolution about the pole, the girl holding the 45-degree streamer must travel a much greater distance than the other. In other words, she makes a bigger contribution to the general effect produced by the May Pole. In fact, because of the greater circle she must describe, she has to do 2.7 times as

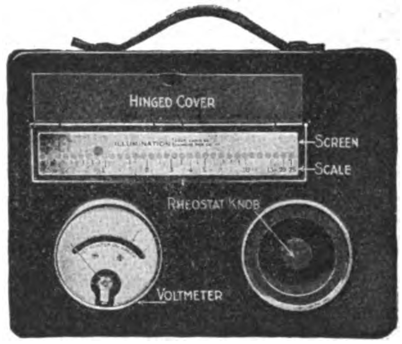


Fig. 10. Foot-candle meter

much work as the girl carrying the 15-degree streamer. In the erroneous use of a distribution curve just referred to, only the length of the ribbon is taken into consideration. From our analogy it is apparent that the zone of travel of the ribbon, or the complete zone in which the candle-power at the given angle is effective, must also be taken into account. Just as in our May Pole the girl taking the 45-degree circle does 2.7 times as much work as the girl in the 15-degree circle, so the quantity of light necessary to maintain an intensity of one candle throughout the 45-degree zone contributes 2.7 times as much to the total light output of the lamp as the quantity of light required to maintain one candle throughout the 15-degree zone. In other words, the farther up from the vertical and toward the horizontal the candle-power shown on the distribution curve, the more weight it must be given as regards its contribution to the total quantity of light emitted by the source.

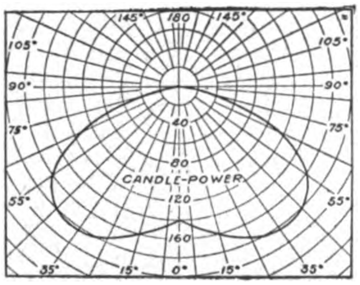
In calculating the flux of light in various zones, we usually find it convenient to calculate for zones of 10 degrees, and it is sufficiently accurate for most purposes to assume that the candle-power value at the center of each 10-degree zone represents the average candle-power of the zone. The following are the factors by which such candle-power values should be multiplied to give the lumens in each 10-degree zone:

Zone	Factor to obtain Lumens from Average C-P.
0°—10°	0.0954
10°—20°	0.283
20°—30°	0.463
30°—40°	0.628
40°—50°	0.774
50°—60°	0.897
60°—70°	0.992
70°—80°	1.058
80°—90°	1.091

Above 90 degrees the factors are the same but in the reverse order.

To use these factors with the curve of any light unit, we take the candle-power at 5 degrees and multiply it by the 0-10 degree factor to obtain lumens in the 0-10 degree zone; we take the candle-power at 15 degrees and multiply it by the 10-20 degree zone factor to obtain the lumens in the 10-20 degree zone, etc. The total lumen for any large zone is the sum of the lumens thus determined in all of the 10-degree sections of the zone.

Angle	Candle-Power	Zone	Lumens
0	142.0		
5	148.0	0-10	14
15	161.0	0-20	60
25	178.0	0-30	142
35	183.0	0-40	257
45	181.0	0-50	397
55	165.0	0-60	545
65	106.0	0-70	652
75	44.1	0-80	699
85	5.1	0-90	704
90			



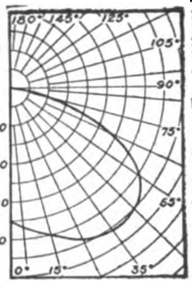


Fig. 11. Three methods of recording candle-power distribution data

Another method of determining the flux in any 10-degree zone is as follows: We first measure the horizontal distance between the vertical axis and the point where the candle-power curve crosses the center of the zone under consideration. We then lay off this distance on the candle-power scale to which the curve is plotted. By adding 10 percent. to this figure, we obtain a value which represents the lumens in that zone. Where it is desired to obtain the summation of the lumens in a number

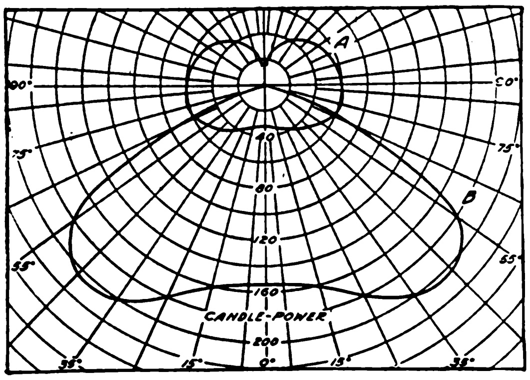


Fig. 12. The area of a distribution curve is not a criterion for judging light output. These two curves represent equal light outputs

of 10-degree zones, for example, from 10 degrees to 60 degrees, it is convenient to mark off these horizontal distances (to the center of each 10-degree zone) successively on the edge of a sheet of paper. The value for the total lumens is then found by simplying laying off the total length thus found on the candle-power scale and adding 10 percent. to the result. The results obtained by this method, neglecting possible errors of measurement, are accurate within 0.2 of one percent.

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SAVING COAL—FOR POWER PLANT OPERATORS

Ten to twenty percent.—that is, from twenty-five to fifty million tons of coal per year—can be saved by the correct operation of steam power plants, using their present equipment, in the industries, in office buildings, hotels, apartment houses, etc.

It is considered most important that all existing fuel-conservation committees, committees of chambers of commerce and national defense, manufacturers' associations, and other bodies be continued in full force, and that the work of such organizations be consolidated with the national program, which comprises certain fundamentals, as follows:

1. Personal inspection of every power plant in the country.
2. Classification and rating of every power plant, based upon the thoroughness with which owner of said plant conforms to recommendations.
3. Responsibility of rating the plants will fall upon an engineer in each district, the rating to be based upon reports of inspectors, who will not express opinions, but will collect definite information. The State Fuel Administrator, in his judgment, may entirely or partially shut off the consumption of coal to any needlessly wasteful plant in his territory.
4. Inspectors are to be furnished from one or more of the following sources: (*a*) Inspectors of the steam-boiler insurance companies; (*b*) State factory inspectors; (*c*) engineering students from technical colleges; (*d*) volunteers.

The ratings will be based upon recorded answers to questions, each of which will be given a value depending upon its relative importance to the other questions. Depending upon the efficiency of methods in use in any plant, it may be rated in class 1, 2, 3, or 4.

Savings Figured on Present Equipment

The ratings will be based upon existing equipment. The difficulty, delay and expense involved in the installation at this time of improved power equipment is fully recognized but experience has proved that 10 to 20 percent. of fuel now used in power plants can be saved by improvements in operation alone.

In advance of the first inspection a questionnaire will be sent to every power plant in each district with notice to the owner that within 60 or 90 days his plant will be inspected personally and the questionnaire will be checked up by the inspector upon his visit. This action will tend to prepare the minds of plant owners for what will follow. It will operate to induce proper care in furnishing information and will also tend to produce a desire to improve their plants, if necessary, so that they may be rated in a high class by the time the inspector calls.

It is recommended that a board of competent engineers be attached to the conservation committee in each State; also a corps of lecturers to arouse public interest and disseminate engineering information.

The Fuel Administration has prepared a 50-minute film of moving pictures showing good and bad operation in the steam-boiler plant, methods of testing boilers, fuels, etc. These pictures will be available for each State in connection with its educational propaganda.

The administration is also preparing a series of official bulletins on engineering phases of steam and fuel economics. Some of these are now ready for printing. They will include:

1. Boiler and furnace testing.
2. Flue gas analysis.
3. Saving steam in heating systems.
4. Boiler-room accounting systems.
5. Saving steam and fuel in industrial plants.
6. Burning fine sizes of anthracite.
7. Boiler water treatment.
8. Oil burning.
9. Stoker operation.

In addition to this service, a list of competent engineers has been prepared in Washington for each State and is available for use of each local administration. As the work develops, still further constructive assistance is comtemplated for helping owners to bring their plants up to a high plane of economic operation.

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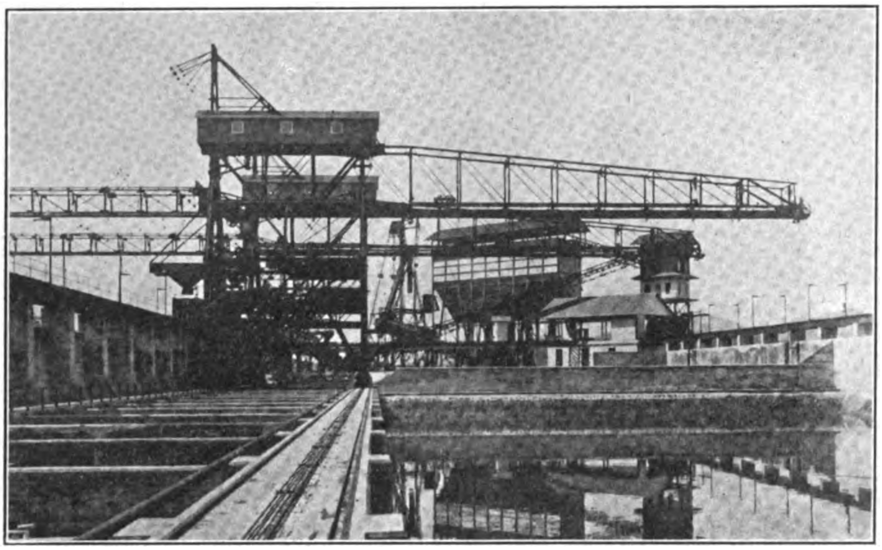
A new use for an electric toaster has been discovered by a hatter who employs it to heat felt pads with which he brushes his hats before handing them to the customer. This not only cleans them, but also gives them a rich, glossy surface which improves their appearance.

THE PROPER STORAGE OF COAL

By J. F. Springer

The recent coal crisis has waked up consumers generally. Many now realize that if their business is to go on uninterruptedly next winter, they and not others must take adequate action in time. That is to say, many consumers are turning their thoughts to storage as the preventive remedy. It is undoubtedly the solution of the problem as that problem exists.

There is abundant coal in the earth—enough for four or five thousand years at the present normal rate of consumption. The output so far in 1918 has, however, fallen distinctly below the necessities of the year. There will possibly be enough transportation available for moving all the coal that will or should be mined; but there will probably not be enough transportation available in the winter to do the job then. For two reasons, then, the consumer will do well to store coal up to his limit, beginning as early as possible. The first reason is the probable shortage in the supply; and the second is the necessity of utilizing the transportation when he can get it. The only wise thing for a central station to do is to buy as early as possible the full amount permissible under the regulations of the Fuel Administration, and to store this coal just as soon as it can on its own property.



Unloading tower, Balboa, Canal Zone, November, 1917

The fact that a crisis is to be expected next winter, primarily because of inadequate working of the mines, will drive many consumers to store in quantities to which they are unaccustomed. This will lead to trouble, provided the proper steps are not taken. The principal thing in respect to which the central station will need to be on the alert is spontaneous combustion. This is a real danger. It occurs so frequently at one big storage yard belonging to an electric light and power company that it has been found necessary to line with steel sheeting the wooden tram cars which carry, as part of their duty, the coal affected with spontaneous combustion the short distance from one part of the yard to another. The United States Government has had trouble with the same thing; and presumably this coal was the high grade steam coal mined in West Virginia and Virginia. Railroads have had trouble. Probably the majority of big users have had repeated difficulties with this peculiar phenomenon. Unlike other fires, it does not occur because someone accidentally drops a live match or kindles a fire; it develops too far down in the pile. Since it was found that the thing is real and that many coal-laden ships have undoubtedly never come into port because of it and also since it has become the fashion to investigate everything, the problem has been very thoroughly studied, particularly in Great Britain and the United States.

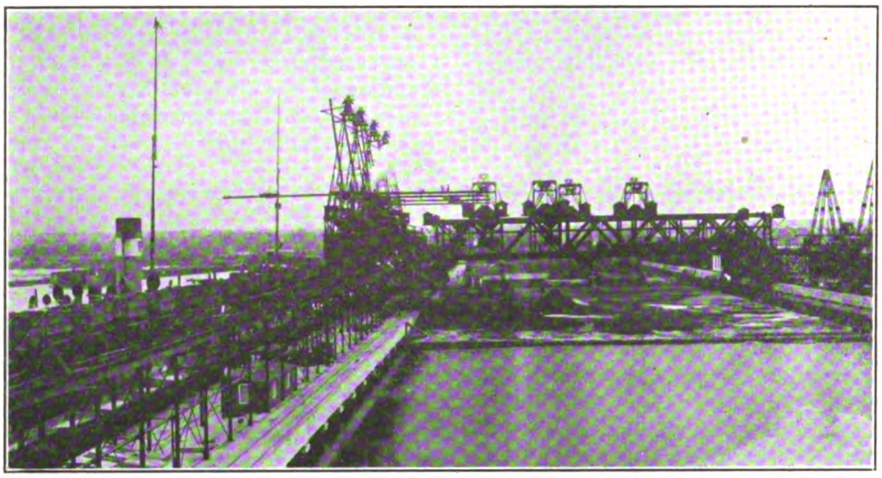
The investigations are not over, but enough has been sufficiently well-determined to enable us to get a general understanding of the manner in which spontaneous ignition gets under way, and consequently to point the way to prevention. It may be said, however, that no certain remedy—with one exception—has come into recognized use. On the other hand, for those who can not use this one remedy, there are precautions, methods and safeguards which reduce the danger both by prevention and, in case of actual occurrence, by a cure for that case.

It is pretty well settled that spontaneous combustion arises because of progressive oxidation. An obvious preventive, once the significance of this statement is realized, is any method which will cut off the oxygen itself. But it has also been found that this is not so easy to do. Some have tried to stop or limit the oxidation, despite the continuance of the oxygen supply. And there has been a measure of success attendant upon one or two such attempts. Perhaps the great storage yard of the Canadian Pacific Railway at Montreal should be cited in this connection.

Oxidation occurs outside and inside the pile. Wherever atmospheric air comes into contact with the coal, there we have—with bituminous coals—the possibility, not to say certainty, of oxidation. Heat results. But heat promotes oxidation, and oxidation generates heat. In consequence, down in a pile, where there is likely to be inadequate cooling, we have a situation favoring the continued rise of the temperature. Some may wonder where the oxygen comes from to keep the oxidation going. Investigation has made it clear that a circulation of air takes place in a coal pile. A European test has shown that a pile of coal, so arranged as to be capable of being alternately exposed to the atmosphere and cut off from it, could be made to heat and cool by admitting and shutting off the air. Investigation has even given us an idea how long it takes for a complete change of air in the voids of a pile to find accomplishment. That air passes into and out of a pile of coal may be taken as a fact. After the alternation of oxidation and heating has gone on for a time, the temperature may get up to 300 or 400 degrees F. After that, it is understood that another stage begins. Oxidation continues and the temperature keeps on going up. Finally, it reaches 800 or 900 degrees and spontaneous ignition takes place. Neither the hand nor attention of man is needed. It may be added that the weather seems to have little or no effect—rain, shine, summer, or winter.

not ignite. There has been, on the other hand, great trouble at Montreal with the low piles stored in the summer.

Perhaps the two greatest factors which promote spontaneous combustion are: (1) high piling, and (2) small size of part of the coal. If slack forms part of the pile, it will be wise to reduce the height severely on this account. Ten or twelve feet should be the limit for coal free from slack. Some may give a higher limit. The fact remains that investigation has not settled the matter; so that in the meantime it will be best to play safe. If slack forms part of the whole of the coal, then 6 feet is to be regarded as the limit. Naturally, we will take risks or avoid risks in accordance with the location of our pile. If it is outside and separated from buildings, we can of course take greater chances than if we pile the coal up under roof and in proximity to inflammable woodwork.



Cristobal coaling station. View looking south from end wharf viaduct. Collier "Ulysses" at dock. February 28, 1918

It is found that depth does affect the matter. Anything from 10 feet up is dangerous. And, I am not to be understood as implying that there are no lesser depths than 10 feet that will give trouble. The kind of coal, its physical condition as to size, and its chemical content, all seem to play a part. Investigation has hardly desentangled these threads as yet; but it has made a beginning. Small coal, other things being the same, is more liable to spontaneous ignition than big coal. This is related to the general principle as to oxidation. The smaller the pieces in a ton, the greater the total surface exposed to the oxidizing operation of the air. Big lump coal free from an intermixture of fine coal is probably pretty safe coal, but even here, it will be well to limit the depth of the pile.

Anthracite coal is a kind of coal not subject to spontaneous combustion. If you use pure anthracite, you are immune from spontaneous combustion troubles. The chemical content of Pochahontas steam coal and Illinois coal are quite different; so also are their liabilities to spontaneous ignition, the inferior coal having the disadvantage.

Spontaneous ignition is understood to be promoted by the presence of external heat, even though the temperature be mild. Thus, a steam pipe passing through a coal pile is to be regarded as a promoter of the first stage of the oxidation which leads ultimately to firing. Similarly, the proximity of a boiler furnace. In short, any external heat which will impart temperature to the coal will probably accelerate the oxidizing activity. The lesson is obvious. Some carry the pracautionary measures so far as to recommend the avoidance of storing coal heated by the summer weather.

The experience of the Canadian Pacific at Montreal would seem to support their advice. The coal comes largely or entirely from Cape Breton Island where it is piled high in the winter while awaiting barge transportation in warm weather. It is stored to a lesser height at Montreal and largely in the summer time. The high piles at the mines, stored cold, do

If the coal should catch fire, we may have but little trouble or we may have a good deal. If we catch the fire when it has just got started, we may perhaps have the thing over within an hour or so by simply digging out the affected coal and getting rid of it or spreading it out at a safe location.

The New York Edison Company operates a big storage yard on the west shore of the Hudson River nearly opposite Grant's Tomb. Here the coal is stored in large piles reaching heights of, say, 30 or 40 feet. They seem to have spontaneous combustion often, but do not get alarmed. The coal is dug out, loaded on a barge and sent to the big central station on the west shore of the East River.

The water cure is to be regarded as no cure for spontaneous combustion. Apparently, the fire, either because of or in advance of the application of water, constructs for itself a protective roof of coke. As the location may be deep down, water applied at the top of a pile will have to be in considerable quantity to offset the tendency to dissipation through the pile and to overcome the coke roof. The practice of using the hose is not regarded as good practice. Digging the affected coal out is so regarded.

A considerable coal pile, whether stored indoors or out, should be watched. This is a rule to be followed pretty closely at the present juncture, because a great deal of coal will be stored warm. Further, there will probably be more coal going promptly from the workings in the mine into storage than is usually the case. We have already considered the storage of warm coal. As to the second point, it may be taken, as pretty well ascertained that freshly mined coal is especially liable to spontaneous combustion.

There is one sure method of preventing the spontaneous ignition of coal. This is storage by submergence in water. Naturally, all circulation of air is cut off. The minute total amount of air particles trapped in the water supplies a negligible amount of oxygen. As for the oxygen chemically combined with hydrogen in the water, it plays either no part at all or an almost inappreciable one. That submerged storage is absolutely safe storage may be accepted and acted upon.

The United States Government has shown its faith in it by extensive arrangements at the Isthmus of Panama. At the Atlantic terminus of the great canal, the Christobal Coaling Plant provides, in addition to dry storage, underwater storage space for some 100,000 tons of coal. At the Pacific terminus, the Balboa Coaling Plant similarly provides for the submergence of 50,000 tons. While the plants are run largely in the interest of commerce passing through the canal, all coal in wet storage is reserved for Navy use. At the Atlantic port, the underwater platform on which the submerged coal is stored is 19 feet below mean tide. A submergence of 18 feet is provided for at Balboa. In England, wet storage is employed. In the United States, there are a number of submerged storage pits. The most notable is probably that on Brunot Island in the Ohio River just below Pittsburgh. Here the Duquesne Light Company has had constructed an enormous pit lined with concrete. Wet storage is thus provided for, the capacity (presumably for submerged storage alone) being 100,000 tons. The Omaha Light & Power Company has a smaller pit, but one which was constructed earlier. Here 10,000 tons of coal may be stored.

Wet storage is something that can not perhaps be provided at short notice, unless the conditions are more than ordinarily favorable. Sometimes there will be an abandoned quarry nearby which has already a watertight bottom or can easily be provided with one. It is not necessary to provide submergence for the entire pile. The upper part may rise above the water level for only a few feet. Probably, it will be found in practice that the water level in the coal is a foot or two higher than the general water level. This adds to the total capacity. At all the plants mentioned, it is probable that a considerable part of the pile may safely be out of the water. In fact, it is possible that the capacities of the two central station pits mentioned may include such dry storage. The water for the submergence may come from a stream close by.

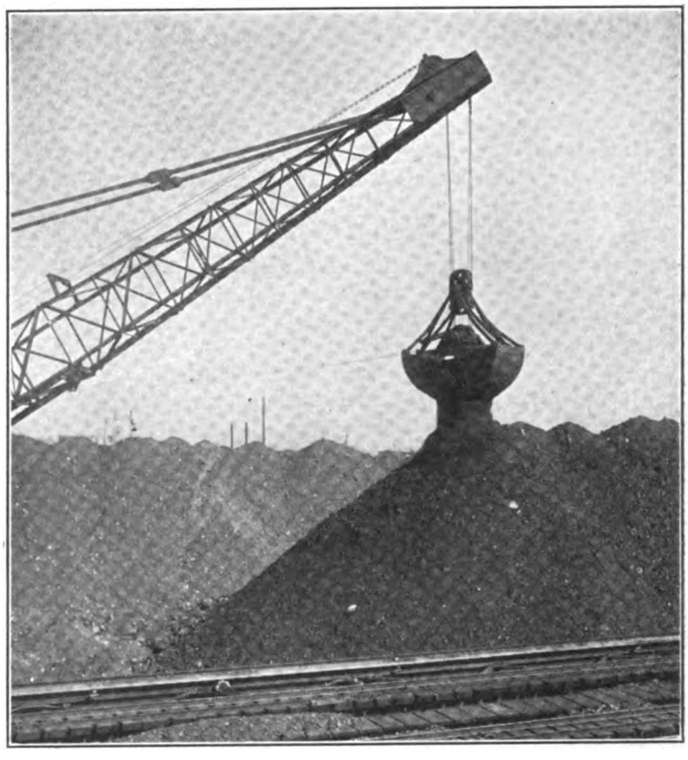
We must assume, however, that submerged storage will be a practical impossibility for the generality of central stations so far as the present is concerned. Outdoor and indoor storage will be their reliance. Fortunately, such storage is usually good storage—except for the one thing, spontaneous combustion. That is, the deterioration of good coal stored in a pile is insignificant or quite moderate. Outdoor storage is as good, or nearly as good, as storage under roof. I am speaking now of the preservation of the steam-generating capacity of coal, and am not concerned over any possible losses of gas-making and coke-making qualities. The steam user needs to be occupied with the question whether storage out of water is going to reduce the British thermal units originally contained in his coal. We will consider this matter in a moment.

Just now a word as to how the consumer may watch his pile that is stored dry. The problem reduces itself practically to keeping track of the temperature changes going on down in the body of the pile. A steel rod thrust down into the mass and left there for a time will naturally assume the same temperatures as the surrounding strata of coal. By pulling it out and running one's hand along its length, it is possible to get a good idea of the thermal conditions in the pile. The thing to do is to have a lot of such rods, each provided with a handle or crook at its upper end, and to have them placed in positions all over the area of the pile of coal. An examination once or twice a day should inform a trusty and intelligent man whether all is well or not. If the temperature begins to rise, a close watch should be kept and effective and prompt measures taken to meet the situation if it gets dangerous.

We come now to the question of the effects of storage upon the calorific value of coal. The United States Government has investigated this matter very thoroughly. We are now in possession of the results, the final report having become available in 1917. Supplementing these investigations are those of others, particularly of the University of Illinois.

The broad fact may at once be stated that submerged storage, whether in salt or fresh water, has little effect upon the thermal content of coal. In fact, the water seem to act as a kind of preservative. Some coals, however, absorb water in such a manner that drainage does not reduce the residue to a negligible amount. Illinois and Wyoming coals are said to retain 5 to 15 percent. of water after draining.

As to the storage in air, both indoors and outdoors, the matter can hardly be put so concisely. A few examples will, however, show pretty well how things stand. New River (W. Va.) coal is among the best steam coals in the world.



New York Edison Co's open air storage at Shadyside, N. J. Locomotive crane placing coal on storage pile.

Tests were made at Norfolk, Va., covering a total period of 5 years. Run-of-mine size had a loss when stored indoors for the full period amounting to only 0.8 percent. of the thermal value. The same kind of coal crushed to ¼-inch size and stored under roof had a calorific loss of only 1.2 percent. Outdoor storage made an inconsiderable difference. Run-of-mine stored 5 years had a loss of 1.1 percent.; ¼-inch size, 1.3 per cent. The climate seems to affect the matter somewhat. Thus, tests were carried out at Key West, Fla., upon the same kind of coal. Indoor storage of run-of-mine, for 1 year (not 5), showed a loss of 0.4 percent.; of ¼-inch size, for 1 year, 1.2 percent. Outdoor storage for the same period gave as good or better results.

We may conclude, then, that high grade steam coal will suffer but little loss if piled up in the air, and that the presence or absence of a roof seems to affect the results only to a small degree. This is confirmed by the investigaton made by the University of Michigan in connection with coal from the Pittsburgh bed. The heat losses for periods running up so 5 years never exceeded a total of 1.1 percent.

As to inferior coals. Take, for example, Illinois coal. Outdoor air storage has been reported on by Prof. S. W. Parr, of the University of Illinois and A. Bement, of Chicago. Both found a calorific loss of 1 to 3 percent. in a year by weathering.

Take another inferior coal—the sub-bituminous variety mined at Sheridan, Wyoming. The report covers a total period of 2¾ years for air storage, under cover and not under cover. For the period, the uncovered coal had a loss of 3.19 percent. But the thing varies. For a 9-month period of similar storage, there was disclosed a loss of 4.07 percent. The maximum loss occurred in a deep bin, closed, where the coal had lain for the entire 2¾-year period. It was 5.26 percent.

On the whole, it would seem that central stations may very well go ahead and store inside or outside, big or little coal of high or low grade, and still be assurred that the calorific losses will be only moderate and may be well-nigh negligible.

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N. E. L. A. CONVENTION, ATLANTIC CITY, JUNE 13-14, 1918

The conditions and characteristics of the 1918 convention of the National Electric Light Association were set forth to the membership by President Lieb in his announcement of April 22, as follows:

The thirty-fourth annual meeting of the National Electric Light Association and its forty-first convention to be held at the Hotel Traymore, Atlantic City, June 13 and 14, 1918, will be devoted entirely to problems of the war.

This will be a strictly business meeting, without entertainment of any kind. It will concern itself entirely with the vital problems of the industry arising out of the war, toward the winning of which the thoughts and energies of every public utility must be consecrated.

No papers will be read. Reports from committees and individuals, and discussions, will be confined to matters of major importance, and the brief two days will allow no time for the usual helpful discussions on general topics relating to the progress of the art. Everything said and done must be keyed to a victorious conclusion, and an early one, of the great struggle on which our nation has entered and in which our industry is taking a part of continually growing importance.

There will obviously be a reduced attendance far below the numbers in pre-war years. Naturally, member companies, large and small, will endeavor to be represented by at least one of their officers or executives; and others in attendance would preferably be selected from among those dealing directly with the member company's activities affecting war work or civilian co-operation with the National Government.

Our industry, increasingly a permeating factor in the national life, is now subjected to abnormal strains on its personnel and resources. It is the desire at such a vital juncture to devote the time and energies of the association and of those at the convention to only one enterprise which now counts—Winning the War.

No women are expected in attendance, and there will be no provision for entertainment.

Probable Agenda of Business

Thursday Morning, June 13—Presidential address; reports of secretary, treasurer, membership committee; reports commercial, technical, accounting, electric vehicle sections; new business.

Thursday Afternoon—Report of national committee on gas and electric service; report of committee on public utility conditions—war financing of utilities, rate increase activities, etc.; report of public policy committee; discussion of central station aspects of the labor problem; female employment; meter reading and testing; economized accounting.

Thursday Evening—Patriotic addresses on the broader national topics of immediate importance to the industry, by distinguished speakers.

Friday Morning, June 14—Address and general discussion on the coal situation; important war time topics introduced by the technical and hydro-electric section.

Friday afternoon—Important war time topics introduced by the commercial, accounting, and electric vehicle sections.

Friday Evening—Round table discussions; and films of war activities of special interest to member companies, and other appropriate features.

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KEEPING TRACK OF OUR SHIPS IN BUILDING

They have a graphic way of following progress on the big 9,000-ton fabricated steel ships being built by the Merchant Shipbuilding Corporation at Bristol Pa., says the *Scientific American*. These ships are to be all alike. More than 80 percent. of their plates will be sent from the steel mills ready to erect. Even the remaining plates are chiefly bow and stern parts which are to be bent at the yard shop for convenience in shipping the raw stock flat.

In the production office, therefore, are charts showing every plate on one of these fabricated ships. As soon as a keel is laid, that ship gets a chart and day by day, as plates are erected and riveted, they are marked on the chart and worked out in terms of tonnage erected on each hull weekly, and also the total percentage of each hull erected.

These figures are for office use, of course, but with so clear a method of recording progress, and with perhaps 300 riveting gangs working on 12 hulls, it would be a simple matter to translate the daily progress into some simple factor interesting to men in the yards. One way that has been suggested is to place a thermometer sign on each hull and show by means of the rising how much of that hull is completed and how it compares with all other hulls.

This yard had eight keels on the ways April 12, and was making good progress. Its first two keels were laid February 16, and the second pair three days later. The next four keels were laid by the old-fashioned method of hauling the plates in place by rollers and skids, for the reason that cranes on those ways were not ready.

The Merchant yard will have to drive something like 225,000 rivets weekly when it strikes its full gait. Last summer there was nothing on the site but a cast iron pipe and foundry plant, which was bought, and some of its buildings utilized in the present shipbuilding plant. The shipyard occupies 265 acres of flat land on the outskirts of Bristol, and has 3,600 feet of river front. The ways will accommodate ships up to a length of nearly 500 feet, and the company's contracts call for 40 fabricated ships of a deadweight tonnage of 9,000 each.

At Bristol, one of the first housing projects of the Emergency Fleet Corporation is being completed. The yard will need at least 4,000 men employees above those who live in Br'stol or commute to Philadelphia, and therefore a complete residence town had to be provided. This town looks like a prosperous city suburb, and is situated convenient to the shipyard. It is well planned, in city blocks, with groups of bachelor clubhouses, boarding houses at the end of each block, apartment houses for small families, group houses for somewhat larger families, and finally, detached residences for single families. All these buildings are standardized as to interior, but great attention has been paid to variety in outer architectural treatment, so that the ship workers' residence town has none of the dull uniformity which often characterizes such housing projects.

AUTOMATIC HYDRO-ELECTRIC PLANT

The automatic hydroelectric generating station of the Iowa Railway and Light Company at Cedar Rapids, Iowa, is a radical step in advance in the elimination of operator's wages in a station of appreciable size, without sacrificing complete control. The brief description which follows is taken from a paper which is to be read at this month's convention of the American Institute of Electrical Engineers.

This station consists of three 400-kw., 500-kva., 60 rev. per min., 2300-volt, vertical generating units, tied in to a system, of which the main generating station contains about 20,000 kva. in steam turbo-generators. One striking feature is the entire omission of the usual governors, the waterwheel gates being motor driven and controlled by contact-making ammeters. Each unit has its individual control panel, consisting of a necessary contactors and relays to connect it to the bus at the proper time. A motor-driven drum controller gives the proper time element between the different steps in the operation of placing the generator on the line. Any generator can be started either by a float switch when the pond level reaches the proper height or by a remote control button in the steam station. The starting of the first generator throws on the line the motor of one of the two exciter sets, and the generator cannot be connected to the bus until the excitation voltage has reached the normal value.

Fig. 1—Exterior of station—front view.

The waterwheel gates are then partly opened and the generator comes up to approximately normal speed. It is then connected to the bus without field through an iron-core reactance. Then a weak field is applied. Next it is raised to full normal value and then the reactance is short-circuited. The contact-making ammeter opens the gates to full gate opening and the generator then carries full load in about 40 seconds after either the control button is closed or the float switch is closed.

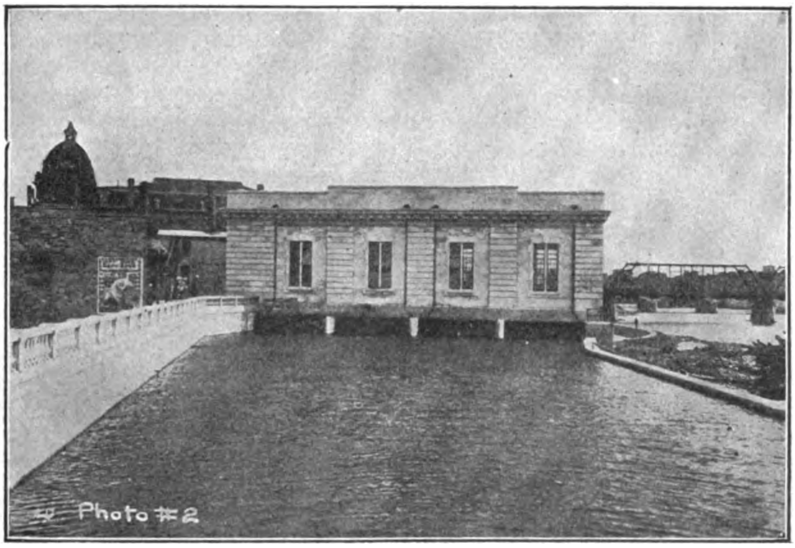

Fig. 2—Exterior of station—rear view.

The plant has now been in operation from October 2 until the present, and so far, no troubles, other than the small ones which always go with any new development, have been experienced, and these have all been of a very minor nature. The changes that have been made, consist essentially of substituting heavier and more reliable relays in one or two points on the control system, and the expectations and hopes of those who have worked on this development have been more than realized. The plant has successfully withstood short circuits exciter failures in the steam plant, low water and high water, and all of the tests that those in charge of the work could conceive of, wrong operations being brought about artificially. It has also been operated by the regular operating force at the steam plant, and there has been no occasion to keep men, nor have they been kept in the hydroelectric plant to watch its operation.

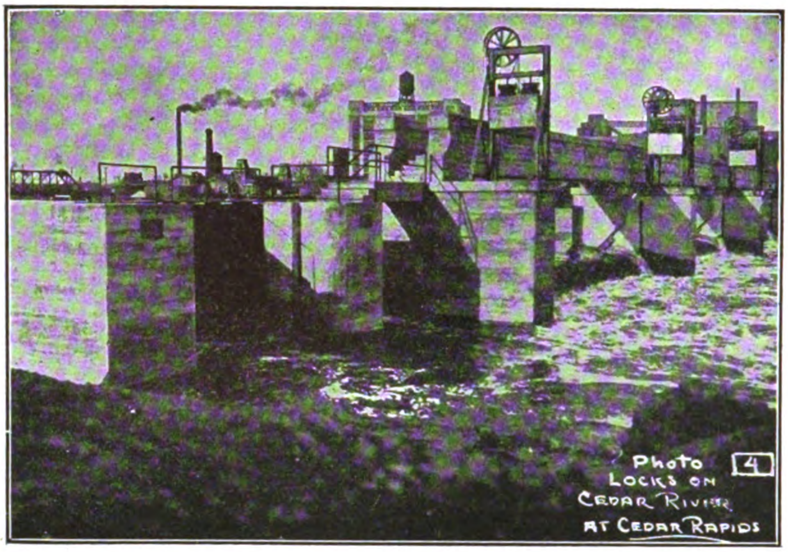

Fig. 3—Locks on Cedar River at Cedar Rapids.

The automatic development, if it means anything at all, means that it will now be possible to develop a large number of small low head plants and tie them in on a high-tension system, leaving their operation entirely to the float switch and voltage relays. If there is voltage on all three phases of the high-tension line and water for the turbines, they will start up and go on the line without wrecking themselves or disturbing the operation of the rest of the system. In these days of scarcity of coal and scarcity of labor, together with its high price, the utilization of our water power is of national importance, for, every pound of coal that can be saved by the water of our rivers is just that much more that can be used by our country for the successful prosecution of the War.

With the elimination of the excessive labor cost of operation of a small plant, many water power sites are capable of development as a paying investment.

As this paper goes to press, the station has been in operation about seven months. Some notes as to experience with it might be of interest. During this time, the total flow of the river has been used at all times, and a toll of approximately 3,000,000 kw-hr. has been fed into the system. There have, of course, been a few failures to start, as no automatic apparatus can be absolutely infallible. The source of such failures has been easily found and corrected. In this connection the equipment is designed to shut down in case of abnormal conditions, so that all the machines will be protected against injury. It is also of interest to note that owing to the pressure of other work and the shortage of help, this generating station ran continually for ten weeks, with no attention to automatic equipment of any kind. Of course, a more frequent inspection and cleaning of the contacts should be made in order to keep the equipment in the best of condition. There have been several cases of exciter trouble, at the main steam station, which resulted in a complete shut down. As soon as bus voltage was restored, the automatic equipment put the hydroelectric plant back on the line without attention of any kind, and with no damage or injury to any of the machines. The expense for operators is a large per-

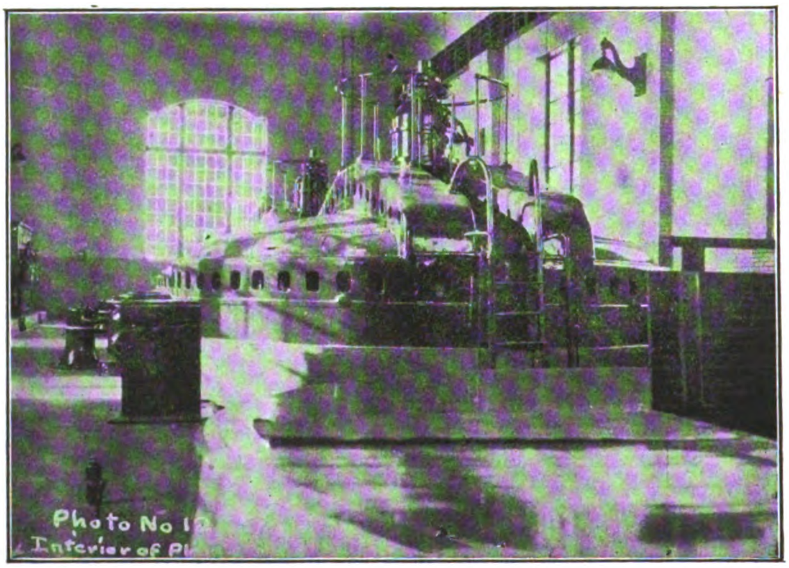

Fig. 4—Interior of station.

cent. of the total cost of the operation of small hydroelectric plants. Many plants have considerable trouble in keeping their operating forces, particularly in these days of shortage of labor. With the present high price of coal and the shortage of labor, many small water powers might be developed with a profit as auxiliary plants on a fairly large steam generating system.

A. I. E. E. ELECTS OFFICERS

At the annual meeting of the American Institute of Electrical Engineers, held in New York on Friday, May 17, 1918, the following officers were elected for the administrative year beginning August 1, 1918:

President, Professor Comfort A. Adams, Harvard University, and Massachusetts Institute of Technology, Cambridge, Mass.

Vice Presidents, Allen H. Babcock, San Francisco, Cal.; William B. Jackson, Chicago, Ill.; Raymond S. Kelsch, Montreal, Quebec; F. B. Jewett, New York, N. Y.; Harold Pender, Philadelphia, Pa.; John B. Taylor, Schenectady, N. Y.

Managers, G. Faccioli, Pittsfield, Mass., Frank D. Newbury, Pittsburgh, Pa., Walter I. Slichter, New York, N. Y.

Treasurer, George A. Hamilton, Elizabeth, N. J.

These officers, together with the following hold-over members, will constitute the Board of Directors for the year beginning August 1, 1918: E. W. Rice, Jr., Schenectady, N. Y.; H. W. Buck, New York, N. Y.; C. E. Skinner, East Pittsburgh, Pa.; John B. Fisken, Spokane, Wash.; N. A. Carle, Newark, N. J.; Charles S. Ruffner, St. Louis, Mo.; Charles Robbins, East Pittsburgh, Pa.; E. H. Martindale, Cleveland, Ohio; Walter A. Hall, West Lynn, Mass.; William A. Del Mar, New York, N. Y.; Wilfred Sykes, East Pittsburgh, Pa.

ELECTED TO HONORARY MEMBERSHIP IN THE A. I. E. E.

Announcement is made that Oliver Heaviside, Fellow of the Royal Society, London, England, has been elected to Honorary Membership in the American Institute of Electrical Engineers. In making this election the Board of Diretcors adopted the following resolutions:

WHEREAS, Oliver Heaviside has rendered service of the highest value in the advancement of electrical science leading to practical results of far-reaching order, and notably in the development of electromagnetic theory; and

WHEREAS, The Constitution of the American Institute of Electrical Engineers provides that, by unanimous vote of all the members of the Board of Directors, Honorary Members may be chosen from among those who have rendered acknowledged eminent services to electrical engineering or to its allied sciences; it is

RESOLVED, that Oliver Heaviside, Fellow, Royal Society, London, England, be elected, in recognition of his contributions to electrical science and engineering, to Honorary Membership in the American Institute of Electrical Engineers.

DON'T PESTER WASHINGTON

Owing to the enormous increase of governmental war work, the governmental departments at Washington are being flooded with letters of inquiry on every conceivable subject concerning the war, and it has been found a physical impossibility for the clerks, though they number an army in themselves now, to give many of these letters proper attention and reply. There is published daily at Washington, under authority of and by direction of the President, a government newspaper—The Official U. S. Bulletin. This newspaper prints every day all the more important rulings, decisions, regulations, proclamations, orders, etc., etc., as they are promulgated by the several departments, and the many special committees and agencies now in operation at the National Capital. This official journal is posted daily in every post-office in the United States, more than 56,000 in number, and may also be found on file at all libraries, boards of trade, and chambers of commerce, the offices of mayors, governors, and all federal officials. By consulting these files most questions will be found readily answerd; there will be little necessity for letter writing; the unnecessary congestion of the mails will be appreciably relieved; the railroads will be called upon to move fewer correspondence sacks, and the mass of business that is piling up in the governmental departments will be eased considerably. Hundreds of clerks, now answering correspondence, will be enabled to give their time to essentially important work, and a fundamentally patriotic service will have been performed by the public.

"COAL WEEK," FROM JUNE 3 TO 8

"Coal week," the period from June 3 to 8, has been selected by United States Fuel Administrator Garfield for an intensive and specific drive on the early ordering of coal. The fuel organizations of the various States, the county chairman of fuel committees throughout the Nation, coal dealers, chambers of commerce, mine operators, and others are all called upon to do their utmost to make this week's drive a big success.

From some States has come the objection that the trouble about the coal supply does not come from the consumers, industrial or domestic, but from the dealers, who complain that they can not get sufficient coal to deliver. In spite of this, the Fuel Administration is very anxious that the early ordering campaign be vigorously pushed.

By accumulating a large volume of orders in the hands of the dealers it is expected that there will be demonstrated to every agency concerned in the distribution of coal the universality and urgency of the demand and this, in turn, will give rise to a steady and increasing pressure for rapid and equitable distribution. This is particularly true as to the railroads and other transportation agencies. Every unfilled order for coal will at once become an active and pressing argument for increased distribution efficiency. By keeping coal orders constantly accumulating, the resulting pressure, it is believed, will have the effect of keeping production at the highest possible point during the summer months.

It is also felt that with the bulk of the year's supply of coal ordered well in advance, the various distribution agencies of the Government will be in a position equitably and properly to adjust the demands as between different communities. It will be possible accurately to gauge the increased demand and properly to divide the available supply.

SLOW MOTOR SPEEDS

Speeds below 600 are known as slow speeds for electric motors. It is in this range that many low head centrifugal pumps operate. Induction motors are by no means adapted for these speeds. In fact the efficiencies are generally low and the power factor also, so that the tendency in the past has been to use some method of belt or gear reduction. The synchronous motor, on the other hand, by the very nature of its characteristics is perfectly adapted for direct connection on slow speed work. The efficiencies at these speeds are remarkably high and the efficiency curve is quite flat, falling off only a small amount for part loads.

FLAG DAY JUNE 14

As a part of a great national movement promoted by Secretary Lane of the Department of the Interior to build a cohesive national American spirit, the Americanization Committee has askea the cooperation of the editors of the business press of the nation, to have a flag raising in every factory and industrial and commercial establishment in this country on Flag Day, June 14.

EDISON MEDAL AWARDED TO COL. J. J. CARTY

John J. Carty, colonel in the United States Army Signal Corps, and chief engineer of the American Telephone and Telegraph Company, has been awarded the Edison Medal in recognition of his services in developing the science and art of telephone engineering.

The medal was presented on Friday evening, May 17, at the annual meeting of the American Institute of Electrical Engineers in the Engineering Societies Building in West 39th Street, New York. Colonel Carty is the eighth American scientist to be honored in this way, the others being Elihu Thomson, Frank J. Sprague, George Westinghouse, William Stanley, Charles F. Brush, Alexander Graham Bell, and Nikola Tesla.

A statement of the history and significance of the medal was made by Dr. A. E. Kennelly, Professor of Electrical Engineering at Harvard University and Massachusetts Institute of Technology, who was Chairman of the Institute's 1917 Edison Medal Committee. Dr. Michael I. Pupin of Columbia University told of the work of Colonel Carty, the foremost telephone engineer in the world. The medal was delivered by the president of the Institute, E. W. Rice, Jr., also a scientist of note, who is president of the General Electric Company.

The Edison gold medal was founded in 1904 by the Edison Medal Association, an organization composed of old associates and friends of Thomas A. Edison. It is awarded annually by a committee of 24 members of the American Institute of Electrical Engineers, and was first awarded in 1909, the recipient being Elihu Thomson. It was designed by James Earle Frazer, and bears on its obverse a portrait of Thomas A. Edison, and on its reverse an allegorical conception of "the genius of Electricity crowned by Fame."

In delivering the medal, President Rice said:

"More than any other man, Colonel Carty is responsible for the development of telephone engineering as it is known today, and it is peculiarly fitting that he should receive this new honor at a time when he is working day and night to promote the best military use of mediums of communication which have been developed largely through his efforts in time of peace for the advancement of the nation's social, commercial, and industrial activities.

Colonel Carty is well known as the engineer of the great transcontinental telephone line, the longest in the world, and as the engineer who made possible wireless telephoning over distances up to 5,000 miles.

He entered the telephone business when it was in its infancy, and it would be difficult to find a phase of its development which does not bear some imprint of his genius. The technical achievements of Colonel Carty are so numerous as to prevent full recounting. He first pointed out the correct theory of induction between telephone circuits, showing how to obtain a balanced metalic circuit and devising methods for correctly transposing phantom telephone circuits. That was in 1887. In 1888 he developed the bridging bell and pointed out the importance of the bridging principle of telephone construction in obtaining efficient operation of telephone systems and in constructing balanced metallic circuits. In 1889 he invented the principle of the best and most generally used common battery system, by which a number of telephone instruments may be simultaneously operated from a single central battery. During this period he also devised important improvements pertaining to switchboard circuits having to do with the busy test featue and the connecting in of operators' instruments.

In 1912 the telephone engineering force built up and directed by Colonel Carty had so far overcome the difficulties in the way of underground telephony as to make possible all-underground talking between New York and Washington, and by 1913 they had extended the range of underground telephony to connect Washington and Boston.

1914 witnessed the fruition of the efforts of these engineers to bring transcontinental telephony into existence, and in 1915 Colonel Carty was able to present to the world important developments in wireless telephony, which made possible the sending of words through space across the American continent from Washington to Mare Island, California, from Washington to Hawaii, 4900 miles distant, and from Washington to Paris, bringing Europe and America into speaking distance of each other for the first time.

Then came the threat of war with Germany and in 1916 Colonel Carty cooperated with the Signal Corps of the Army and with the various departments of the Navy in making arrangements which would insure the readiness of the Bell Telephone System for military service in case this country did become involved in the great conflict. 1917 saw these plans put into active use with a marvelous degree of success.

Colonel Carty's technical telephone achievements alone would entitle him to his preeminent position in his field, but he also occupies an equally high place in the regard of scientists because of the character of his work in directing, developing and coordinating telephone engineering. Men who have been associated with him say that his success is due not only to his scientific genius, but also to his understanding of the requirements of the service he has done so much to improve.

After E. W. Rice, Jr., President of the Institute presented the medal, Colonel Carty, in his speech of acceptance, gave credit for the American telephone achievements to the engineers, who have been associated with him in the Bell System and paid a tribute to Major George O. Squier, chief signal officer of the United States Army for his work in planning before the United States entered the war for the rapid mobilization of telephone wires and telephone men for Signal Corps work. Referring to the Bell System engineers, Colonel Carty said:

"We hear a great deal about the German scientist and the wonderful things he has done and has been planning. Many years ago, when German 'Kultur' was interpreted by many to mean German culture it was suggested to me that we should send to Germany to get some of the Herr doctors to teach us the high science. I always opposed that, believing that the Yankee mind, the Yankee boy, when his attention was turned to scientific problems, would surely outdistance a German. I concluded that our work could be trusted to these young Yankee minds and that they should be trained in our work and that through them we would undertake to outdistance anything that has been done in Germany. That policy has worked out successfully. The young men who have collaborated with me all these years are graduates of over one hundred universities, all here in America.

When at the opening of the war there was a searching of hearts and a census and a taking account of stock to find out who was loyal and who was to be suspected, I know you will all be pleased to hear that among all of these scientists and all of these engineers all working in the Bell System all over the United States, we were not able to find one single Hun; they were all true Americans to the core."

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Of the several high explosives now in use, the War Department has pronounced tri-nitro-toluol (T.N.T.) as best. It is the easiest high explosive to make, and the safest to transport. For its manufacture toluol is required. At the present time we are producing annually approximately 11,000,000 gallons of tuluol from the by-product retort coke ovens which have increased so rapidly in number since the war began. This quantity, however, is under contract for the supply of the navy and our Allies. At least a year is required for the construction of a large battery of by-product ovens. For the new army the only quickly available source of tolul is the gas plants. A statement to that effect was made quite recently by General Wm. H. Crozier, the former chief of the Bureau of Ordnance of the War Department. Gas plants can be equipped within three to four months, some more quickly, to remove the toluol from gas.

EDITORIAL

THE RED CROSS AND THE VACUUM CLEANER

A happy thought found novel expression during the Red Cross drive in New York last month when funds were collected through the medium of an electric vacuum cleaner. Folk who are likely to tighten up when appealed to for money in the ordinary way, loosened up freely when the latest method of filling a vacuum made its appearance at the library building uptown. The novelty of it caught their fancy, while the machine itself caught their money in much the same way that the sagacious elephant gathers peanuts from the unsophisticated small boy. Nature, 'tis said, abhors a vacuum, and is ever on the alert to put it out of being—if perchance a thing can be said to be when it is nothing. None the less to be abhorred is he who won't give up his mite when that mite is perhaps all that bridges the little gap between life and death to some sorely wounded lad in far away France. The one who won't give up is thoughtless more often than he is selfish, so means must be adopted to divert his mind from its narrow channels and coax the coin from his pocket. The enterprising body who found the electric way of filling the Red Cross bag is quite worthy of a distinguished service order or something of that kind, for if getting Red Cross money out of a congenial tightwad by means of suction induced by a rapidly revolving electric motor is not distinguished service, what is it? The results of the experiment measured up with the novelty of the conception, for several times during the afternoon that the cleaner was working the dust bag was filled to capacity. Electro-deposition of silver, nickle, and copper someone with a turn for epigram called it.

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CARTY AND THE EDISON MEDAL

Last month the Edison Medal was awarded to John J. Carty, chief engineer of the American Telephone & Telegraph Co. and now a coloned in the Signal Corps of the United States Army. Never was the recipient of this medal more worthy of it, for of all the eight men who have been awarded it thus far he more clearly personifies the type of man for whom it was designed. It was designed for engineers, and to engineers only should it be awarded, though on some occasions in the past others in whom engineering abilities were subordinated to commercial characteristics seem to have been honored with it. Carty's contributions to engineering have, as is well known, been confined chiefly to the telephone field. In this field he has labored long and patiently and industriously. As a result of his ability, patience, and industry, the telephone system in America to-day is without exception the most efficient public utility we have. If anyone has any doubts about Carty's fitness for this signal honor, let him stop and compare the telephone system of 1918 with that of 1880, and then compare it with our other utilities, such as steam railroads, street railways, and water supply. And at all times he has had to deal with a far more intricate, elusive, and complex set of problems than are found in all the other utilities combined.

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ENGINEERS IN THE WAR

Like many business concerns whose employees have enlisted or been caught in the draft, the engineering profession has been "shot to pieces" by the war. Anyone who wants to find that out for himself needs but go to an engineering society meeting, or to take luncheon or dinner at an engineers' club. Where young engineers were wont to hold forth at these places, nowadays one finds only graybeards. men past fifty. The younger men are in the service somewhere, either in a civilian or a military capacity—in France, in Washington, or at the camps. A section meeting of the Institute held in Washington last month resembled an annual midsummer convention of ten or fifteen years ago, well known engineers from all parts of the country helping to fill the hall. Many of them were in uniform, their straps indicating ranking ranging from colonel to second lieutenant. Some of them looked comfortable and well set up in khaki with upstanding collar and heavy leather puttees; others sort of looked as if they preferred a warm weather uniform of a middy blouse and Highland kilts, their work for Uncle Sam being of more moment than their adornment or their military rank. In the group were several past-presidents of the Institute, and a number of men who had at one time or another served as directors or chairman of important committees. What is true of the Institute is of course equally true of the mechanical, civil, and mining engineers—to refer only to the four large national engineering societies—for they, too, are out to help win the war and thus keep our country and our homes safe from invasion by the despoiler. Setting aside all thought of personal comfort, the en-

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?

gineers—who are indispensable in this war of chemists and engineers—have sacrificed far more than any other profession in the effort to teach the Hun his place. Almost to a man they have abandoned lucrative practices and cut loose from tender home ties in the hope that their efforts will turn the tide. Their presence is felt strongly in all branches of the service—their knowledge, their training, their experience, and their ways of solving problems being utilized more and more as the war goes on and the climax approaches. There are now between five and six thousand engineer officers in service.

THE ENGINEERING TRADES

The Government needs all the money, material, and labor it can get, and more. This is a war of equipment, designed by engineers, made by engineers, operated by engineers. The destructive side of chemistry is also utilized to the limit. No matter how brave our men are, they cannot face the greatest military organization the world has ever known with bare hands. There is not enough labor and material in the country for our usual comforts and luxuries and for our fighters' necessities. These necessities, due to the nature and extent of the conflict, demand that the engineering trades get down to a primitive basis of living until the war is won. Begin today.

KEEP UP THE COAL SUPPLY

To electrical men the status of the coal supply and output is most important, for without coal—and such a contingency is not unlikely—all electrical apparatus is, for the time being, inert and worth only its weight as old metal. A generator that is not normally living up to its name is a slacker in the power house; and a slacker there means other involuntary slackers all along the line. Back of the generator in all plants that are not hydroelectric in nature—aside from the comparatively few that are driven by oil combustion—is the coal supply. The normal usefulness of a generator and all its dependants hangs solely on the coal supply, this supply being the determining factor in the problem as to the operation or the non-operation of the plant. On the operation of the plant depends, in turn—our modern system is so extremely complex and interdependent—the operation of all industrial plants equipped for electric light or heat or power, any or all of them. Then we come to the railroads that carry the coal, most of the mines being located many miles away from the power plant, and back of that the coal miner. On the coal miner rests, then, the burden and the responsibility of sustaining this vast complex economic system, of producing the coal for the railroads to carry. Judging from past experience, the coal miner is both selfish and wayward. He likes holidays and he takes them, while the rest of us like them but go without, both as a matter of self-discipline and in the effort to do our bit in peace as well as in war. Then when unpleasant things come to pass the mine operator, the miner, and the railroad "pass the buck" while the generators slow down, the voltage drops, the lamps go out, the motors stop rotating, and the dear public, as usual, is made to pay the price in inconvenience and loss of trade and friends. The administration has a firm grip on most things these days, and in view of the coal miner's close relation to the rest of us and to the actual winning of the war it were well perhaps if, for the period of the war every miner were conscripted as a government employe and controlled and regulated as such.

UNITED STATES AS AN EMPLOYER

Uncle Sam in his capacity as the world's greatest employer is discovering that his workers will not "live by bread alone" and that high wages are not of themselves a sufficient inducement to hold men to their work. He is discovering that men are social animals and that employes must have certain social and community facilities if they are to remain contented on the daily job.

In a certain district are located two great munition projects. One of them, lacking almost everything in the way of recreational and welfare facilities, has had a labor turn-over of many hundred percent. The other with identically the same work and the same rates of pay has had no such turn-over. The reason evidently is that the latter is located on the edge of a city whose social facilities while meager have yet been sufficient to bring into the lives of the men that social contact with their fellows which they crave.

At nearly all Government projects there are now under way provisions of the wherewithal of recreation and social welfare. Community huts are being erected where men may meet and play their games, where they may smoke and spin yarns and build that invisible, intangible something known as esprit-de-corps. Moving pictures ar being provided and are attracting increasingly great audiences and it is an interesting sidelight that the most popular pictures are those of current events and not those of the slapstick variety.

Reading rooms with books and magazines are being furnished for those studiously inclined. Baseball diamonds and tennis courts and up-to-date equipment are being built and baseball leagues organized.

Lectures and concerts are to be provided from time to time and bands are being organized and equipped.

Y. M. C. A. men are in charge in some of the large projects and ordnance welfare executives are being provided at others. Health conditions are being improved and at one project the U. S. Public Health Service is undertaking a clean-up resembling that so efficiently inaugurated at Panama.

In short, Uncle Sam is following the example of other great employers of labor and undertaking to keep his men sound in mind and body and watching with a jealous eye their comfort, convenience and happiness.

Another interesting phase of work which is being undertaken by the Ordnance Department through the Community Organization Branch of its Industrial Service Section is to work hand in hand with groups of citizens in those cities containing factories producing munitions, to eliminate those community conditions which may be adversely affecting the welfare of labor.

AMERICAN ENGINEERING STANDARDS COMMITTEE

A movement is on foot to form an organization to be known as the American Engineering Standards Committee, the object of this committee being to unify and simplify the methods of arriving at engineering standards, to secure co-operation between the different societies, and to prevent duplication of work. The main committee will consist of three representatives from the following societies: American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, and American Society for Testing Materials.

VIA THE SHEARS AND PASTE-POT ROUTE

Items of Interest Gleaned From Various Sources

An electric iron was offered free with each housewiring contract in a campaign conducted by a New England company. At the completion of the work a salesman was sent to the newly-wired home with the iron, and some other appliances. The free iron gave the representative an excellent opportunity to demonstrate other devices and the men made many sales in this way.

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From San Antonio, Texas, comes the information that tailors at Camp Travis are using electric irons for smoothing out the wrinkles of soldiers' uniforms. Heretofore, it has been necessary to use the old-fashioned solid iron gooses familiar in the tailor shop of fifteen years ago. Are you near a cantonment? Look up the "company" tailors. Urge merchants and tailors in the nearby towns to go after this business. Here's a good field for large industrial irons.

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Every time the cord on an electric iron fails it means one less appliance for the day load of the local central station. In order to help retain irons in service a Pennsylvania central station now keeps a number of flatiron cords on hand. When a customer brings in a cord needing repairs, he is given a new one in its place. The damaged cord is then promptly repaired and put back in the exchange cord stock. The plan not only makes for better service to the customer but it also conserves revenue for the company.

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Charity contributions are the bane of most business men. When a good customer comes in with a subscription list it takes a hard-shell or a diplomat to sidestep the issue without giving offense or signing for more than he can afford.

The following scheme of an electrical dealer in Cleveland is worth copying: During a vigorous campaign of solicitation on behalf of a babies' hospital, this dealer erected a large sign over his door, "This week you can donate One Dollar to the Babies' Fund by purchasing an electric iron at regular price."

During the first week he made a record sale of flatirons at list price, and for each sale he turned over a dollar to the charity.

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In the electrical goods section of a department store in an eastern city, the local central station has posted a conspicuous announcement of its willingness to send a representative to demonstrate in the purchaser's home, any of the devices sold over the counter in that store. It often happens that the salesperson is not thoroughly familiar with the device, and such an offer on the part of the electric company inspires confidence in the minds of the purchasers as to the usability of the device and so gets and keeps many appliances on the company's lines.

In case of trouble with any appliance, the electric light company will also, on request, take up with the manufacturers the matter of adjustment and repair of the faulty appliance.

A central station recently disposed of more than 200 irons through the aid of boys and girls in its locality. The company advertised that for every iron sold at the special price, it would give one copy of some popular juvenile book, to be chosen by the youthful salesperson. Either cash or C.O.D. orders were accepted. In the case of C.O.D. orders the signed orders to deliver irons were exchanged for the premium books, the deliveries of appliances being made by the company's men. On the cash sales the children made their own deliveries. Besides the direct revenue to the company through its increased load, the sale interested a large number of people in electric service and made many friends for the company among the parents of the book-earners.

Another idea would be to pay commissions to the children by means of Thrift Stamps.

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Sir Adam Beck, Chairman of the Hydro-Electric Power Commission of Ontario is the father of cheap power in America. In a few short years he has built the greatest high and low tension systems owned by the people in the whole world and has given them the cheapest power. Five years ago, Sir Adam started to develop water powers until today he is constructing a power plant to develop a quarter of a million horse-power with a head over 300 feet high near Niagara Falls, as outlined above. His work has been a success from every point of view—engineering, financial and service. His watchword is efficiency, and he would welcome anything that would increase the efficiency and maintain the present beauty of the Falls.

But it would mean comparatively little change in the plans to make this inital development 500,000 horsepower instead of 250,000 horse-power; and this would be the quickest way to secure the additional power so urgently required for the operation of war industries within transmitting distance of Niagara.

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"HELLO!"

With a clamp on her head like a cage for her hair,
She sits all the day on a stiff little chair
And answers the calls that come over the wire
From people of patience and people of ire;
And "Number?" she queries of noble or chrul—
A wonderful voice has the telephone girl.
She has to be pleasant, and hustling and keen,
With a temper unruffled and ever serene.
There are forty-five things she must think of at once
Or some rough subscriber will call her a dunce;
Since it seems a general custom to hurl
The blame for your grouch on the telephone girl.
It's wearisome work on the nerves and the brain.
Continual hurry, continual strain,
And Central gets tired—as other folks do—
And needs to be thoughtfully treated by you;
So think of her doing her best 'mid the whirl,
And try to be white to the telephone girl.

—From Telephony

to disconnect all coils from one another so as to have 36 separate coils. These coils are to be regrouped, and the number of coils per group is found by the use of the following formula:

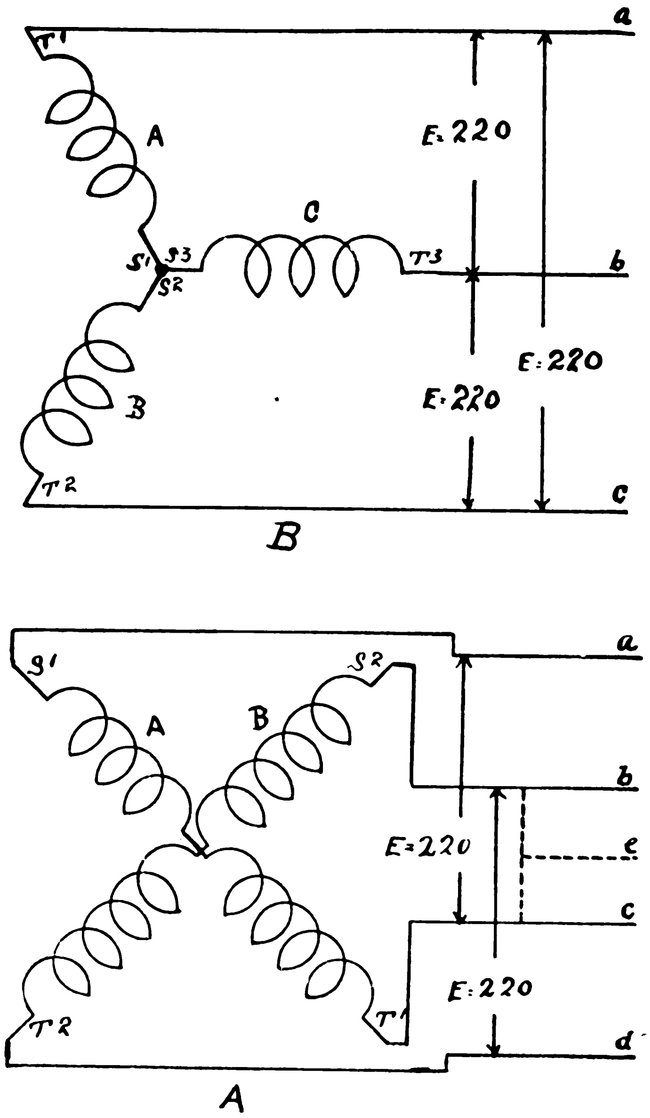
$$\frac{\text{Coils} \times 2}{\text{Poles} \times \text{Phases} \times 2} = \frac{36 \times 2}{6 \times 3 \times 2} = \frac{72}{36} = 2$$

The regrouping and connecting for a three-phase winding is shown in Fig. 32, in which there are 2 coils in series per group, and 18 groups, as compared with 3 coils in series per group and 12 groups in Fig. 32, the original two-phase connection. The following table shows the manner in which the winding of Fig. 32 is made up.

No. of coils forming a group.	No. of group.
1 and 2 in series form	1.
3 and 4 in series form	2.
5 and 6 in series form	3.
7 and 8 in series form	4.
9 and 10 in series form	5.
11 and 12 in series form	6.
13 and 14 in series form	7.
15 and 16 in series form	8.
17 and 18 in series form	9.
19 and 20 in series form	10.
21 and 22 in series form	11.
23 and 24 in series form	12.
25 and 26 in series form	13.
27 and 28 in series form	14.
29 and 30 in series form	15.
31 and 32 in series form	16.
33 and 34 in series form	17.
35 and 36 in series form	18.

Groups 1, 4, 7, 10, 13 and 16 form phase 1.
Groups 3, 6, 9, 12, 15 and 18 form phase 2.
Groups 5, 8, 11, 14, 17 and 2 form phase 3.

A two-phase circuit is either a three or a four-wire circuit while a three-phase circuit is a three-wire circuit. In Fig. 33 these two symbols are shown. When terminals b and c are joined as per dotted line in illustration A, it becomes a three-wire two-phase circuit. Between terminals a and c-e phase



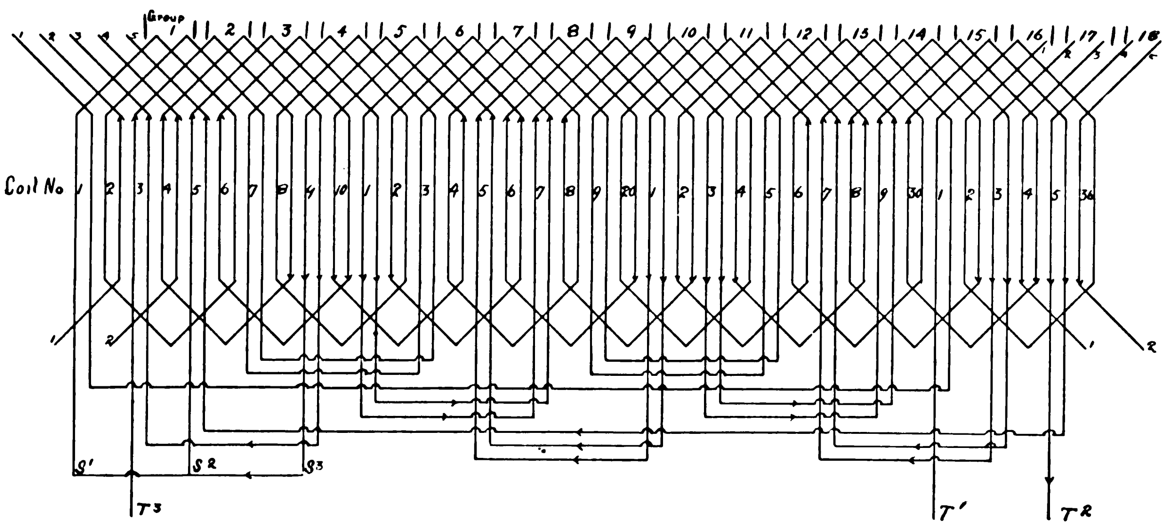


Fig. 32

A is connected in series with the external line, and between terminals b-e and d, phase B will be connected. The voltage impressed at the terminals a and c, also at b and d, are shown to be 220 volts.

In illustration B is a three-phase star connected circuit, and between any two of the three terminals a, b, and c there are two phases in series. This shows that there are more coils between terminals a and b in illustration B, than between terminals a and c-e in illustration A; still the impressed voltage across all terminals remains the same. This shows that a two-phase machine reconnected for a three-phase circuit as in Figs. 31 and 32 will not run with the same efficiency, as will be explained later.

By comparing the current as traced through the windings of Figs. 31 and 32 it will be seen that there are 33 percent. more conductors in a circuit in the three-phase than there are in the two-phase windings, and to have the motor operate under the same conditions it would mean an increase of voltage.

Another method of changing a two-phase to a three-phase winding is shown in Fig. 34. Fig. 31 is again taken as the original connection. When all the connections have been opened and the winding is reduced to 36 separate coils, a certain number of coils are dropped; that is, they will not be reconnected but will be dead-ended, for the following reason. In most two-phase windings there are about 20 to 25 percent. more turns than in a three-phase winding, and as the line voltage will remain the same the number of turns should be reduced by the above amounts. Then to find the number of coils to be used in the reconnection, allowing 20 percent. to be dropped, we figure as follows: $36 \times 0.80 = 28.8$ coils to be used.

The number of coils to be dropped must be made the nearest number which will be a multiple of the number of poles. As seen from the above figures, 7.2 coils are to be dropped and the nearest number to be a multiple of the number of poles will be 6, or 1 coil per pole, and the remaining 30 coils will be used for the reconnection, to be equally divided and grouped into three phases. $\frac{30}{3} = 10$ coils per phase to be connected into 6 groups per phase. The following table shows how this is done so as to have the proper number of conductors per pole.

Coils No.	form group No.
1 and 2	1.
3 and 4	2.
5	3.
7	4.
8 and 9	5.
10 and 11	6.
13 and 14	7.
15	8.
16 and 17	9.
19 and 20	10.
21 and 22	11.
23	12.
25	13.
26 and 27	14.
28 and 29	15.
31 and 32	16.
33	17.
34 and 35	18.

Groups 1, 4, 7, 10, 13 and 16 form phase 1.
Groups 3, 6, 9, 12, 15 and 18 form phase 2.
Groups 5, 8, 11, 14, 17 and 2 form phase 3.

Coils number 6, 12, 18, 24, 30, and 36 are the 6 coils which are dropped and are marked with a D in Fig. 34.

The remainder of the connections are made the same as they are in Fig. 32. By comparing the number of conductors or coils in series between terminals S^1 and T^1 in Fig. 31, and between T^3 and T^2 in Fig. 34, it will be found that they are exactly alike.

In comparing these two methods of reconnecting a two-phase winding to a three-phase winding, as in Fig. 31 and 32, when reconnected to a three-phase winding, we find there has been an increase in the number of coils between terminals, (not per phase) by 33 percent.; this will cause the motor to run on about 66 percent. of its normal voltage, consequently there will be a reduction in the horse power. When changing the winding, as from Fig. 31 to 34, where 1-6 of the total number of coils have been left out so as to have the same number of coils between terminals (not per phase) in both cases, it will be seen that the amount of copper has been reduced by one-sixth also, which will also cause a loss of efficiency.

From these comparisons it will be seen that when reconnecting from a two-phase to a three-phase winding there is bound to be a loss one way or another, and it is most advisable to rewind a motor when a change in phase is required. To change from three-phase to two-phase the same difficulty will be met, and the same directions as given above will apply.

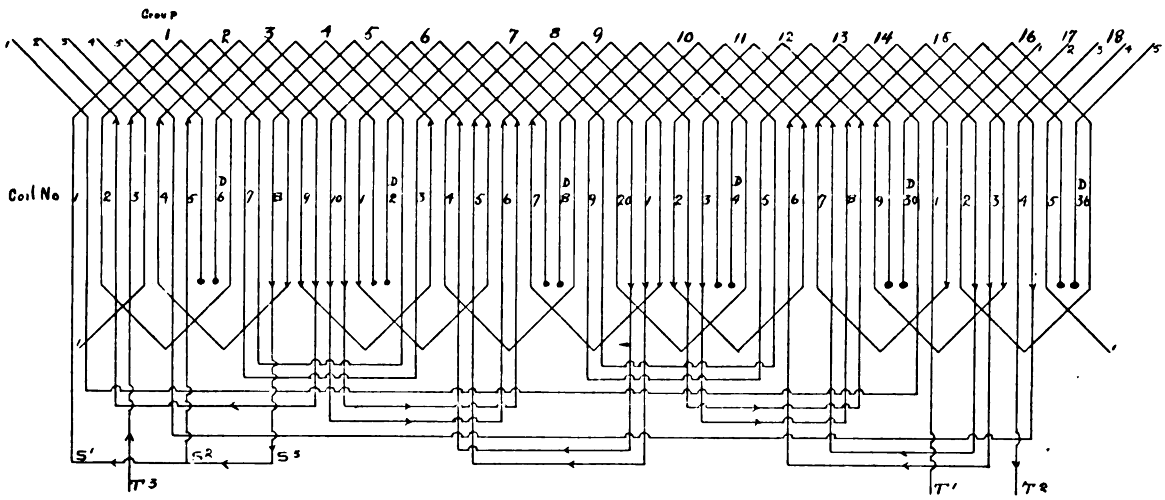


Fig. 34

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NAVY NEEDS AT ONCE 1,000 GAS ENGINE MEN

The Naval Reserve Force must enroll at once 1,000 men experienced in the operation and maintenance of gasoline engines.

This is an urgent call. The men are required for immediate duty. They will be rated as Machinist's Mates.

Age limits are eighteen to thirty-five inclusive. Applicants must be American citizens. Draft registrants with letters from their local boards will be accepted.

Apply at Naval Reserve Enrolling Office, 51 Chambers St., New York, or any Navy Recruiting Station.

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The outdoor sub-station, together with weather-proof switching, fusing and protective equipment, now occupies a definite place in high tension distribution.

GEORGIA WANTS INCREASED RATES

The Georgia Railway and Power Company and the Atlanta Gas Light Company a short time ago made application to the Georgia Railroad Commission for permission to advance their rates on electric light and power, gas, and street car transportation.

This step followed similar moves by public service corporations in many parts of the country, which had found it impossible to carry on adequate service under enormously increased costs unless some method of increasing their income in proportion to expenditures was found.

The companies have set forth, in their statement to the railroad commission, and in advertisements published in the Atlanta newspapers, several of the reasons why such advances in rates are necessary if the companies are to continue to give the public that service which is necessary to modern social and business life.

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THREE-WIRE DISTRIBUTION

To secure the advantages of an economical power voltage and yet have a lower voltage available for lamps, the three-wire system is recommended by the Crocker-Wheeler Co. The use of the third or middle wire adds two circuits, each of one-half the full voltage. Motors are connected to the two outside conductors supplying say 230 volts, while lamps receive half this voltage, being connected to the middle and one or the other of the outside wires. The 115-volt lamps or other apparatus are so connected that both sides of the system or of any branch will have about equal load. The middle wire carries only the current due to the difference between the loads on the two sides.

The chief advantage of such a system is the saving in copper for distribution. This saving may amount to as much as 60%. It is also a fact that large generators and motors for 125 volts are more expensive than for the same output at 250 volts. In short, the three-wire system permits the operation of motors on 230 volts and lamps on 115 volts with maximum economy.

When one side of the system carries more load than the other, the voltage can be maintained the same on both sides by a small rotary-balancer consisting of two machines mechanically connected together and with armatures electrically connected in service. These act automatically to supply the necessary current in the middle wire, which is connected between the two armatures. Such balancing transformers are made in all sizes to take care of any amount of unbalance required.

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COAL CONSERVATION

Samuel Insull, in a letter to B. C. Forbes, editor of *Forbes Magazine*, regarding the plans for coal conservation by consolidating electrical production in Great Britain, says that what they are proposing to do under the report made to the British Reconstruction Ministry is what those of us who have been following good central station practice have been doing in this country for the last twenty years.

Practically all the electric energy used in the industrial and mining territory of Illinois has been produced for years under the same general plan now proposed to be adopted in England, and this is true of a great portion of the electric energy distributed throughout the United States.

There are sixty-one different undertakings, some privately owned and some municipally owned, all for the purpose of electricity supply within the county of London alone. The high cost of energy and the economic waste of this policy has been one of the crying shames of my line of business in England for years past. It is the direct result of bad legislation inaugurated by the late Mr. Joseph Chamberlain.

It has been somewhat amusing, he adds, to read communications from the Fuel Department at Washington, advising their local representatives to get people engaged in the production of electric energy to follow the course now being pursued in England. A very large portion of American electrical development of recent years has been along these very same lines, and what they are proposing to do in England is based on American experience and American successes in the same direction.

The trouble is that political theorists in this country have been so busy criticizing public utility managers as public enemies, that they have failed to recognize the economic advantages these same 'public enemies' have long since inaugurated in connection with the production of energy until our friends across the sea start to copy us.

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MUNICIPAL OWNERSHIP A MISNOMER

James B. Wootan, in a convincing article condemning municipal ownership, in the Public Utilities Review supplement of the New York Evening Post, says that Municipal ownership is a misnomer. The real owners of the city plant are the bondholders, who get their pay in interest whether the plant is economically run or not. The public has a much wider possible scope of practical interest in what goes by the name of a privately-owned utility. Its ownership is as widely diffused as the sale of its stock. Under the rather new plan of 'customer ownership' much of this stock is held in the community by the very people the plant serves. That is public ownership in the best sense. It intensifies the basic principle of mutual interest between the company and the people on the broad ground of copartnership.

Now add to this the public's power of regulation, he continues, and you have all the practical advantages possible, the conditions that guarantee service, and that is the object of the enterprise.

It comes down to this: in private ownership the public, through the purchase of stock and its authority over rates and conditions of operation, controls the utility; under municipal ownership the politicians control it. The politicians generally succeed in making the people believe they enjoy advantages under municipal ownership which they could not obtain under private ownership. This is a transparent barrage to any one who will take the trouble to penetrate it, for with very rare exceptions the municipal plant is not held to the public regulation, which controls the privately-owned plant. The theory of exemption corresponds with that on which public property escapes taxation. Municipal ownership's exemption cannot be justified, though, from the standpoint of superior operation or service.

"It is a fact, says Halford Erickson, former chairman of the Wisconsin Railroad Commission, 'that municipally owned plants need regulation fully as much as and even more than the privately-owned plants. Relatively more complaints are received by us affecting municipally owned plants than privately owned plants.'

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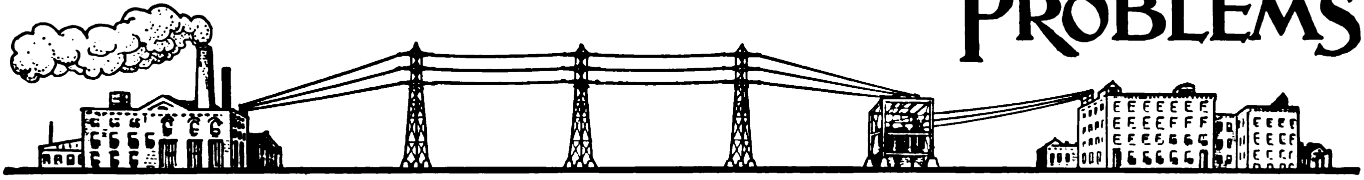
Babson, the economist, tells us that trade is not hurt by economy. This talk of saving is just a question of spending, an option of whether you spend for temporary or permanent account. The public calls it saving when a dollar is put into the bank, but the money is almost immediately loaned out and spent for machinery, improved roads, or other permanent goods. The less there is spent for transitory merchandist, such as food and clothing, the more will be spent for factories and farm implements. This keeps up the total volume of trade, regardless of thrift or extravagance.

POWER PLANT, LINE AND DISTRIBUTION PROBLEMS



A Record of Successful Practice and Actual Experiences of Practical Men

CHANGING THE PHASES OF AN INDUCTION MOTOR WINDING

By T. Scnutter

In the article in our May issue, in which the stator windings of induction motors were reconnected so as to be operated at a higher or a lower voltage than that for which they were originally connected, it was shown to be a comparatively simple matter to adapt the motor to change of pressure. It is merely a matter of regrouping the windings per phase so as either to increase or decrease the number of turns in service per phase; and this is accomplished by connecting the various groups per phase in series, parallel, or series-parallel, according to the increase or decrease of the voltage.

As was explained in the March issue of ELECTRICAL ENGINEERING, single-phase induction motors are not self-starting unless some special devices are used, such as a starting winding or a special type of commutator. For these reasons it is not probable that a single phase motor would be reconnected for a polyphase winding, where the line voltage will remain the same.

The changing of the phase of an induction motor winding is more or less injurious to the machine. As a rule it impairs the efficiency, power factor, torque, etc.; and the combination of all these losses makes it more advisable to purchase or make a new set of coils for the proper winding, as it will be a saving in the end.

In reconnecting a two-phase to a three-phase winding, or vice versa, the following method can be employed: the winding for a two-phase, 6 pole induction motor stator with 36 coils as shown in Fig. 31, is to be reconnected for a three-phase, 6-pole winding.

First, consider the conditions of the two-phase winding. The coils are laid so that they spread from slot 1 to 6, (the beginning of each coil lies in the slot of corresponding number) and being a two-phase winding there will be one-half of the total (36) number of coils per phase $\frac{36}{2} = 18$ coils. These 18 coils are divided into 6 groups; then $\frac{18}{6} = 3$ coils per group. The following table covers the present conditions and connections of Fig. 31.

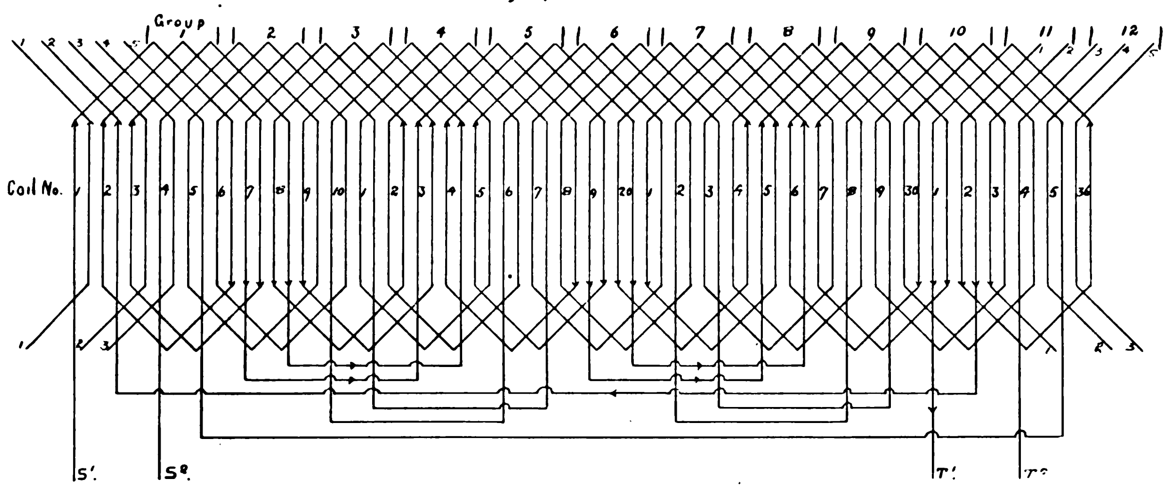


Fig. 31

No. of coils forming group.	No. of group
1, 2 and 3 in series form	1.
4, 5 and 6 in series form	2.
7, 8 and 9 in series form	3.
10, 11 and 12 in series form	4.
13, 14 and 15 in series form	5.
16, 17 and 18 in series form	6.
19, 20 and 21 in series form	7.
22, 23 and 24 in series form	8.
25, 26 and 27 in series form	9.
28, 29 and 30 in series form	10.
31, 32 and 33 in series form	11.
34, 35 and 36 in series form	12.

Groups 1, 3, 5, 7, 9 and 11 form phase 1.

Groups 2, 4, 6, 8, 10 and 12 form phase 2.

By a careful study and comparison of the above tables and Fig. 31 the reader should obtain a clear understanding of the existing conditions of the two-phase, 6-pole winding.

To change this to a three-phase winding, the first step is

A FEW WORDS ABOUT MAGNETISM

The word magnet in its present form and accepted meaning is applied to all substances and combinations of material that are available for establishing a field of magnetic force. History tells us that a stony substance found in the vicinity of a town in Asia Minor called Magnesia, would attract iron, and if suspended by a string, the same part of the surface of this stone always turned toward the north, and that if a piece of iron was rubbed with this stone the iron would act in the same way. This led to the use of this particular kind of stone by the sailors for indicating the north point when all other visible means of guidance was lacking.

This kind of stone became known as a load stone and the stone from magnesia was probably known by a modification of the town name, this name being applied to all things that exhibited the same phenomena.

You see from the above that the name magnet has been handed down to us from the dim past; use has broadened the meaning of the term to include a wide field of forms and materials.

In order that you may develop a mental picture of the field of force called magnetism, we will consider a few examples of fields of force with which we are more familiar, and while the following statements may not always be exactly true, still they will serve the present need.

Man has no sense which can be made to respond to the magnetic field of force, our eyes serve us in the field of light, our ears serve us in the field of sound and our whole physical being responds to the effect of heat. As light and heat develop a field of force that is the nearest parallel to the magnetic field, we make use of them here.

The word lamp is applied to all kinds of contrivances which are used to establish a field of force that is so direct in its appeal to the normal man, that few of us ever stop to consider the field of force that surrounds us when we are within the effective zone of light established by a lighted lamp.

The word heater, this can be and is, applied to a wide range of objects that are used to establish a field of force that appeals almost directly to the human mind.

Man is so constituted that the force called light is readily recognized through the medium of the eye and its optical system, which transforms this force (light) into another force that acts on the brain.

If man was so constituted that he had no eyes and no optic system, he would probably feel that light was a very mysterious and awe-inspiring force, and in order to realize in even a small way, what light really accomplished, he would have to have some medium with which he was familiar and upon which light had some well defined effect.

A person born totally blind could move in or out of a field of light and never know the difference, he would have no sense through which light could act upon his mind, he, therefore, does not know of its presence.

If you were so constituted that changes in temperature had no effect upon you, it would be possible to view at close range the brilliant effect of fire and not realize the heat force that is given off, nor feel the variation of temperature as you approach or recede from the flame.

Having no sense organs that respond to magnetic force, we must, therefore, gain our knowledge of this force, through its effect upon things with which we are familiar.

Light moves in straight lines directly away from its source and from every portion of its luminous surface, the effective field of light force surrounding a given luminous body, can be assumed to extend to those distances from which the normal eye just ceases to respond to the rays or lines of light that are given off and is modified by the degree of light that surrounds the observer, in some cases the light from a candle will have a field that extends a mile or more. For instance, on a very dark, but clear night you can detect the rays from a candle a very long way off, if the night was one of the clear bright ones, you would not be able to detect the lines of light at any where near the same distance from it, and in the day light you would not be able to detect the lines of light except at very short distances.

Heat moves in straight lines away from a heated body, and the extent of this field of force can be gauged by the limits to which the heat rays can be detected. This limit will be modified by the size of the heated body; also, by the amount of difference of temperature between the surface of the heated body and that of the surrounding atmosphere. Placing your hand close to the heated body it would be in a comparatively dense field of heat force. Moving the hand away from the heated body it would pass to a less dense portion of the field.

All of the above statements with regard to heat and light are made for the purpose of fixing in your mind a mental picture of a field of force, so that you may more readily follow the line of reasoning that is applied to that field of force known as "magnetism."—From *Here we are published by The Georgia Railway & Power Co.*

✤ ✤ ✤

ORDNANCE WANTS SKILLED TECHNICAL MEN

An urgent call for high grade technical men and operatives to fill war positions in industrial establishments has been made through the Civil Service, by the United States Army Ordnance.

Salaries ranging from $1600 to $6000 a year will be paid the men who qualify for the places.

Chemists and chemical engineers, men experienced in the manufacture of gas, mechanical engineers on high pressure apparatus, engineers to take charge of power houses, and foremen of machine shops are needed. Persons of military age accepting appointment will not avoid the obligations of the Selective Service Law.

The Army Ordnance, in issuing its call for these men, is insisting on one point: this is, applications will be accepted from Government employes or employes of firms or corporations engaged in contracts for the Government or its allies, unless written assent to such application is given by the head of the establishment that might be seriously handicapped in its war work by the loss of the man.

Superintendents for plants engaged in chemical manufacturing processes, especially these connected with nitrogen fixation and the manufacturing of acids and explosives, will be pa'd salaries ranging from $2400 to $6000 a year. Assistant superintendents of nitrate and chemical plants will be paid $1600 to $2400 a year.

Applications for superintendencies must have a standard high school education or its equivalent, and at least five years operating experience involving chemical processes in a manufacturing plant, or they must be college or university graduates with at least three years of such experience. They must have been in responsible charge for at least two years of operations involving important chemical proceses and must have earned a salary of at least $2000 a year.

Assistant superintendents of nitrate and chemical plants, must have had at least three years' operating experience if they are high school graduates, or one year's experience if college or university graduates. In either case they must have earned at least $1200 a year. These superintendents and assistant supintendents will be assigned to duty at the Ordnance Department in Washington or elsewhere.

Salaries ranging from $1600 to $2400 will be paid junior mechanical engineers on high pressure apparatus who wish to do their bit toward winning the war by working for the Ordnance Department. Experience in the operation and control of high pressure hydraulic and gas machinery is necessary. At least one year such experience will be required of graduates in mechanical engineering courses from recognized colleges. Four years' experience is required of high school graduates.

Power house engineers will be paid $1800 to $2400 a year while working for the Ordnance Department. Supervision of operation of water-tube boilers condensers, pumps, steam turbines, and alternating and direct current generators and motors are among the duties of these men. Machine shop foremen with salaries from $1800 to $2400 also are wanted by Army Ordnance. Ten years' experience as machinists—three years in a responsible supervisory capacity—is required.

Assistant operatives in the manufacture of water gas and producer gas; mechanics experienced on high power apparatus; and operatives of acid and chemical apparatus are wanted by the Army Ordnance. Many positions are open. The needs of the service, the Ordnance Department announces, are so imperative, that applications will be received indefinitely. Further information regarding the Army Ordnance positions that must be filled is obtainable of the Civilian Personnel Section, U. S. Army Ordnance, 1330 F Street, Washington, D. C.

UTILITIES INSURE AGAINST BOMBARDMENT

The big gas and electric lighting companies of New York city have arranged for insurance in excess of $50,000,000 covering bombardment from the air or the sea and other forms of war risk. According to the *Aerial Age Weekly*, $40,000,000 worth of the total insurance has been taken by the Consolidated Gas Company, whose plant comprises one of the most valuable properties in the city. From $7,000,000 to $10,000,000 has been taken by the New York Edison Company. Three million is said to have been taken by the United Electric Light and Power Company, although the correctness of this sum has not been confirmed. In their decision to insure against loss from enemy attack, the big lighting companies have followed the example of a number of other large concerns who, since the outbreak of the war have insured themselves against invasion to an extent estimated by Howard P. Moore, assistant secretary of a large insurance company, at close to $200,000,000.

PIONEER LIGHTING PLANT

Carlow, a small Irish city, situated about 38 miles from Dublin, and in the centre of the richest agricultural section of the Green Isle, claims the distinction of being the first town of its size in the world to be lighted by electricity says the *Edison Monthly*. The system was installed in 1884 and was in operation in 1887, the year of Queen Victoria's Golden Jubilee. American education and training were, however, responsible for Carlow's leadership, as William J. Handley, the engineer who did the work, was the American son of Irish parents. He made his studies in electricity in Cornell University and served a short apprenticeship at the Edison shops in Menlo Park, N. J. As a reward for his initiative, Her Majesty bestowed upon him a special decoration, and the South Kensington (London) Society presented him with a gold medal.

The original electric lighting system in Carlow consisted of iron posts about eight feet high, on each of which was placed a single incandescent lamp behind which was set a reflector about 12 in. in diameter. The posts were set 200 ft. apart and were extended over two and one-half miles of street.

The old laborious method of cleaning the hulls of warships is being replaced by electricity. Formerly, it was customary to allow 170 to 200 man-days for the work but several electrically driven machines have been found to do the work far more expeditiously. By the use of electrical scrapers and brushes, the task has been more economical and an 18,000-ton battleship can be completely cleaned in twelve hours.

A COMPROMISE CRAFT

They agreed then to flip
For a tank or a ship—
Heads had it: the ship won the day.
So they cabled the land
And cradled the sand
When the tide was at flood in the bay.

One wanted a sail,
Another a whale—
Most of 'em wanted a yacht,
Or an oil tanker built
With a submarine tilt,
A battleship, dingy, what not.

At last 'twas decided
To have all kinds provided
And build them a compromise boat;
So they hammered and drilled,
Both layman and skilled,
Expecting, maybe, she would float.

They toiled on the craft,
Both forrard and aft:
Each rope had a sailorman's bight.
On front end and starboard,
On rear end and larboard,
She fulged with a nitrogen light.

Her knees were abundant,
Her anchors redundant,
She'd a sort of triangular keel.
With a horn a la fog,
An electrical log,
And for rudder a gyroscope wheel.

When finally finished,
Her chances diminished
Of staying upright in the pool.
So, propped by the stays,
She clung to the ways,
This craft of the potpourri school.

Lacking courage and hope,
She hung to the rope
That held her in place on the slide,
Till a few lusty knocks
On the grease-coated blocks
Sent her fearsomely into the tide.

As she launched, she listened,
She found herself christened
With water instead of live wine.
Off the ways then she slunk,
Turned turtle and sunk—
Requiescat, bottom up, in the brine.

M. M. Hornor.

American electrical goods, always well liked in Australia, have been in much greater demand there since the war started than ever before, according to a report published on April 24, by the Bureau of Foreign and Domestic Commerce, Department of Commerce. The report is entitled "Electrical Goods in Australia," Special Agents Series No. 155, and is sold for 15 cents by the Superintendent of Documents, Government Printing Office, Washington, D. C., and by all the district and co-operative offices of the Bureau of Foreign and Domestic Commerce.

THE TRADE IN PRINT

What The Industry is Doing in a Literary Way

> **NOTCE 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.

Price and Data Book on Speed Controllers has just been issued by the Ward Leonard Electric Co. of Mt. Vernon, N. Y. It contains four pages and is illustrated.

✣ ✣ ✣

Small Circuit Breakers is the subject of a four-page illustrated circular just issued by the Ward Leonard Electric Co., of Mt. Vernon, N. Y.

✣ ✣ ✣

Electrical Engineers Equipment Co., 710 to 714 West Madison St., Chicago, are now distributing advance sheets of their No. 107 Bulletin describing a new line of bus-bar supports. Copies of this publication will be sent on request.

✣ ✣ ✣

Lower Pumping Costs with E-M synchronous motors forms the subject-matter of Bulletin 183 just issued by the Electric Machinery Co., of Minneapolis, Minn. It contains much that is original, and is fully illustrated with cuts of E-M apparatus and results of tests in the form of curves.

✣ ✣ ✣

Crocker-Wheeler Co., Ampere, N. J., is distributing Bulletins 183, 184 and 185. No. 183 is entitled: "Motor Drive for Printing Machinery." No. 184 is entitled: "Direct-Current Lighting and Power Generators;" and No. 185 "Coupled and Belt Types of Alternating-Current Generators." All three are fully illustrated.

✣ ✣ ✣

Wheeler Condenser & Engineering Co., Carteret, N. J., announce that the fourth edition of their handbook entitled "Steam Tables for Condenser Work," is now off the press, making a total of 20,000 copies. One reason why this handbook has met with such success is that the pressures below atmosphere are expressed in inches of mercury referred to a 30-in. barometer. Another is that it is complete. It includes a discussion of the mercury column, the errors in such measurements, and constants for their correction. A complimentary copy of the handbook will be furnished on request to those in responsible positions who are not yet provided with a copy and who deal with steam and its many problems.

✣ ✣ ✣

"The Proper Care of Belts" is the title of a new booklet got out by the Joseph Dixon Crucible Company. We suggest that engineers obtain a copy for their files. As long as the original conditions of life and pliability of a belt is preserved it is worth its cost price. To neglect belts will result in a two-fold loss: a waste of power due to the inefficiency of the belts; and increased cost due to frequent belt renewals. Just now as never before it is essential that belting be given careful attention. The booklet contains helpful suggestions for getting maximum results from belts and in addition has several pages devoted to useful information of a general character. Those interested should write to the Joseph Dixon Crucible Co., Jersey City, N. J., Dept. 1290, for a sample of Dixon's Solid Belt Dressing.

✣ ✣ ✣

Wonder It Is that anybody should still stick to the old carbon lamp. Several contractors have secured complete lighting equipment by going into shops, laundries and other like establishments putting an ammeter on one of the old carbon lamps to convince the boss that it would register 3.5 amps. Then he removed the carbon lamp and screwed into the same socket a Mazda. Nobody can get around such proof and a demonstration like this is almost sure to land a contract.

✣ ✣ ✣

Vacuum Cleaner ideas would seem to have been exhausted but an entirely new thought is presented by one large electric house which says on a folder, "There are a hundred brooms in every lamp socks that will clean your home without fuss, dust or muss." The story is woven from the idea that the Vacuum Cleaner is equal to a hundred brooms for efficiency and that it can be attached to any lamp socket. The usual arguments for sanitary cleaning and convenience are offered.

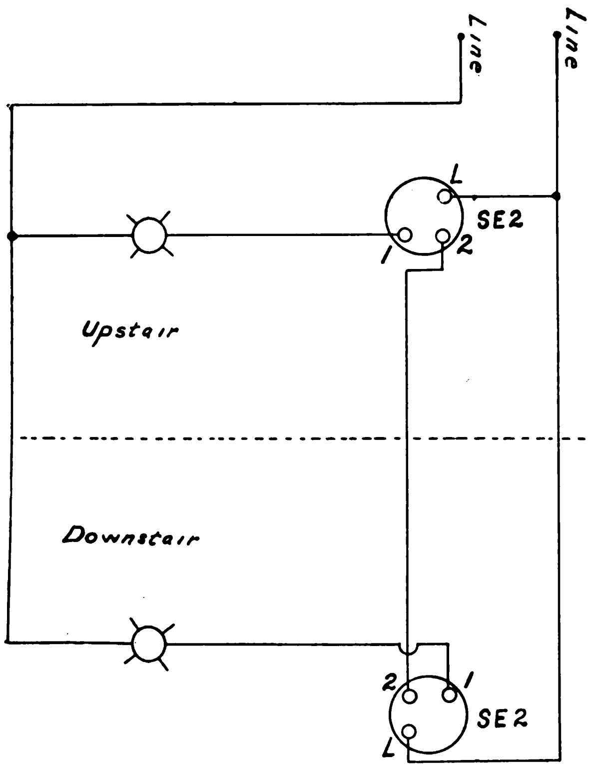
✣ ✣ ✣

The Electric Iron Market has hardly been scratched. On a basis of every iron sold being in actual use, there is still room for the sale of a new iron in every other wired house. This may not be the case in your own city, but this average holds good throughout the country. The electric iron is a necessity. Sell it as such. The electric iron long since left the luxury class and become a necessity. If people in your city haven't learned this, it is only because they haven't been told. The sale of electric irons is no different and no more difficult than the sale of any electrical appliances. On the contrary, it should be easier to sell irons. The electric iron is not a new or unknown quantity to the average house-owner therefore you don't have to tell them what an electric iron is, but only how much better the electric iron will do their ironing for them. You don't have to explain so much how an electric iron "works"—as you do with other appliances—because of the educational work already done on this score.

NUTS FOR THE KNOWING ONES.

QUERIES AND ANSWERS IN TECHNICS

In reference to an article in your April, 1918, issue relative to the control of lamps upstairs and downstairs by means of two 2 circuit electrolier switches, I wish to say that the wiring diagram and switch connections shown will not operate as stated, but will simply light the lamps in parallel; that is, both will be "on" or "off" together, and it will be impossible to operate one independent of the other. The writer of the article failed to consider that a 2-circuit electrolier switch in the "off" position has its terminals 1 and 2 directly connected and for this reason the lamps could not be controlled as he stated, using the wiring diagram that was shown; as the following illustrations clearly prove.



Sketch showing location of service line, switches, and lights.

The desired results may be obtained, however, with the standard 2-circuit electrolier switch; SE2, 1-2-1 and 2-off, using the wiring diagram shown below. When the upstairs switch is operated the first position puts upstairs lamp on, the downstairs lamp is off; second position puts downstairs lamp on, the upstairs lamp is off; third position puts both upstairs and downstairs lamps on at the same time; fourth position puts both lamps off. The lamps may be controlled as described, from either the upstairs switch or downstairs switch; but the other switch must be in the off position. H. P. Gorman, N. Y.

✦ ✦ ✦

Can you give me a short rule for converting kilowatts into horsepower, also for converting horsepower into kilowatts?

M. O. Ellsworth,
Calais, Me.

To convert kilowatts into horsepower, add one-third. To convert horsepower into kilowatts, subtract one-fourth. For example:

$$1000 \text{ kw.} = 1000 + \frac{1000}{3} = 1333 \text{ hp.}$$

$$1333 \text{ hp.} = 1333 - \frac{1333}{4} = 1000 \text{ kw.}$$

✦ ✦ ✦

When starting elevators with full magnetic control, state how the switches are closed and what causes the action. I would also like to know how these switches are arranged so as to close in sequence rather than simultaneously.

JAMES D MILLER,
New Britain, Conn.

In starting up an electric elevator, the cutting out of resistance in the armature circuit is usually controlled by a series of electrical magnet switches which in turn operate the contacts, which contacts cut out blocks of this resistance. The electric magnets get their current by a parallel connection with the armature circuit, and are electrically interconnected with each other.

The first switch in the series is so wound that its resistance is low enough always to pull in, and the other switches follow in sequence, due to the increase in the counter electromotive force, as the motor speeds up, due to the successive operation of these magnets.

In other words, the gradual cutting out of resistance is due to the variation in the voltage in the armature, and that variation, in turn, is due to the speed of the motor, which is controlled as above.

✦ ✦ ✦

I have a four-cell rectifier made up in accordance with the diagram on page 50 of ELECTRICAL ENGINEERING for March, 1918. The cells are ordinary crockery jars and the plates are sheet lead and sheet aluminum. The solution is hydrant water and sodium phosphate. I used one pound of the salt to two and one quarter quarts of water.

When forming the cells as indicated in the last paragraph on bottom of page 50, I used a 200-watt lamp, but did not notice the lights dimming, even after two hours formation.

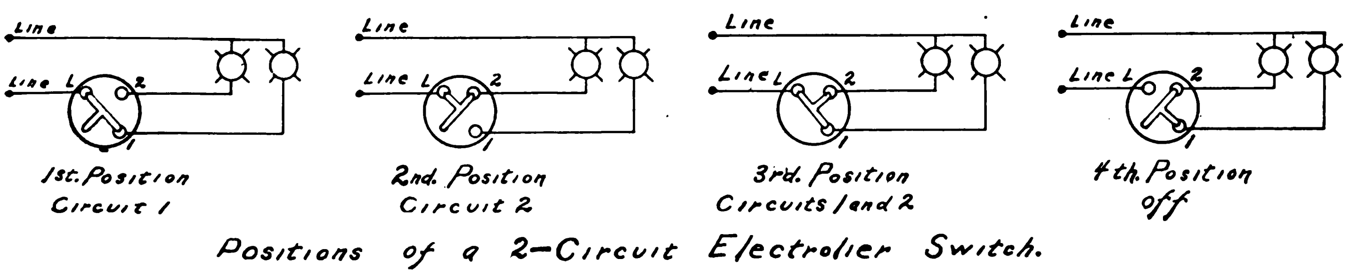


Diagram showing positions of a two-circuit electrolier switch for turning lights on and off upstairs and downstairs.

In using the rectifier, I placed a Viking transformer between the lighting circuit and the rectifier and reduced the voltage at the rectifier to 8 volts, 14 volts, and 32 volts, according to the markings on the transformer. A Weston direct-current voltmeter when connected across the terminals of the direct current circuit gave no indications of voltage whatever in either the 8-, 14-, or 32-volt circuits. On connecting a telegraph sounder across the direct-current terminals, the armature of the sounder vibrated at the same speed as the alternations of a circuit, as indicated by the sound from the rectifier and transformer.

The rectifier plates are fastened on to pine boards by means of iron screws and the terminals of the direct-current wires show good indications of current although the direct-current voltmeter shows no indications of voltage.

The rectifier is wanted for use in charging storage batteries at 8 volts and for operating a direct-current motor at 110 volts.

I would appreciate any information you can give me which will enable me to get results from this device.

C. D. Hill, Mt. Kisco, N. Y.

✦ ✦ ✦

The trouble here seems to be chemical rather than electrical, as the connections are in accordance with established practice. As the voltage depends somewhat on the electrolyte, I suggest that your correspondent try ammonium phosphate, if he can get it in war times, or sodium borate in place of sodium phosphate.

P. S. Dwyer, Saratoga, N. Y.

DID YOU KNOW THAT-

BITS OF GOSSIP FROM THE TRADE

Electrical Industries led the Class B contestants in the recent Liberty Loan contest in New York with a total subscription of close to $9,000,000. The nearest competitor, the Building and Allied Trades, came second with a total subscription of about $6,000,000.

✦ ✦ ✦

Sprague Electric Works, of General Electric Co., reports that every employe (1482 men and women) subscribed to the Third Liberty Loan. These subscriptions aggregate the sum of $116,850, or an average subscription of $78.85 from each one. This enthusiastic, patriotic achievement is worthy of note.

✦ ✦ ✦

National X-Ray Reflector Co., 235 West Jackson Boulevard, Chicago, announces that F. Ernest Lauderbach is no longer associated with them in business, and that the St. Louis office of the company, of which he had charge, has been discontinued. H. O. Bourkard will look after the interests of the company in that territory.

✦ ✦ ✦

American Power & Light Co. report for the year 1917, shows earnings of $11,389,659 compared with $10,344,895 for the year 1916, an increase of $1,044,764, equal to 10 percent. Net earnings for the year 1917 aggregate $4,762,411 compared with $4,717,754 for the year 1916, an increase of $44,660, equal to a little less than 1 percent. The substantial increase in gross earnings reflects the generally prosperous conditions in the territory served, while the small increase in net earnings reflects the heavy increase in operating costs and taxes so general among public utility companies.

✦ ✦ ✦

Rutland Railway, Light & Power Co. announce that Government officials have been investigating water powers in this territory with the idea of recommending additional developments for the purpose of saving coal in New England. It is understood that they have recommended that the government finance three different developments in that territory.

✦ ✦ ✦

Reading Transit & Light Company, of Reading, Pa., has just announced an increase of one cent an hour in the wages of its 600 motormen, conductors and other car service men, employed over the company's entire system in Reading, Norristown, Lebanon and their suburbs, to take effect June 1st. The new rate of wages will be from 28 to 31 cents an hour dependent upon length of service of from one to three years.

✦ ✦ ✦

Thrift Stamp Day in the U. S. A. has come to stay. The results of the first Thrift Stamp Day were so satisfactory, that the National War Savings Committee of Greater New York has decided to hereafter set aside every first day of each month as Thrift Stamp Day, and all business houses throughout the Greater City have been asked to co-operate and make a special drive to boost the sales of Thrift and War Savings Stamps on those days.

✦ ✦ ✦

Liberty Loan Campaign efforts among employees of the Westinghouse Electric & Mfg. Co. and its subsidiaries netted $2,601,000. Of this, $2,217,000 was taken by employees of the parent company. Three subsidiaries showed 100 percent. of employees subscribing—the R. D. Nuttall Company, the Krantz Mfg. Company, and the Pittsburgh Meter Company. In addition to this, the Krantz employees subscribed the largest percent. of total payroll—10.4 percent. and the largest amount per subscriber $87.27. The electric company employees to the number of 32,048 subscribed $69.18 per capita, 5.2 percent. of the payroll. All figures show a gratifying increase over those of the Second Loan, showing that Westinghouse men and women are solidly backing their four thousand fellow workers now with the colors.

✦ ✦ ✦

Crane Packing Company announces the removal of its New York City office to larger quarters in the Park Row Building and the appointment of Julian N. Walton as manager. A. W. Payne, connected for some time as manager of this district, has been made sales manager of the United States and Canada with headquarters at the home office in Chicago. The Pittsburgh offices are located in the May Bldg., Pittsburg, the Philadelphia office in the Colonial Trust building.

✦ ✦ ✦

Joseph Dixon Crucible Co., Jersey City, N. J., held its annual and regular meetings on Monday, April 15. The following directors and officers were elected. Directors: Geo. T. Smith, William G. Bumsted, J. H. Schermerhorn, George E. Long, Edward L. Young, Harry Dailey, Robt. E. Jennings. Officers: George T. Smith, president; George E. Long, vice-president; J. H. Schermerhorn, vice-president; Harry Dailey, secretary; William Koester, treasurer; Albert Norris, ass't. sec'y. and ass't. treas.

The report made by President Smith, and the remarks made by him on the business of the company were received by the large number of stockholders present as most satisfactory and pleasing in every way. The American Graphite Company, incorporated under the laws of the State of New York, is a subsidiary of the Joseph Dixon Crucible Company, and its annual election was held on the same day.

✦ ✦ ✦

Enameling & Stamping Corporation of New York has established in Long Island City the largest enameling works in the East devoted exclusively to the service of manufacturers for work of this character. The company has purchased the plant of the Fickling Enameling Corporation in Long Island City, at 2nd and Webster Aves. (near the end of the 59th St. Bridge). Its capacity is greatly enlarged and still further additions are being made to ovens and equipment.

✦ ✦ ✦

An address on "American Economic Interests in the Asiatic East" was made by M. A. Oudin, manager foreign department, General Electric Company, before the Fifth National Foreign Trade Convention, Cincinnati, last month.

✦ ✦ ✦

PURELY PERSONAL

Lieut. William Sikes Tucker, formerly connected with the sales department of the Electric Storage Battery Company, Philadelphia, has been awarded the French war cross for bravery.

✦ ✦ ✦

Ralph W. E. Donges, president of the Board of Public Utility Commissioners of New Jersey, has been commissioned a lieutenant-colonel in the National Army.

✦ ✦ ✦

W. W. Erwin has been appointed chief operating engineer of the New York Edison Company to succeed the late J. P. Sparrow.

✦ ✦ ✦

Frank V. Burton has been appointed to the newly established position of general sales manager of the Bryant Electric Company of Bridgeport, Conn.

✦ ✦ ✦

John D. Ryan, president of the Montana Power Company, Butte, Mont., and the Anaconda Copper Company, was recently appointed director of aircraft production for the Army.

✦ ✦ ✦

Prof. Thomas Corwin Mendenhall, physicist,, former president of Worcester Polytechnic Institute and a United States delegate to the International Electrical Congress in 1893, has been awarded the Franklin medal by the Franklin Institute.

✦ ✦ ✦

G. C. Marshall has been transferred by the American Gas & Electric Company from the Newark office of the Ohio Light & Power Company to the Steubenville (Ohio) office of the Ohio River Power Company as commercial manager.

✦ ✦ ✦

F. E. McKenna, formerly superintendent of the Oregon Power Company at Coquille, has been transferred to Marshfield as general superintendent for the Coos Bay division of the Oregon Power Company.

✦ ✦ ✦

W. W. Hanks, superintendent of the electrical department of the Charlotte (N. C.) branch of the Southern Public Utilities Company, has resigned to become associated with the Charlotte Electric Repair Company, in which he is interested.

✦ ✦ ✦

William Marconi has been awarded the Franklin medal by the Franklin Institute.

A. P. C. Schramm, who for the last five years has been the chief engineer of the Klaxon Company, Newark, N. J., has established himself as a consulting engineer at 276 Canal Street, New York City.

✦ ✦ ✦

R. A. MacGregor has resigned as sales manager of the Merchants' Heat & Light Company, Indianapolis, to accept a position as sales engineer for the Lakewood Engineering Company of Cleveland in its Pittsburgh territory.

✦ ✦ ✦

Frank L. Fox, who for the past four years has been manager of the Thomasville (S. C.) branch of the Southern Public Utilities Company, has been transferred to the Chester (N. C.) branch of which he will be manager.

✦ ✦ ✦

F. H. Newell, head of the department of civil engineering at the University of Illinois and organizer and director of the United States Reclamation Service, was recently awarded the Cullom Geographical Medal by the Geographical Society of New York.

✦ ✦ ✦

J. C. Chestnut has resigned as superintendent of the New Castle (Pa.) Electric Company, a subsidiary of the Mahoning & Shenango Railway & Light Company, to become general manager of the Choctaw Power & Light Company, McAlester, Okla.

✦ ✦ ✦

Prof. Dugald C. Jackson, the head of the department of electrical engineering of the Massachusetts Institute of Technology, has received the commission of major in the Engineers' Reserve Corps and has been ordered to France. All three Jackson brothers are now in active service.

✦ ✦ ✦

Dr. A. E. Kennelly, acting head of the electrical engineering department of the Massachusetts Institute of Technology, has been awarded by the Franklin Institute its Howard N. Potts gold medal for his invention of the hot-wire anemometer and his application of this device to the measurement of convection from small heated wires.

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M. W. Arthur has resigned from the Westinghouse Electric & Manufacturing Company to accept a position as superintendent of sales for the Northern Ohio Traction & Light Company of Akron. Mr. Arthur for seven years has been connected with the railway and power department of the Westinghouse company at Cincinnati.

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A. S. McAllister has gone to Washington, D. C., as assistant to Major Thompson in the Progress Section of the Control Bureau of the Ordnance Department. Prior to going to Washington Dr. McAllister had been active in New York in engineering society committee work relative to war matters.

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Major Charles G. Baird, Signal Corps, U. S. A., reported dead from disease in France, was the chief of the entire telephone and telegraphic service of the American Expeditionary Force in France. He entered the army immediately after Congress declared war on Germany and organized the 413th Telegraph Battalion, one of the first of the Signal Corps units ordered overseas.

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Otto E. Osthoff, vice-president of H. M. Byllesby & Co., has just returned from a trip to the California properties of H. M. Byllesby & Company. He says that the electrical transmission line to connect the distribution system of the

San Diego Consolidated Gas & Electric Company to the supply system of the Southern California Edison Company will soon be completed and the San Diego Company will begin purchasing water power energy from the Edison Company about June 1. This will enable the San Diego company to cut its consumption of fuel oil in the manufacture of electricity to a very low point.

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W. K. Dunlap, assistant to vice-president of the Westinghouse Electric & Mfg. Co., has been appointed general manager of the Westinghouse Electric Products Company into which firm the Copeman Electric Stove Company, of Flint, Michigan, has been merged. The new organization will have a factory at Mansfield, Ohio, which will be devoted to the manufacture of heating appliances such as previously were made at the Newark works and Flint, Michigan.

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M. C. Turpin, formerly assistant to manager, Westinghouse Department of Publicity, has resigned to enter the Federal service as assistant to manager, Technical Publicity Bureau, Ordnance Department, Washington, D. C. Mr. Turpin's work will be on the dissemination of information from the War Department to manufacturers, through the medium of the trade press. Mr. Turpin is a graduate of Alabama Polytechnic Institute and of Cornell University. After several year's experience in the construction and operation of central station plants, he entered the Westinghouse Department of Publicity in 1909.

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James A. Farrell, president National Foreign Trade Council and president United States Steel Corporation, made a forecast of business conditions after the war in an address given early last month. He said that there can hardly be a question that for a good many years after peace is restored the rehabilitation of the vast territory wasted by the war and the replacement in neutral countries of equipment which has necessarily suffered from deterioration while replacements have been impossible will provide a large outlet for surplus production. Whatever may be the eventual terms of peace, one conclusion would seem to be reasonably certain: We and our allies will have sacrificed our blood and treasure in vain if we have not succeeded in insuring hereafter conditions of peace under which we shall be free to carry on our domestic and foreign commerce without the fear of military dictation.

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ASSOCIATION NEWS

American Institute of Electrical Engineers announces that its next annual convention will be held at Atlantic City, N. J., on June 26, 27 and 28, 1918.

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Electrical Club of Detroit is boosting the sale of War Savings Stamps at each of the weekly luncheons. The war activities committee desires the more active co-operation of the companies who are represented in the club.

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Society for the Promotion of Engineering Education.—"The Engineering School and the War" will be the subject of a discussion at the twenty-sixth annual meeting of the Society for the Promotion of Engineering Education, to be held at Northwestern University, Evanston, Ill., June 26-29.

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War Problems were the chief topics discussed by representatives of all branches of the electrical industry at Del Monte, Cal., last month. In session with the annual convention of the Pacific Coast Section of the National Electric Light Association were the Pacific division of the Electrical Supply Jobbers' Association, the California Association of Electrical Contractors and Dealers, manufacturers' representatives and others. There were about 400 delegates in attendance.

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A. I. E. E., Schenectady Section.—"The Romance of the Pictures" was the subject of an address by C. Francis Jenkins, president of the Society of Motion Picture Engineers, before the May 10 meeting of the Schenectady Section of the American Institute of Electrical Engineers.

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Electrical League of Cleveland, is continuing its lively and interesting weekly meetings. Thrift Stamps, War Savings Stamps, Red Cross donations, and the buying of Liberty Bonds—all these method of aiding the Government to win the war are conducted with great industry and vigor by this efficiently operated association.

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I. E. S., Philadelphia Section.—"The Relation of Light to Health" was the subject of a paper read by Dr. C. E. de M. Sajous before a joint meeting of the Philadelphia Section of the Illuminating Engineering Society and the Philadelphia Safety Council on May 17. Howard Lyon also gave a short talk on "Methods of Calculation."

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General Officers of the Illuminating Society recently elected are as follows: President, George A. Hoadley; vice-president from Chicago Section Otis L. Johnson; vice-president from New England Section, H. K. Morrison; vice-president from Philadelphia Section, H. A. Hornor; general secretary, Clarence L. Law; treasurer, L. B. Marks; directors, John C. D. Clark, Evan J. Edwards, James J. Kirk.

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A. E. R. A. Annual Convention.—The annual convention of the American Electric Railway Association and affiliated associations will be held at Atlantic City, N. J., this year during the second week in October. According to the tentative program so far prepared, the American association meeting will open on Tuesday afternoon, Oct. 8, and close on Wednesday afternoon. The affiliated associations will meet on Wednesday and Thursday mornings.

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American Society of Mechanical Engineers will hold its spring meeting at Worcester, Mass., June 4-7, 1918. Papers will be presented upon subjects relating to New England's industries under war conditions, including: Converting a factory for munitions manufacture; fire protection; training labor for shipbuilding; oil fuel in New England power plants.

A general war session will be held at the Hotel Bancroft on Wednesday evening, June 5. The general theme of this session will be: How the engineering societies can assist in the procurement program of the government. Some major topics to be discussed are: Ordnance and ships for the Navy Department; munitions for the Army; aircraft material.

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National Electrical Credit Association.—The nineteenth annual meeting of the National Electrical Credit Association will be held at the La Salle Hotel in Chicago on June 17 and 18. The National Association of Credit Men will also hold its annual meeting at the Hotel La Salle, June 18 to 21 inclusive. President W. T. Pringle, of the Pringle Electric Manufacturing Company of Philadelphia, will preside at the electrical credit men's meeting, and the program will be conducted under the surpervision of M. A. Curran, Western Electric Company, New York, as chairman of the committee on arrangements, and H. E. Wilkins, of the Belden Manufacturing Company, Chicago, chairman of the local committee of entertainment.

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The Society for Electrical Development held its annual meeting on Tuesday, May 14, at the offices of the society in New York. James R. Strong presided at the meeting. The general manager read his annual report, reviewing the work of the society during the past year and suggesting activities for the coming year. The treasurer's report was read and accepted. The election of directors resulted as follows:

For directors to represent central station interests: J. E. Montague, 4 years; W. W. Freeman, 2 years; E. N. Sanderson, 1 year.

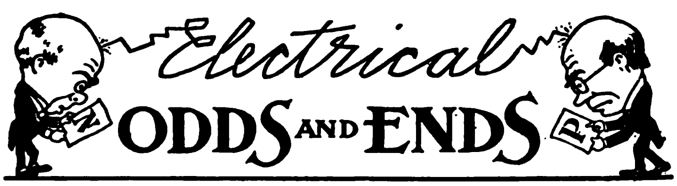
For directors to represent manufacturing interests: L. P. Sawyer, 4 years; W. D. Steele, 1 year.

For director to represent jobbing interests: Fred Bissell, 4 years.

For director to represent contracting interests: G. M. Sanborn, 4 years.

At the board of directors' meeting which followed the annual meeting, with J. E. Montague presiding, it was decided to continue the work of the society for another year upon the present basis and to conduct a "Convenience Outlet" campaign as suggested by the general manager. An appropriation was made to carry on the campaign along national lines, similar to the "Wire Your Home" and "America's Electrical Christmas" campaigns.

Henry L. Doherty was again elected president. Joseph E. Montague was elected to succeed W. H. Johnson as vice-president and as a member of the executive committee. Gerard Swope was elected chairman of the executive committee. James M. Wakeman was reappointed general manager, and James Smieton, Jr., secretary-treasurer for the ensuing year.



BRIEF TIDINGS FOR THE BUSY MAN

The functions of a reflector are properly to redirect and diffuse the light from the lamp and to shade the brilliant filament.

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A light blanket is now on the market, which is electrically heated. The blanket is equipped for three heats. The sleeper can have it mildly warm, warm or almost hot. A very small amount of current is required.

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It is announced that the Baltimore & Ohio Railroad has commenced the installation of electric headlights on all of its locomotives, totalling about 2,500. The improvement will be installed at the rate of 75 to 100 engines a month.

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Wet cells require more attention than dry cells and this fact is responsible for the great popularity of the dry cell. However, as there is no closed circuit dry cell, the use of wet cells is at times imperative.

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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.

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While all polished-metal surfaces reflect light, 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.

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Byllesby power companies are helping to build ships, extract ingredients for explosives from kelp, operate flour mills, mine ore, run munition and agricultural implement factories, and assisting hundreds of establishments to increase the output of necessary articles. Every industrial plant connected to their lines is saving fuel compared with the consumption of isolated power plants. Besides this, 40 percent. of all power supplied by Byllesby companies is generated by water power. The bulk of the gas furnished by these properties is natural gas. There are three army training camps at Byllesby properties—Louisville, San Diego, and Tacoma.

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For use in connection with relatively small ampere capacity loads, say 50 amperes or less at 33,000 volts, the automatic oil circuit breaker is handicapped, due to its high initial and installation costs. The practical method of interrupting these high voltage low capacity circuits is by means of fuses which will clear the circuits just as, or even more, quickly than the expensive oil circuit breakers. One of the most successful types developed is the chemical form, consisting of a short fuse wire under tension and hermetically sealed in a glass tube filled with a carbon-tetrachloride solution. This form of fuse has the desired characteristics of quick action, minimum disturbance to the system, positive indication whether open or closed, and ready replacement.

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According to Preston S. Millar, of the Electrical Testing Laboratories, the coal used in the production of electric light is less than 2 percent. of the total coal output of the country. Curtailment of lighting can therefore accomplish relatively little as a coal saving measure. Standards of illumination intensity before the war were in general too low. In view of the war and the fuel shortage, lighting ought to be reduced in some classes of service and increased in others. Any practical curtailment is about 3 percent., which means about 360,000 tons of coal per annum, or a trifle more than five one-hundredths of 1 percent. It is practicable to effect much larger savings by other methods with less disadvantage to the public.

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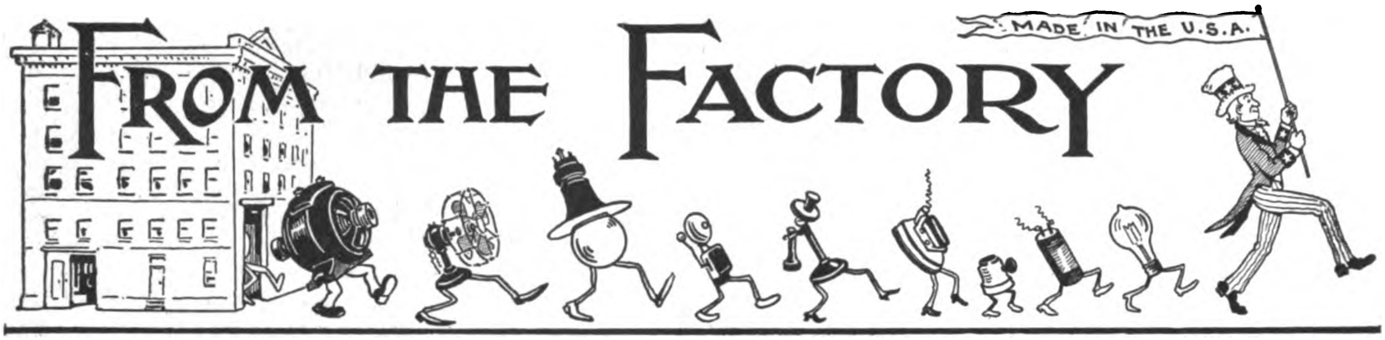
Each of the different lines of the spectrum has a different visual effect. The relative luminosity of the different colors is as follows:

Red	12
Yellow	280
Green	1000
Violet	16

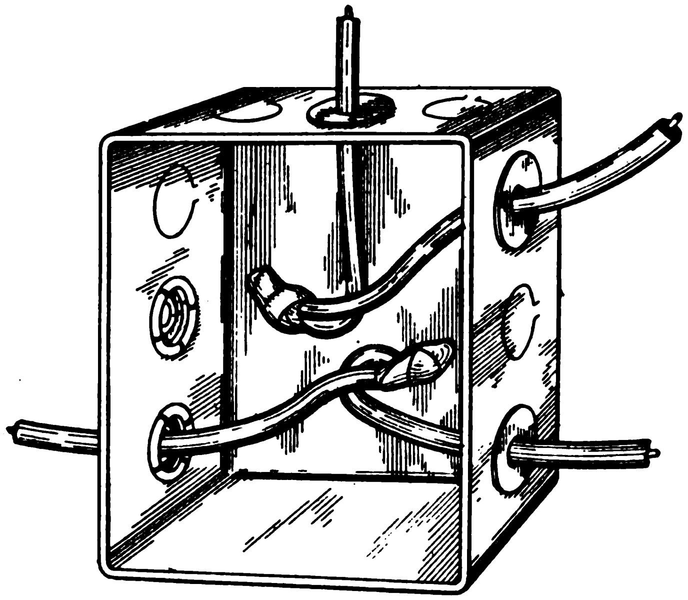
This means that to see as clearly with a light composed entirely of red rays, as with one of green, we would need 83 times as much energy transformed into light. The most efficient light would come only from the mono-chromatic green line, which for the same energy consumption would give about 100 times as much light as given by an ordinary tungsten lamp. The light of the firefly is confined to approximately this one line.



Short Stories About Electrical Goods Offered By Manufacturers

CABINET BUSHINGS THAT SNAP INTO PLACE

A metal bushing for use in knockouts, gutter linings of cabinets, meter loops, drop-cord covers and signs has been



Snap in Bushing. J. J. Duck, 432 St. Clair Street, Toledo, Ohio.

developed by J. J. Duck, 432 Saint Clair Street, Toledo, Ohio. No spring or locking device is necessary, as the bushing snaps into place like a glove fastener.

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OUTLET BOX HANGER

M. B. Austin & Company, of 700 Jackson Boulevard, Chicago, Ill., is offering the trade a new outlet box hanger. It was designed by the engineering department of the Commonwealth Edison Company to meet the need for a hanger for outlet boxes in old buildings or for revision work in tile buildings. The bar is flat and is said not to tear through the plaster. A special locknut, which locks the outlet box firmly into position, is provided for each stud.

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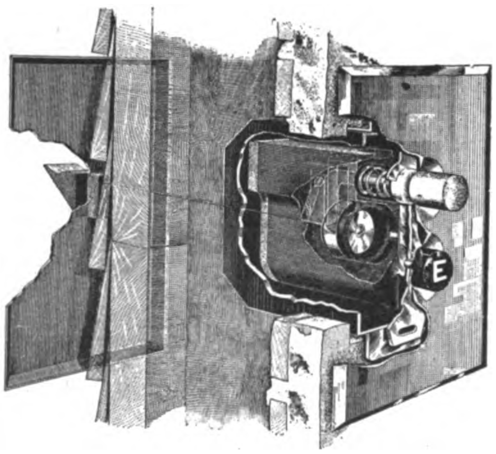
TIME REGULATING PUSH BUTTON SWITCH

A novel device that will attract much attention is a new type of push-button switch recently developed by Samuel M. Elser, 59 East Adams Street, Chicago, Ill. It can be closed by either direct or remote control, and will stay closed for from a few seconds to 10 minutes by means of an adjustable dash-pot. To close the switch for an indefinite period, press upward the button shown at E in the annexed illustration. The button shown just above button E is used for operating the time-limit apparatus.



Push-button switch with automatic time regulation. Samuel L. Esler, 59 East Adams Street, Chicago, Ill.

This device is designed for use in places where electrical service is ordinarily used for short intervals, as in halls, cellars, and garages. It saves the operator the bother of remembering to turn off the light after leaving the hall or cellar or garage. It saves money by preventing the lamp in the cellar or garage from burning all night because somebody forgot to press the "out" button.

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MOTOR-DRIVEN DRILL AND TAPPER

To speed up production without danger to machine or operators, is the purpose of the new Barnes self-oiling, all geared drill and tapper which handles high speed twist drills from ½-in. to 2-in.

This is essentially a manufacturing machine, built for heavy-duty and rapid production. Belts are entirely eliminated, all power being transmitted through gears.

With the exception of the spindle sleeve and cross spindles, all bearings and all gears are continuously lubricated by an automatic self-oiling system. The oil for this purpose is pumped from the reservoir at the base of the machine by a geared pump.

Eight changes of speed are provided, with control levers within easy reach of the operator from his position in front of the drill. The spindle may be stopped by placing the shifter lever on the neutral position, or by throwing out the clutch gear. All transmission gears except the friction clutch gears, are cut from special high-grade chrome nickel steel, heat-treated, and tempered to prevent wear, and to increase strength and stiffness.

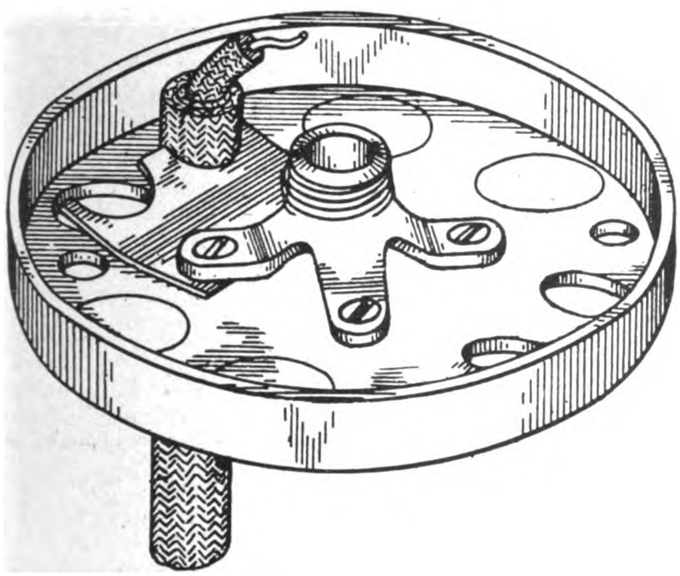
There are ten instant changes of geared feeds, controlled by levers directly in front of the operator. The feeds are indicated in plain figures on an index dial plate. All important feed gears are cut from steel and are case-hardened. A safety collar protects the machine against damage from overloads.

For tapping, the machine may be equipped with an automatic reversing mechanism, which is very desirable, especially for depth tapping. A trip on this mechanism can be set so that the instant the tap reaches the depth required, the spindle will automatically reverse. It is also possible to set the shifting lever so that when tripped, either automatically or by hand, it will return to the neutral position, thus stopping the spindle instantly instead of reversing it. A small hand trip lever is always ready for use if it is desired to stop or reverse the spindle at any point in the operation.

These machines are driven through a silent chain by a Westinghouse 10 h.p. direct-current motor provided with a Westinghouse automatic starting panel.

LOOM FASTENER FOR OUTLET BOX

A loom fastener, approved by the National Board of Fire Underwriters, that will fasten two pieces of loom at one time to an outlet box is announced by J. J. Duck, 432 St. Clair St., Cleveland, Ohio. The fastener will grip a piece of loom ex-



Loom Fastener. J. J. Duck, 432 St. Clair Street, Toledo, Ohio.

tending only 1/4 in. through a box or plate. When a stud is used on the outlet box the same bolt or screws that hold the stud will also serve to hold the fastener in place. The device is made of spring brass and will hold 1-5 in. and 1/4 in. flexible tubing.

ARMORED CORNER INSULATOR FOR FEEDER CABLES

A new Pittsburgh-type corner insulator, for securely holding feeder cables on curves, is being marketed by the Westinghouse Electric & Mfg. Co.

It is provided with a special collar or retaining ring for use where the curve is slight and the cable likely to slip off an ordinary insulator. This collar has an extended lip which curves up around the cable and keeps it in the groove, regardless of the angle at which the cable turns. This eliminates the necessity for tie wires and saves time in erection.

This collar is free to move on the insulator cap, so that after the insulator is screwed to the pin, the collar may be turned until the cable seat is in the proper position best to support the cable.

For sharp curves, the insulator can be used without this collar, as the deep side groove holds the cable firmly in position.

These insulators are made of moulded insulation surrounding by a sherardized malleable iron cap. They are made with a one-inch pin hole and are furnished in two sizes for feeders of 500,000 and 1,000,000 cir. mils respectively.

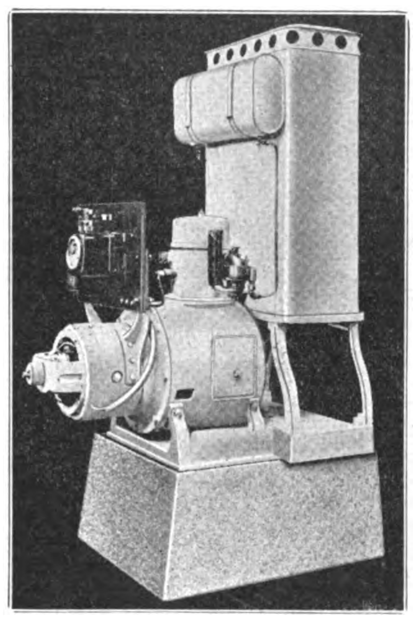
SOCKET-ATTACHMENT BELL TRANSFORMER

A new type of bell transformer provided with a plug to fit the ordinary lamp base is announced by B. F. Miller, 201 South Clinton Avenue, Trenton, N. J. It is called the "Liberty Bell" transformer and can be screwed in to any standard size lighting socket, thus doing away with the necessity of the soldering of any connections, as it is provided with secondary binding-post terminals. According to the manufacturer, no harm will result, should the secondary terminals be accidentally short-circuited.

ISOLATED LIGHTING PLANT

The Gile Tractor & Engine Company of Ludington, Mich., has recently brought out a new type of household electric plant—one big enough for the average home and at a price that is only possible where the plant is built under one roof from foundry to paint shop.

The manufacturer has arranged with the Consolidated Utilities Corporation of Chicago, to distribute this plant through their organization.



Isolated lighting plant. Gile Tractor & Engine Co., Ludington, Mich.

This plant in no way conflicts with the well-known Matthews product which this concern is handling, because the different plant sizes supplement each other. The Consolidated line now includes this new 600-watt plant and the 1, 2, 5, and 15-kw. Matthews plants.

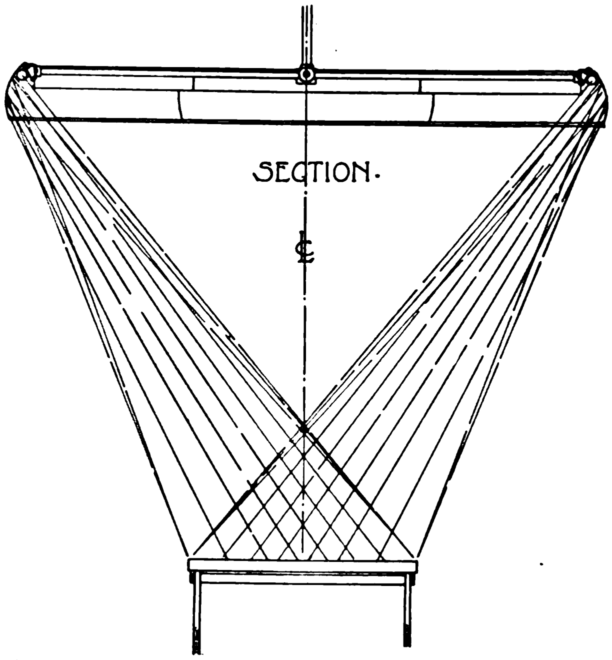
The rating, at 600 watts, is conservative, as the manufacturer guarantees a continuous generator output of 750 watts.

The engine is a 2 5/8 by 3 1/2 in. valve-in-head, four cycle, water-cooled, speed 1600 rev. per min. Generator is rated at 32/40 volts. The plants are fully equipped, including special governor, and an arrangement for the use of kerosene, if desired.

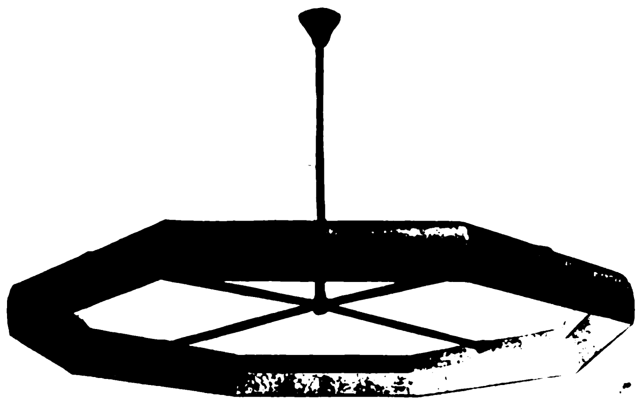
OPERATING TABLE REFLECTORS

A lighting fixture for hospital operating rooms is announced by I. P. Frink, 24th Street and 10th Avenue, New York.

It consists of an octagonal reflector 6 ft. in diameter surrounding the entire table, so designed that the direct light of the lamps and reflected light is confined to the top of the table. The Frink Linolite lamp used with this fixture consists of a glass tube 1-in. in diameter and 11¾-in. long. The filament extends the entire length of the tube throughout its center. Each section of the octagon contains two 40-watt Linolite lamps,



Linolite Concentration fixture for illuminating hospital operating tables showing way light rays are directed.



Linolite Concentration with reflector arrangement for a line of light around table. I. P. Frink, New York.

making 640 watts or 480 cp. per fixture. The metal part of the fixture is finished in white enamel inside and out. Special sockets are used with this lamp consisting of one-piece procelain with only one movable part.

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RECEPTACLE CLUSTERS FOR TABLE USE

Receptacle clusters that can be set on the dining-room table and used for supplying energy for cooking utensils are among the new things announced by the Anderson Electric Specialty Company, 118 South Clinton Street, Chicago, Ill. They are constructed by using a Benjamin wireless cluster that is inverted and set upon the table. The plug at the top is connected to the dining-room lighting fixture, and the energy supply is distributed from the receptacle to toaster, chafing dish or percolators that are used on tables. These devices are made in two styles, with either the two outlet or the three-outlet receptacle.

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TWO-OVEN RANGES

A two-oven range, which consists of two ovens, a broiler, a warming closet and either four or six 8-inch stoves, is announced by the Simplex Electric Heating Co., of Cambridge, Mass. Each unit has a three-heat snap switch and is properly fused in a cut-out box located at the end of the range. There is a signal lamp to indicate whether the current is on or off.

The ovens have double walls and are packed with heat insulating material. Each oven has a top and bottom heater.

The ranges are wired for three-wire service at 110-220 volts.

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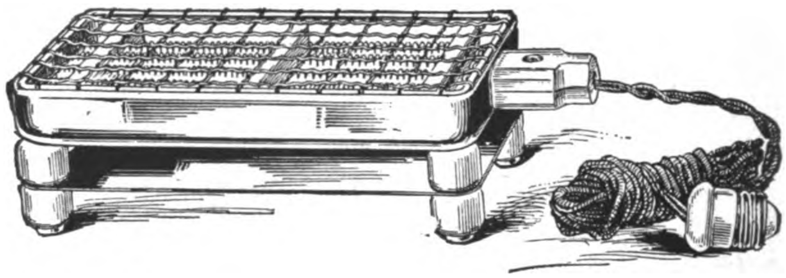
REDDY ELECTRIC TOASTER

This toaster is made of polished nickel steel with sanitary legs and plugs. The heating surface measures 4¾ in. wide and 8 in. long. Underneath this surface is a polished nickeled



Reddy toaster range. Curtainless Shower Co., 25 W. Broadway

shelf where toast or shallow dishes can be placed and kept warm. A suitable plug and cord is provided. The rating of the toaster is 480 watts. It is offered by the Curtainless Shower Co., 25 West Broadway, New York.

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PULL CANOPY FIXTURE SWITCH

The demand for a compact device that will at once supplant the hollow canopy, and its companion ceiling switch, has been met by P & S 1213, the new brass canopy fixture switch recently brought out by Pass & Seymour, Inc., Solvay, N. Y.

The porcelain base of this device is arranged to be used on both the 3¼ in. and 4 in. outlet boxes, and is fitted with an insulating lip which prevents the grounding of the brass canopy. This device needs no insulating ring, nor does it need a crowfoot or insulating joint.

No. 1211 pull canopy fixture switch. Pass & Selmour, Inc., Solvay, N. Y.

This device is especially recommended for metal ceilings or walls. The line terminals are fully ½ in. from the surface wired over, and are especially arranged for loop winding.

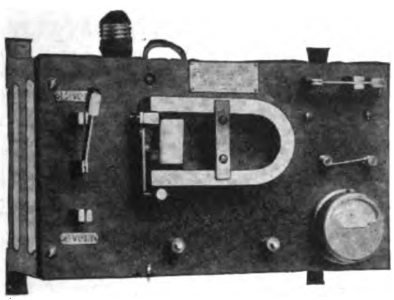
The ability to loop the line wires over the terminals and thereby carry the line wires directly to the terminals of the unit without break or splice, is to be desired because of neatness, safety and saving of time.

P & S 1213 may be used for the better class of pendant or drop cord work. It is capable of supporting a long heavy cord, or fancy silk or velvet covered cord, for special high class units.

A special card grip, located immediately above the cord terminals, relieves the strain on the terminals. The linen cord, being 10 ft. in length, allows the unit to be located far out from a balcony or high above the plane of illumination, as may be desired. The brass canopy snaps on or off instantly without the use of tools.

VIBRATING TYPE RECTIFIER

The Fore Electrical Manufacturing Company, Inc., 5643 Easton Avenue, St. Louis, Mo., has developed a vibrating type rectifier for charging lighting and starting batteries. This outfit can be placed on the running board of an automobile and the battery charged without removing it from the car or disconnecting it. The outfit can also be mounted on the wall in one, two or three units, for charging a group of batteries. It will charge two 6-volt, 80, 100 or 120 ampere batteries, at 6 amperes charging rate at one time, or four 6-volt batteries at 3 ampere rate, or one 12-volt battery at 6-ampere rate.



Vibrating type rectifier for charging batteries. For Electrical Mfg. Co., Inc., 3653 Easton Avenue, St. Louis, Mo.

BROOKS INDUCTOMETER

This instrument, a variable self and mutual Inductometer, was originally designed by H. B. Brooks and F. C. Weaver, of the Bureau of Standards, Washington, D. C., and is described in Scientific Paper of the Bureau of Standards, No. 290.

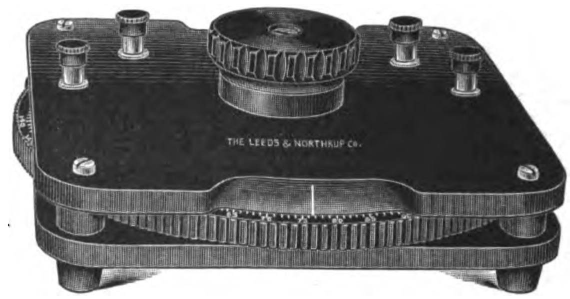
It consists of two pairs of stationary coils and one pair of movable coils, the latter being mounted on a disc played between two outer plates holding the stationary coils. The disc may be rotated and has two scales, one calibrated in millihenrys, reading self-inductance, and the second in degrees. The mutual inductance value is determined by a simple calculation.

This design is said to have a number of advantages over the Ayrton-Perry form of variable inductometer, among which are a fair degree of astaticism, which tends to eliminate errors due to stray field effects, and it is less expensive, and at the same time is fully as accurate as the Ayrton-Perry instrument. It occupies less space.

The instrument has a very nearly uniform scale, which is only obtainable by using proper proportions for the coils.

It has a good ratio of maximum inductance to minimum inductance (about 9 to 1), and also has as high a time constant as is consistent with good design and moderate size. Since the time constant is the ratio of inductance to resistance, it is desirable to have it as high as possible.

The Inductometer has six link-shaped coils. The four fixed coils are mounted in pairs in the two outer fixed plates which are held together by four screws and separating pieces, and form the body of the instrument.



Brooks Inductometer. Leeds & Northrup Co., 4901 Stenton Avenue, Philadelphia, Pa.

The two movable coils are mounted on the inner disc, and are placed with their long axes at right angles to a diameter. The outer plates and the disc are of moulded bakelite, which insures good insulating qualities and permanency of form, as well as durability. The plates are 9¾ inches square and the disc is 10⅜ inches in diameter.

The four fixed coils in series are connected to two binding posts, and the two movable coils are connected in series to another pair of binding posts. The scale reads self-inductance with all the coils in series. To use the instrument as a variable mutual inductometer the fixed and movable coils are used as primary and secondary respectively, and no connection is made between them. The mutual inductance is found by subtracting a constant for the instrument from the scale reading and dividing the remainder by 2. This constant will be given with each instrument.

TRANSMISSION LINE TESTING SET

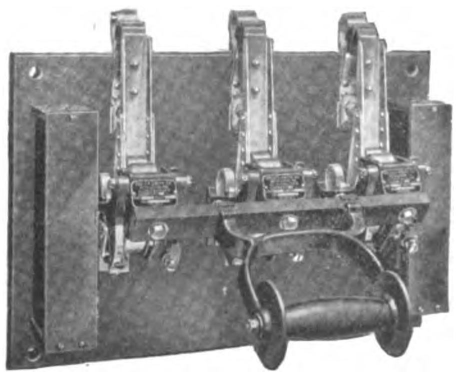
A testing set for use by patrolmen on high-tension transmission lines has just been brought out by the Holtzer-Cabot Electric Co., Mass. With the receiver in the holder, the generator rings through the buzzer. When the receiver is out of the holder it rings direct to line, the receiver at the same time is shunted out by the generator. With the receiver out, the generator will ring ten 1600 ohm bells through a resistance of 4000 ohms.

Portable test set for use by linemen. Made by Holtzer-Cabot Electric Co., Boston, Mass.

The whole outfit, including generator, ringer, transmitter, watch case receiver and box, weighs only 7½ lb.

SELF-TIMING CIRCUIT BREAKERS

The Roller-Smith Company, 233 Broadway, New York City, has developed what is to be known as the self-timing type of circuit breaker. This breaker is designed to trip instantaneously when the load, for which it is adjusted, is applied. Interposed in the path of its trip armature is a pivoted hook shaped barrier under two independent controls, one of which is thermal. The expansion of a metal rod heated at the same rate the motor is heated by the passage of the same current which drives the motor, retracts the barrier and allows the breaker armature to trip if the heating is excessive, no matter how that excess comes about. This cares for the starting current and the variable motor loading protection requirements. The other control is electromagnetic, instantaneously retracting the barrier and allowing instantaneous trip if a heavy overload occurs.



60- *ampere, 250-volt, three-pole, rigid-arm, plain overload circuit breaker with two self-timing attachments; wall mounting. Roller-Smith Co., 233 Broadway, New York.*

These circuit breakers have been designed to take care of the conditions attendant upon normal motor operation. The normal starting current of a motor is well in excess of the value which is the limit of safety for continuous operation and during the starting period the triping point of the circuit breaker should thus be just above normal starting current value, tripping if that valve is exceeded but otherwise remaining closed. If, however, through faulty apparatus or faulty manipulation, the starting current strength is applied too long, the motor would be injured by overheating. The length of time for which the setting remains at the starting current value point must thus be limited to that for which the motor can carry that current without injury. If, with these conditions met, the motor has been brought up to speed, the breaker setting should change itself so that if the normal load current, which is obviously a fraction of starting current, is continuously exceeded, the circuit will be interrupted.

PRESSED STEEL AUTOMATIC STARTER

The advantages of automatic control for machine tools have been so persistently preached by the motor and control manufacturers, that it is doubtful if there remain many operators who are not convinced that this type of control is both economical and productive. This kind of starting gives the operator a sense of relief in knowing that he need not face the possibility of injuring the motor, or his machine, by improper starting. It permits him to concentrate his attention on the work on his machine, insuring a greater output of the finished product.

The Westinghouse Electric & Mfg. Company is now marketing a small compact starter, specially adapted for direct-current motors of 10 h.p. and less.

The complete controller is entirely enclosed in a dust proof case, (approximately 15-in. high, 17-in. long, and 10-in. deep), which may be locked to prevent unauthorized persons tampering with the switches. The knife line switch is operated from the outside of the case by a crank handle extending through one end, thus isolating the operator from current carrying parts. The switch may be locked in the off position if so desired.

The counter emf. method of acceleration is used, and as the time of acceleration is dependent on the motor load, positive protection against too rapid acceleration is assured.

Experience shows that in all ordinary services, motors up to 15 h.p., require only two points of acceleration, and these are obtained in this starter by the use of only one accelerating contactor. Where the starting is exceptionally heavy, as in the case of machine tools with large flywheels, positive pressure blowers, or long line shafting, two accelerating contactors are used, giving three points of acceleration.

The main parts of the contactors are made of pressed steel, thus combining strength, uniformity, and light weight. Provision is made for either conduit or open wiring through the top, bottom, and end of the case opposite the switch handle.

These starters are provided with protection against failure of power, and may be so arranged that either the motor will be started again when the power returns, or it will require the service of the operator to start it.

The latter arrangement is used for machine tools and similar applications where the unexpected starting of the machine might cause injury to the machine, or to its operator.

By using pressure gauges, or other automatic devices in connection with these starters, automatic service may be obtained, and continual operation provided, without any attendent. They are built both with and without provision for dynamic braking, and may also be used with a field rheostat for adjustable speed service.

FARM LIGHTING PLANT

A farm lighting plant that is not equipped with a battery has been brought out by the Electromatic System Company, 2136 Michigan Avenue, Chicago. It is entirely automatic and is designed for use on the farm or in the suburban home, in public garages, stores or theaters, or in any place where light and power are needed. It delivers 115 volts direct from the generator and is started by the turning of the switch at the point where electricity is to be used. It will remain in operation until the entire load has been removed. The plant is made in two sizes.

SENSITIVE BENCH DRILL PRESS

A bench drill press with several novel features has recently been developed by The High Speed Hammer Co., Inc., of Rochester, N. Y. The press is suitable for all work ranging from the smallest to a 3/16 in. hole. The height of the drill is 24-in. over-all and the base is 7½ x 18 in. The standard spindle speeds are 2100 to 6000 rev. per min. but special pulleys can be furnished to give a main spindle speed of 10,000 rev. per min.

A quick adjustable table is provided which has a working surface of 5½ x 5 in. and will take work up to 4⅜ in. in height The surface of the table is ground to insure accuracy and has a self cleaning taper. The base is also provided with a ground working surface 4 x 6 in. and will take work up to 7½ in. in height. The base has an oil groove and self cleaning column support.

The spindle lock permits quick changes of drills without making it necessary for the operators hands to come in contact with belts or pulleys.

The drill is equipped with a 1/10 hp. vertical Robbins & Myers motor.

ELECTRICAL ENGRAVER

The R. I. Electrical Instrument Co., of Providence, R. I., is marketing an electrical engraving device which contains two available range transformers enclosed in an oak case.

The main set of wires leads to the copper electrode which does the engraving; second set leads to a manually controlled switch, located near the point of the pencil. In using this device, the forefinger rests upon this switch, the switch remaining open while the writing or engraving is going on. When the operator wants to raise the pencil from the work, he presses the switch with his finger and breaks the current to prevent flashing or arcing.

The second set of wires which is controlled by the small connecting switch on the pencil, runs back through the instrument board into the interior of the device. On one side dry cells are interposed to give a direct current for operating a circuit braker fastened to the side of the cabinet. Writing with this device, say the makers is as easy as writing on paper with a pencil.

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SMALL GEARED TURBINES

To drive small electric lighting outfits, exciter units for large alternators, or for direct mechanical drive, there has been a demand for a line of steam turbines which would be constructed along the same lines which give durability, ease of adjustment, and high economy to the larger turbine units. To meet this demand, which now comes principally from our new merchant marine for lighting sets, the Westinghouse Electric & Manufacturing Company has developed a line which is being manufactured in sizes from 15 to 50 kw. for direct-current service; from 30 to 50 kw. for alternating-current service, and from 30 to 100 h p. for mechanical drive.

One of the special features on this unit is the automatic throttle valve, operated directly from the governor by means of a connecting rod. This valve is of the balanced type and very sensitive in operation, thus insuring a close speed regulation.

One of the latest refinements provided on very few small turbines, is the overspeed governor release. This is a simple device contained in a small hole drilled in the shaft between pinion and rotor, and it consists of a cylindrical weight held in place by a coil spring surrounding it. In case the turbine should speed up to ten percent. above normal speed, the weight due to centrifugal force, overcomes the spring tension and protrudes a short distance from its normal position. By so doing, it comes in contact with a lug, which, in turn, is fastened to a lever, the movement of which trips the throttle valve catch and allows the valve to be closed by a heavy coil spring.

This line of turbo-generators conforms to the Navy Department's specifications for ship service, being provided in this case with both steam and water-sealed glands, and non-corrosive brass piping.

THE CLEARING HOUSE

Advertisements on this page 5 cents a word. No advertisement accepted for less than $1.00. Electrical Engineering reserves the right to open all letters addressed in its care and agrees to forward only answers that are germane to the product or subject advertised.

DIRECTORY OF CONSULTING ENGINEERS ARCHITECTS and CONTRACTORS

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AIR COMPRESSORS
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Western Electric Co., New York City.

AMMETERS and Voltmeters
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Weston Elec. Inst. Co., Newark, N. J.

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ARMATURES
Chattanooga Armature Works, Chattanooga, Tenn.

BATTERY CHARGERS
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Southern Electric Co., Baltimore, Md.

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Dixon Crucible Co., Jos., Jersey City.

BONDS AND STOCKS
Electric Bond & Share Co., N. Y. City.

BOOKS, Technical & Practical
Technical Journal Co., New York City.

BOOSTERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

BOXES, Conduit
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National Metal Molding Co., Pittsburgh, Pa.

BOXES, Cutout
Adam Electric Co., Frank, St. Louis.
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Adam Electric Co., Frank, St. Louis.
Columbia Metal Box Co., N. Y. City.
National Metal Molding Co., Pittsburg.

BRUSHES, Motors and Generators
Calebaugh Self-Lubricating Carbon Co., Philadelphia, Pa.
Dixon Crucible Co., Joseph, Jersey City.
General Electric Co., Schenectady, N. Y.

BRUSHINGS
National Metal Molding Co., Pittsburgh, Pa.

BUS BAR SUPPORTS
Delta-Star Electric Co., Chicago, Ill.

CABINETS
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Columbia Metal Box Co., N. Y. City.

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CABLE, Insulated
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Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Steel Taped
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Submarine and Lead Covered
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Hazard Mfg. Co., New York City.
Moore, Alfred F., Philadelphia, Pa.
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Rome Wire Co., Rome, N. Y.
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CABLE, Steel Armored
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Roebling's Sons Co., John A., Trenton, N. J.
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Underground
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Standard Underground Cable Co., Pittsburgh, Pa.

CABLE, Junction Boxes
Standard Underground Cable Co., Pittsburgh, Pa.

CARBONS, Brushes
Calebaugh Self-Lubricating Carbon Co., Philadelphia, Pa.
Dixon Crucible Co., Jos., Jersey City.
General Electric Co., Schenectady, N. Y.

CIRCUIT BREAKERS
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Palmer Electric & Mfg. Co., Boston, Mass.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CLEATS
National Metal Moulding Co., Pittsburgh, Pa.

COILS, Armature and Field
Chattanooga Armature Works, Chattanooga, Tenn.

COILS, Choke
Delta-Star Electric Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

COILS, Induction
Thordarson Elec. Mfg. Co., Chicago.

COMMUTATORS
Chattanooga Armature Works, Chattanooga, Tenn.

COIL TAPING MACHINES
Chattanooga Armature Works, Chattanooga, Tenn.

COMPOUNDS, Boiler
Dixon Crucible Co., Joseph, Jersey City.

CONDENSERS
Allis-Chalmers Mfg. Co., Milwaukee.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CONDUCTORS, Armored
National Metal Molding Co., Pittsburgh.
Roebling's Sons Co., John A., Trenton.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT FITTINGS
Columbia Metal Box Co., N. Y. City.
National Metal Molding Co., Pittsburgh.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT, Flexible
American Circular Loom Co., New York City.
National Metal Molding Co., Pittsburgh.
Tubular Woven Fabric Co., Pawtucket.

CONDUIT, Interior
American Circular Loom Co., New York City.
American Conduit Mfg. Co., Pittsburgh.
National Metal Molding Co., Pittsburgh.
Tubular Woven Fabric Co., Pawtucket.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT, Rigid
American Circular Loom Co., New York City.
National Metal Molding Co., Pittsburgh.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONDUIT, Underground
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CONNECTORS, Frankel Solderless
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CONSTRUCTION Material
Southern Electric Co., Baltimore, Md.

CONTROLLERS
Allis-Chalmers Mfg. Co., Milwaukee.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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CORDS
Moore, Alfred F., Philadelphia, Pa.
Samson Cordage Works, Boston, Mass.
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CORD, Arc Lamp
Samson Cordage Works, Boston, Mass.

CORD, Flexible
General Electric Co., Schenectady, N. Y.
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Samson Cordage Works, Boston, Mass.
Southern Electric Co., Baltimore, Md.
Standard Underground Cable Co., Pittsburgh, Pa.

CORD, Telephone
Moore, Alfred F., Philadelphia, Pa.
Standard Underground Cable Co., Pittsburgh, Pa.

CORD, Trolley
Samson Cordage Works, Boston, Mass.

CROSS-ARMS
Southern Exchange Co., The, New York City.
Western Electric Co., New York City.

CUT-OUTS
Brady Elec. & Mfg. Co., New Britain, Conn.
Cutter Co., Geo., South Bend, Ind.
General Electric Co., Schenectady, N. Y.
Palmer Electric Mfg. Co., Boston.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

DYNAMOS AND MOTORS (Second Hand)
Chattanooga Armature Works, Chattanooga, Tenn.

ELECTRICAL REPAIRING
Chattanooga Armature Works, Chattanooga, Tenn.

ELECTRIC FIXTURES
Adam Electric Co., Frank, St. Louis.
Luminous Specialty Co., Indianapolis.
Southern Electric Co., Baltimore, Md.

ENGINES, Gas and Gasoline
Allis-Chalmers Mfg. Co., Milwaukee.
General Electric Co., Schenectady, N. Y.
Westinghouse Machine Co., E. Pittsburgh, Pa.

ENGINES, Steam
Allis-Chalmers Mfg. Co., Milwaukee.
Westinghouse Machine Co., E. Pittsburgh, Pa.

ENGINEERS, Consulting
Arnold Co., The, Chicago, Ill.
Byllesby, H. M. & Co., Chicago, Ill.
Cooper, Hugh L. & Co., N. Y. City.
Sanderson & Porter, N. Y. City.
Stone & Webster Boston, Mass.
White & Co., J. G., New York City.

ETCHING SOLUTION
Union Electric Co., Pittsburgh, Pa.

FANS, Exhaust
Robbins & Myers Co., Springfield, Ohio.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

FAN MOTORS
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, Ohio.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

FIBRES
Continental Fibre Co., Newark, Dela.

FINANCIAL
Electric Bond & Share Co., N. Y. City.

FIXTURES, Lighting
Adam Electric Co., Frank, St. Louis.
Luminous Specialty Co., Indianapolis.
Southern Electric Co., Baltimore, Md.

FRICTION Tape and Cloths
Okonite Co., The, New York City.

FROSTING SOLUTION
Union Electric Co., Pittsburgh, Pa.

FUSES, Electric
Delta-Star Electric Co., Chicago, Ill.
Economy Fuse & Mfg. Co., Chicago.
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City.

FUSES, Refillable
Economy Fuse & Mfg. Co., Chicago, Ill.

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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GLOBES, SHADES, Etc.
General Electric Co., Schenectady, N. Y.

GRAPHITE
Dixon Crucible Co., Jos., Jersey City

HAND LAMPS, Electric
Southern Electric Co., Baltimore, Md.

HANGERS, Cable
Standard Underground Cable Co., Pittsburgh, Pa.

HEATING Apparatus, Elec.
General Electric Co., Schenectady, N. Y.
Russell Electric Co., Chicago, Ill.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

HOISTS, Electric and Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

HYDRAULIC MACHINERY
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

INDICATORS
Duncan Electric Co., Lafayette, Ind.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

INSTRUMENT, Electrical
Duncan Elec. Mfg. Co., Lafayette, Ind.
General Electric Co., Schenectady, N. Y.
Norton Electrical Inst. Co., Manchester, Conn.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Inst. Co., Newark

INSULATORS
General Electric Co., Schenectady, N. Y.
Locke Insulator Co., Victor, N. Y.
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International Insulating Corp., New York City
Moore, Alfred F., Philadelphia, Pa.
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

INSULATOR PINS
Southern Exchange Co., The, N. Y. C.

IRONS, Electrical
General Electric Co., Schenectady, N. Y.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMP CORD
Moore, Alfred F., Philadelphia, Pa.
Samson Cordage Works, Boston, Mass.
Standard Underground Cable Co., Pittsburgh, Pa.

LAMP GUARDS
McGill Mfg. Co., Valparaiso, Ind.

LAMPS, Carbon Arc
General Electric Co., Schenectady, N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Flaming Arc
General Electric Co., Schenectady N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Incandescent
General Electric Co., Schenectady. N. Y.
National Lamp Works, Nela Park, Cleveland, Ohio
Southern Electric Co., Baltimore, Md.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Westinghouse Lamp Co., N. Y. City

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General Electric Co., Schenectady. N. Y.
Southern Electric Co., Baltimore, Md.

LANTERNS, Electric
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LIGHTNING ARRESTERS
Delta-Star Electric Co., Chicago, Ill.
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General Electric Co., Schenectady. N. Y.
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Calebaugh Self-Lubricating Carbon Co. Inc., Philadelphia, Pa.
Dixon Crucible Co., Jos., Jersey City.
Galena Signal Oil Co., Franklin, Pa.

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Erdle Perforating Co., Rochester, N. Y

MAGNET WIRE
American Steel & Wire Co., N. Y. C.
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Western Electric Co. New York City

MECHANICAL STOKERS
Westinghouse Machine Co., E. Pittsburgh, Pa.

MERCURY RECTIFIERS
Cooper-Hewitt Electric Co., Hoboken, N. J.

METAL, Perforated
Erdle Perforating Co., Rochester, N. Y.

METAL PUNCHING
Erdle Perforating Co., Rochester, N. Y

METALS
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METERS
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Weston Elec. Inst. Co., Newark, N. J.

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General Electric Co., Schenectady, N. Y.
McGill Mfg. Co., Valparaiso, Ind.
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Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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PHOTOMETER Standards
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PLATINUM
American Platinum Works, Newark.
Baker & Co., Newark, N. J.

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Adam Electric Co., Frank, St. Louis
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General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

POLES, Ornamental Street
Brady Elec. & Mfg. Co., New Britain, Conn.

POLES, Brackets, Pins, Etc.
Brady Elec. & Mfg. Co., New Britain, Conn.
Southern Exchange Co., The, N. Y. C.
Western Electric Co., New York City

POT-HEADS
Brady Elec. & Mfg. Co., New Britain, Conn.
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.

PRODUCERS, Gas
Westinghouse Machine Co., E. Pittsburgh, Pa.

PUMPS
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

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General Electric Co., Schenectady, N. Y.
Roebling's Sons Co., John A., Trenton, N. J

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General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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REFLECTORS
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General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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RESISTANCE UNITS
Dixon Crucible Co., Jos., Jersey City
General Electric Co., Schenectady, N. Y.

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General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

ROSETTES
National Metal Molding Co., Pittsburgh, Pa.

SCREENS AND SIEVES, Perforated
Erdle Perforating Co., Rochester, N. Y.

SEARCHLIGHTS
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City

SEWING Machine Motors
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.
Wisconsin Elec. Co., Milwaukee, Wis.

SOCKETS and Receptacles
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.

SOCKETS, Turndown
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SOLDERING IRONS
General Electric Co., Schenectady, N. Y.
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SOLDERING MATERIAL
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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SOLENOIDS
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STAGE Lighting Apparatus
General Electric Co., Schenectady, N. Y.

STAPLES, Insulating
American Steel & Wire Co., N. Y. C.

STARTERS & CONTROLLERS, Motor
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

STOCKS AND BONDS
Electric Bond & Share Co., N. Y. City

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STRAINERS, Perforated
Erdle Perforating Co., Rochester, N. Y.

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SUPPLIES, Electrical
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General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

SUPPLIES, Telephone
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City

SURFACING, Steel and Tin
Erdle Perforating Co., Rochester, N. Y.

SWITCHBOARD Supplies
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SWITCHBOARDS, Light and Power
Adam Electric Co., Frank, St. Louis
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Enclosed
Palmer Electric & Mfg. Co., Boston, Mass.

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SWITCHES, Flush and Snap
National Metal Molding Co., Pittsburgh, Pa.
Southern Elec. Co., Baltimore, Md.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Fuse
General Electric Co., Schenectady, N. Y.
Palmer Electric & Mfg. Co., Boston, Mass.

SWITCHES, Knife
Adam Electric Co., Frank, St. Louis
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Oil
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SWITCHES, Pole Top
Delta-Star Elec. Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.

SWITCHES, Remote Control
General Electric Co., Schenectady, N. Y.
Palmer Electric & Mfg. Co., Boston, Mass.

TAPE
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.

TELEPHONE Equipment
Western Electric Co., New York City

TERMINALS, Cable
Dossert & Co., New York City
Standard Underground Cable Co., Pittsburgh, Pa.

TESTING, Electrical
Electrical Testing Laboratories, New York City

THEATER DIMMERS
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TOOLS, Linemen's
Western Electric Co., New York City

TRANSFORMERS
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Duncan Elec. Mfg. Co., Lafayette, Ind
Enterprise Electric Co., Warren, O.
General Electric Co., Schenectady N. Y.
Kuhlman Electric Co., Bay City, Mich
Moloney Electric Co., St. Louis, Mo.
Packard Electric Co., Warren, O.
Pittsburgh Transformer Co., Pittsburgh
Thordarson Elec. Mfg. Co., Chicago
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J

TRANSFORMERS, Bell Ringing
Southern Electric Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

TURBINES, Steam
Allis-Chalmers Mfg. Co., Milwaukee Wis.
General Electric Co., Schenectady N. Y.
Leffel & Co., James, Springfield, O.
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

VACUUM CLEANERS
Western Electric Co., New York City

VENTILATORS
Erdle Perforating Co., Rochester, N. Y

WASHING MACHINES Electric
Western Electric Co., New York City

WASHERS, Iron, Steel and Mica
Erdle Perforating Co., Rochester, N. Y

WATER Wheels and Turbines
Allis-Chalmers Mfg. Co., Milwaukee Wis.
Leffel & Co., James, Springfield, O.

WATTMETERS
" See Instruments, Electrical

WIRES AND CABLES
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American Steel & Wire Co., N. Y. C
Detroit Insulated Wire Co., Detroit
General Electric Co., Schenectady N. Y.
Lowell Ins. Wire Co., Lowell, Mass.
Moore, Alfred F. Philadelphia, Pa.
Okonite Co., The, New York City
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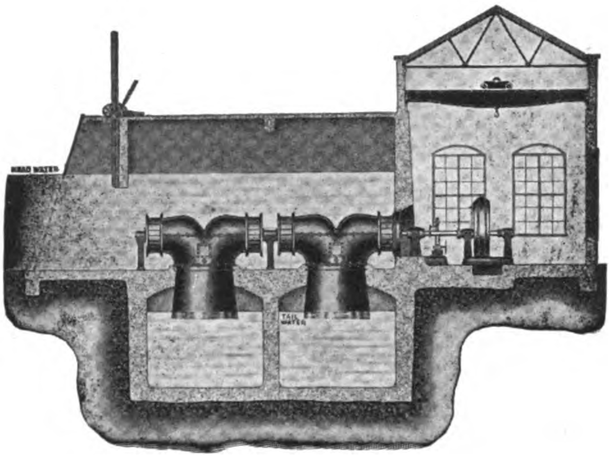

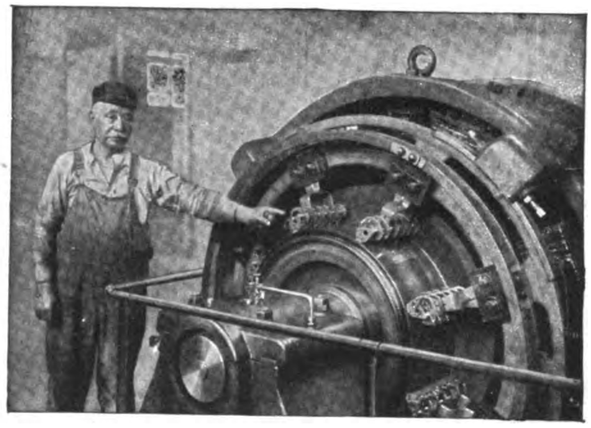

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Volume 52. No. 1 JULY, 1918 20 Cents per Copy

Electrical Engineering

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

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GEO. A. WARDLAW, Editor

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MEMBER ABE

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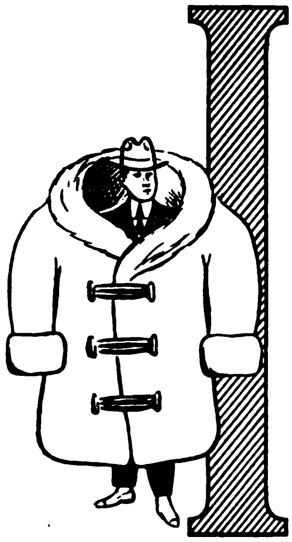

IT was the brain of Alexander H. Stephens that directed the Confederate Cabinet, and his was the skill that planned the foreign alliances that were so nearly successful. When Lincoln, who had heard much of Stephens, met him for the first time he was thunderstruck at sight of the diminutive, sickly man who stood before him, the body seeming altogether too small for the soul that animated it. Stephens wore a big ulster, and Lincoln looked to see a large figure appear when it was taken off. "Well," he remarked with one of his peculiar smiles, "you are the biggest pea in the smallest pod I ever met."

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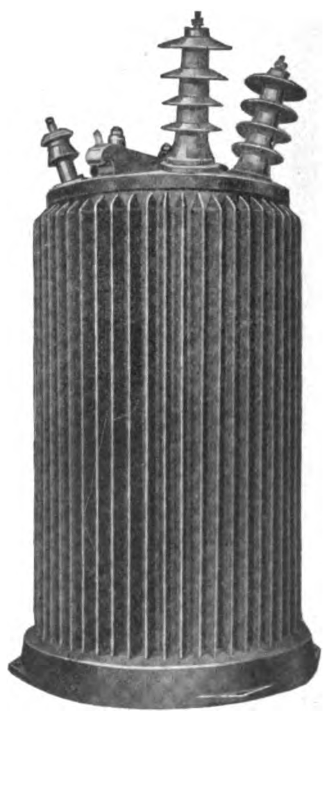

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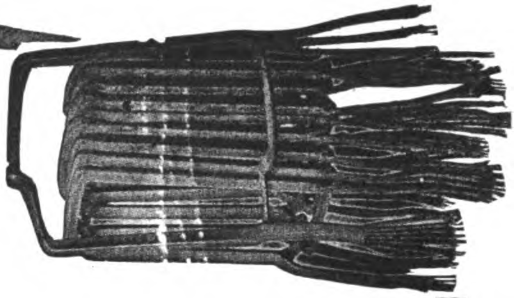

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Wm. R. Gregory Co., New York

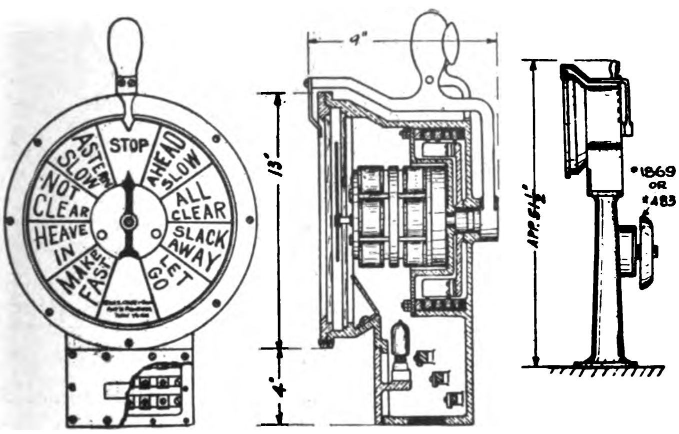
Vol. 52 **JULY, 1918** **No. 1**

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



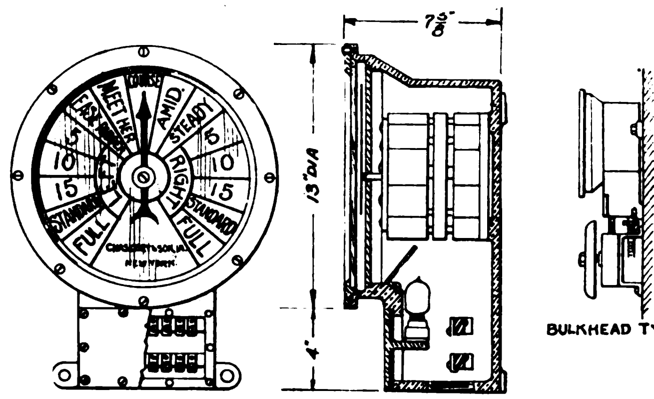
ELECTRIC DOCKING TELEGRAPH

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.

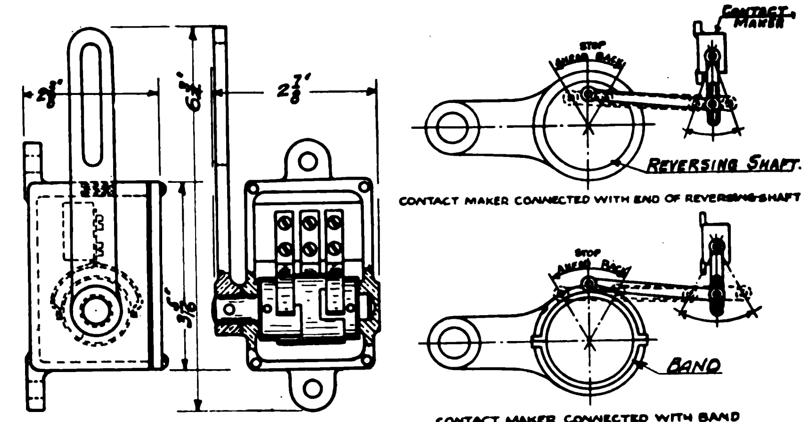
That the mariner today is just as safe in a fog bank off the coast as if the sun were shining and the fair blue of the sky all around him, is due entirely to those men whose conviction in the transmission of sound through water was firm enough to lead them into a great expenditure of time, energy, and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



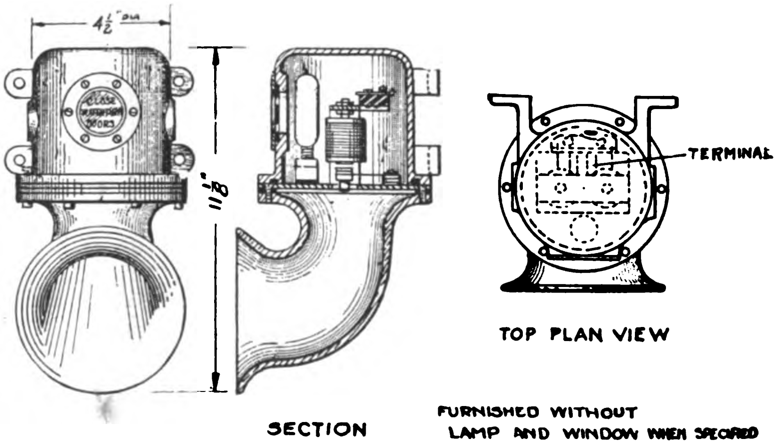
CONTACT MAKER FOR ELECTRICAL ENGINE DIRECTION INDICATOR

tical purposes as all the large maritime nations have equipped their coasts with submarine bells.

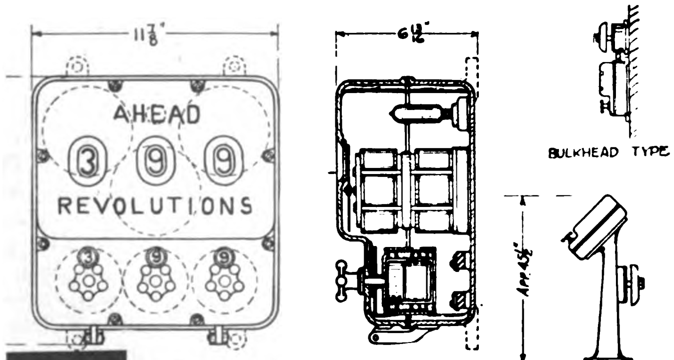
The second part of this problem; namely, the transmission of messages under water between two vessels, or between a vessel and the shore, is more complicated. The apparatus is also too expensive for general adoption in merchant ship practice. It consists broadly of an electrical oscillator which impresses 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.

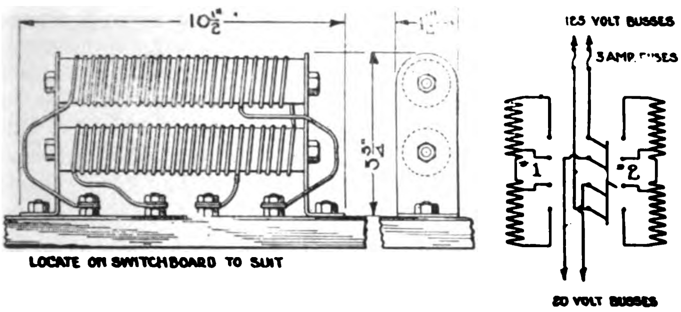


COMBINED TRANSMITTER-INDICATOR ENGINE REV. TELEGRAPH

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

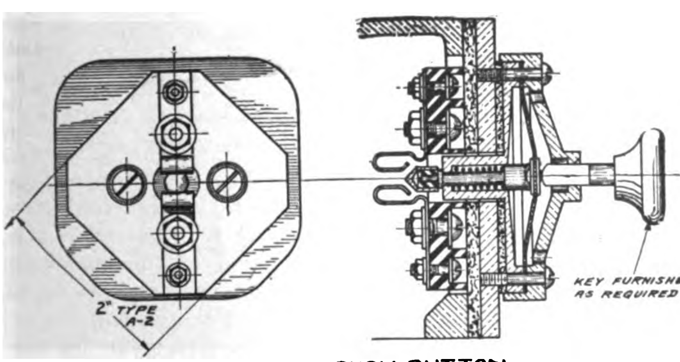


RESISTANCE UNIT FOR LOW VOLTAGE INTERIOR COMMUNICATING APPARATUS.

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."

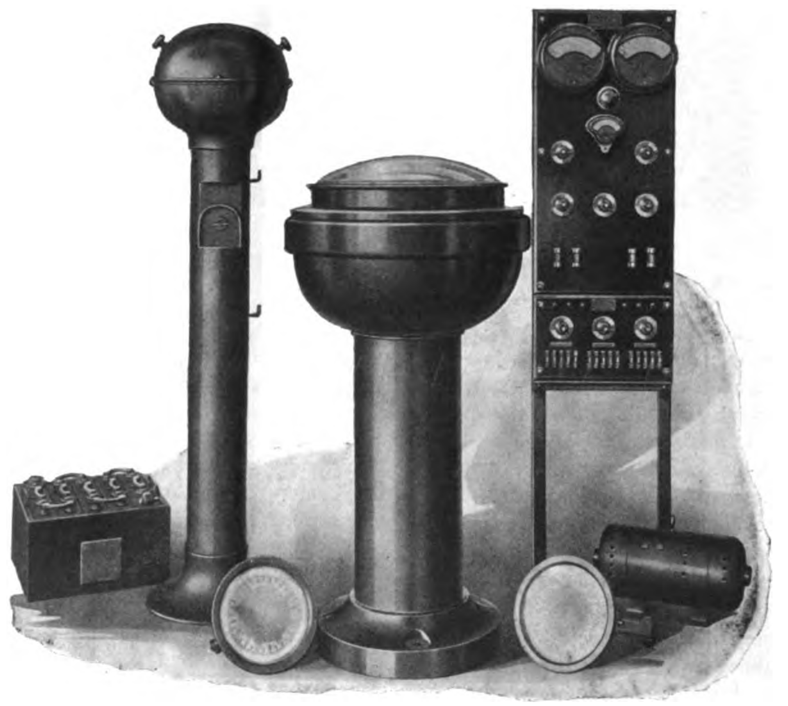
In later years the names of two men are inscribed upon the practical development of this revolutionizing device, that of Anschutz of Germany, and Sperry of the United States. A detail description of the work of these men would be out of place, as consideration must be given solely to the application 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

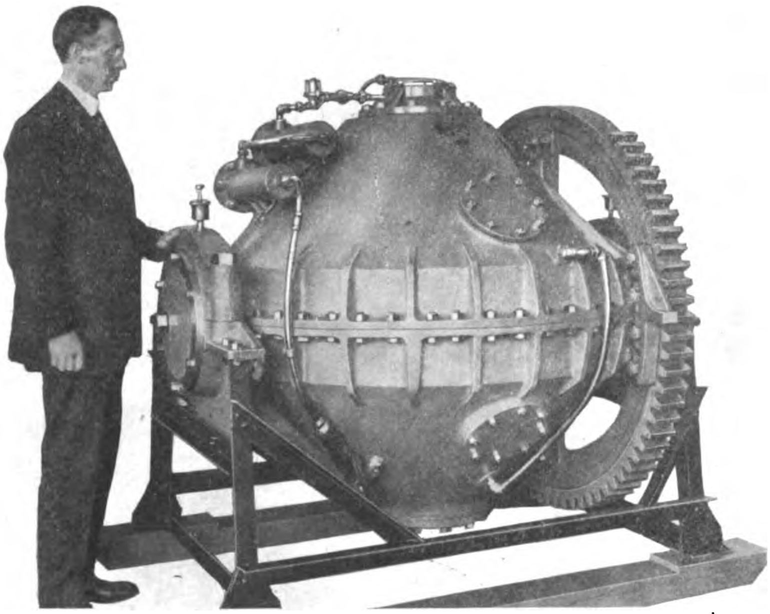


Sperry Commercial gyro-compass equipment. Sperry Gyroscope Co., Manhattan Plaza, Brooklyn, N. Y.

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)*

THREE AND FOUR-WAY SWITCH CIRCUITS

By Terrell Croft

Application of Switches

The application of three-way and four-way switches offers a wide range of combinations for multiple-location control of interior wiring lighting circuits. A single lamp or a group of lamps may be so arranged, in relation to two three-way switches, that the lamp or lamps can be lighted or extinguished by either of the switches independently of the other. If additional control locations are desired, four-way switches may, as will be described later, be called to the circuit to provide them. The wiring connections and diagrams for these various switch circuits will be considered.

Utilized as Single-Pole Switches

Three-way and four-way switches may be utilized as single-pole switches if connected in a lighting circuit, as shown in Fig. I and II. These methods, of course, provide only one control

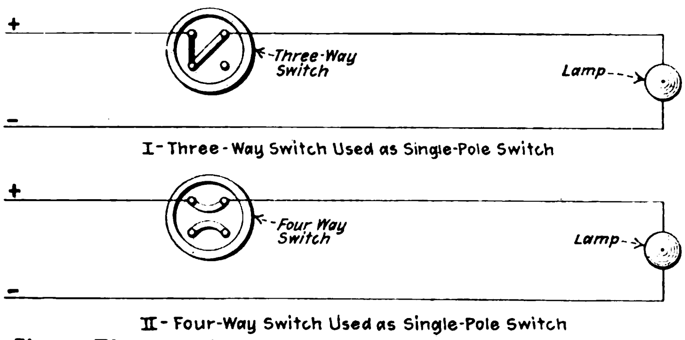


Fig. 1.—Three and four-way switches used as single-pole switches.

location on the lighting circuit, in which they are installed. While the usage of Fig. 1 is uneconomical, it may, in emergencies be employed when single-pole switches are not available.

Diagrams of Connections

Diagrams for simple or elementary three-way switch circuits for the control of the circuits from two locations are shown for surface snap switches in Figs. 2, 3, 4, and 5. Fig. 5 is a phantom view showing the actual connections of the switches for such service, while Figs. 2 and 3 are diagrammatic representations. From the connections of these two illustrations it is evident that at no time, either one of the switches being open, are both polarities of the feeding circuit present in either switch. This feature renders a connection of this type strictly in compliance with wiring rules which are enforced in certain cities and which are based on *National Electric Code Rule 24c. Fig.* 6 shows the connections where flush, push-button switches are used.

Feeding Three-Way Switch Circuit

A three-way switch circuit which is fed from different branches is outlined in Fig. 7. It will be noted that this connection is essentially the same as the connections of Figs. 2 and 5 with the exception that the feed wires approach the switch-and-lamp circuit from opposite sides and feed from different branch circuits. In making the connections of Fig. 7, it is imperative

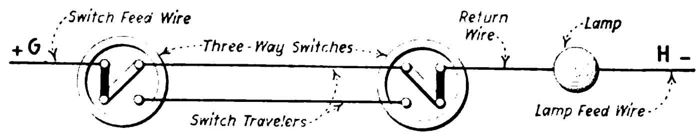


Fig. 2—Simple three-way switch circuit feeding from each end.

that proper care be taken to insure that the wires of correct polarities enter the switch-and-lamp circuit from each of the branch circuits, *H* and *G*. Otherwise the system would be inoperative. Wherever this system is utilized, the switch-feed and the lampfeed wires should each be protected by its own single-

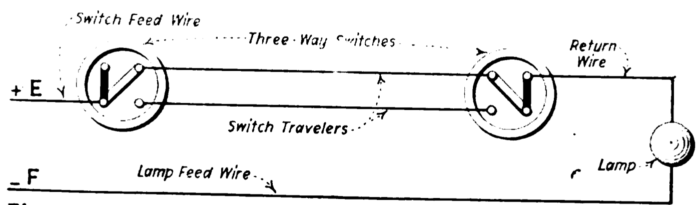


Fig. 3—Three-way switch circuit feeding from one end only.

pole cut-out to satisfy *code* requirements. Serving a three-way switch circuit from two different branch circuits as in Fig. 7 is not recommended because of complications which may de-

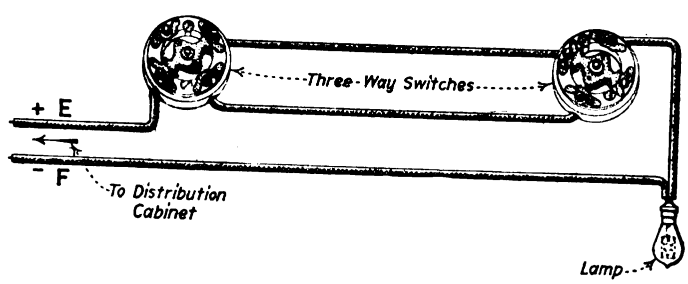


Fig. 5—Phantom diagram of a three-way switch circuit.

velop when trouble occurs in the circuit. It is, however, sometimes advisable when wiring finished buildings so that the taking up of extra flooring may be avoided, and for other pos-

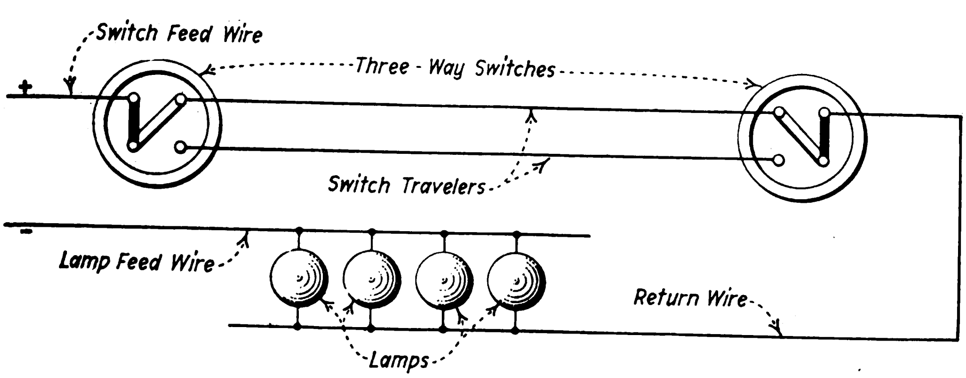


Fig. 4—Three-way switch circuit feeding from one end, for control of several lamps.

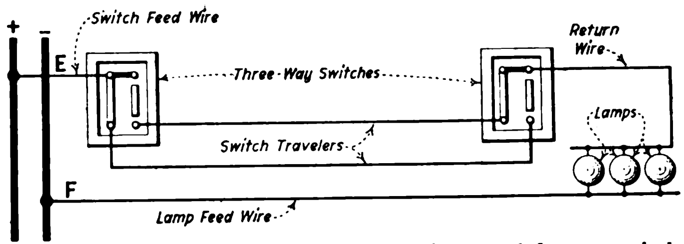


Fig. 6—Wiring diagram for three-way flush push-button switch circuit.

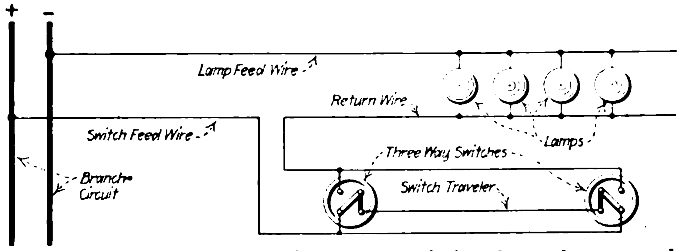


Fig. 8—Three-way switch circuit for switches located near each other.

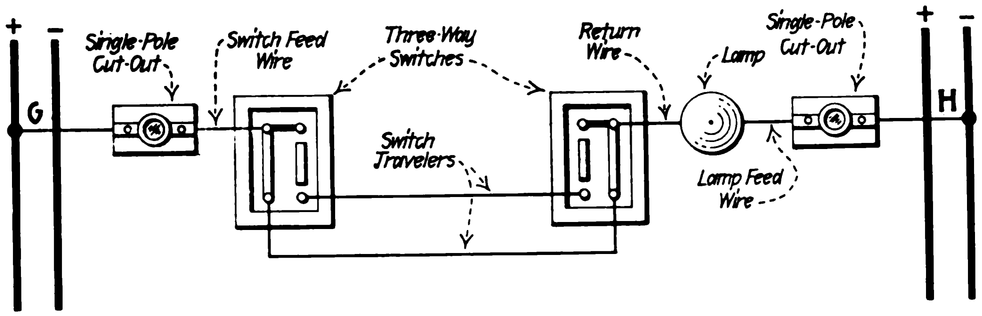


Fig. 7—Three-way switch circuit feeding from two different branches.

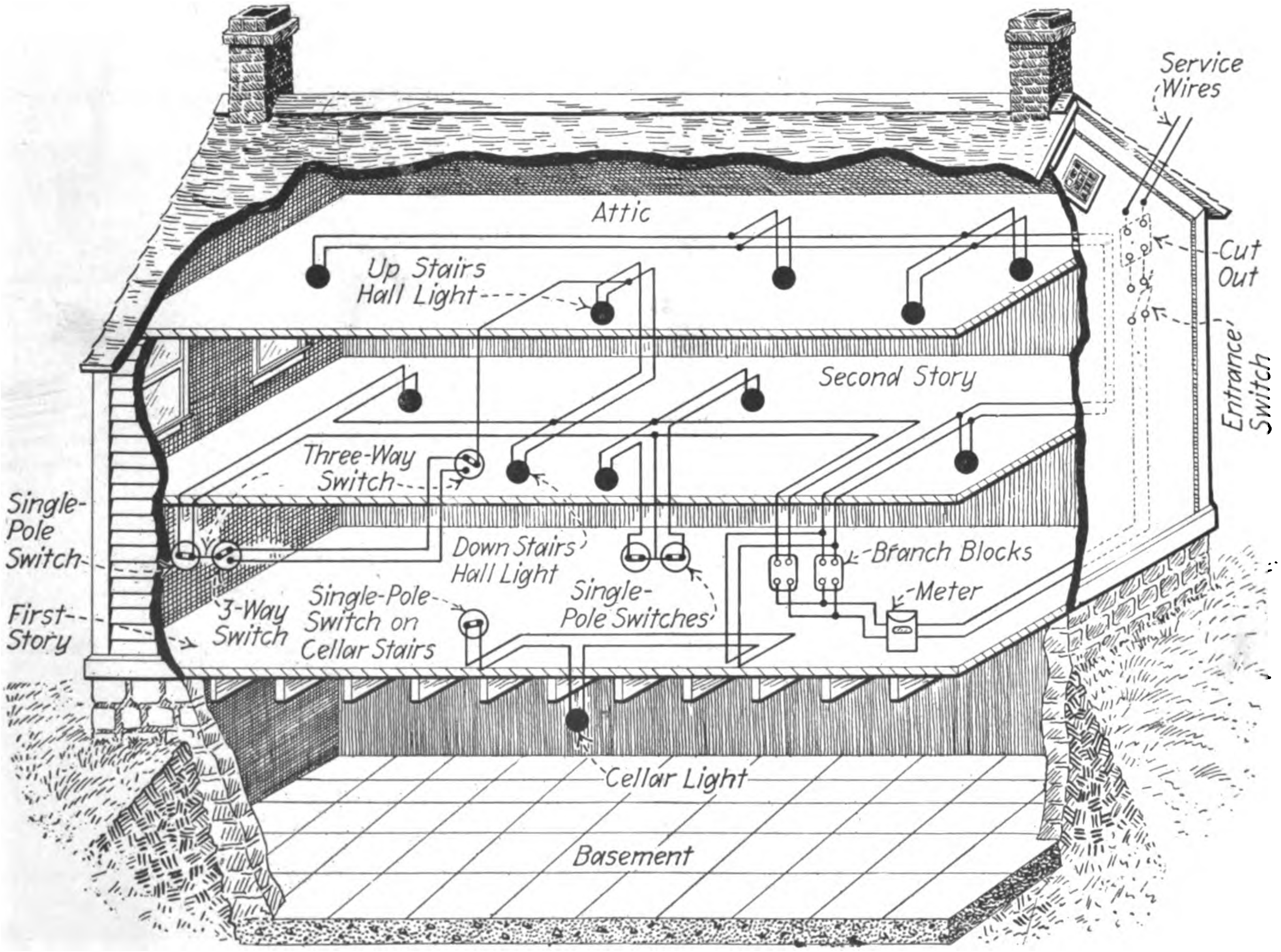


Fig. 10—Wiring in a cottage showing three-way switch circuit for control of hall lights.

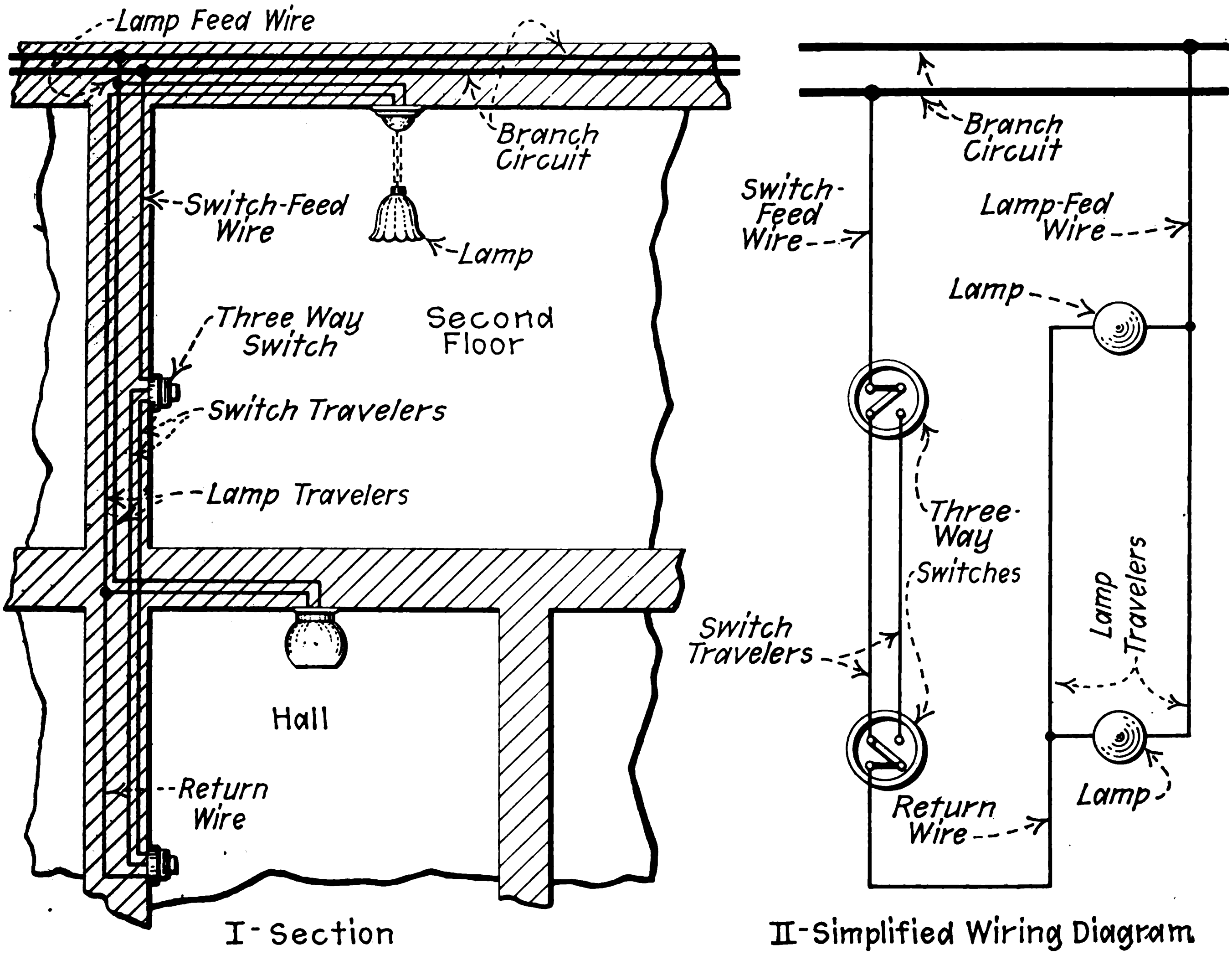


Fig. 11—Lay out and connection diagram for a residence three-way switch circuit.

sible economic reasons, to install a three-way switch circuit as shown in Fig. 7.

The wiring for a three-way switch circuit which may be used when the switches are located near each other is illustrated in Fig. 8. This is an adaptation of the "Carter" system of wiring which will be described more in detail in a following section. the lamp-feed wire and the switch-feed wire tap the branch circuit are spaced a considerable distance apart. The reason for this is that a wireman may, under these conditions, have difficulty in tracing out the branch circuit. Such an incorrect connection is shown in the diagram of Fig. 9 where *C* and *D* are both connected to wires of the same polarity. When a three-way

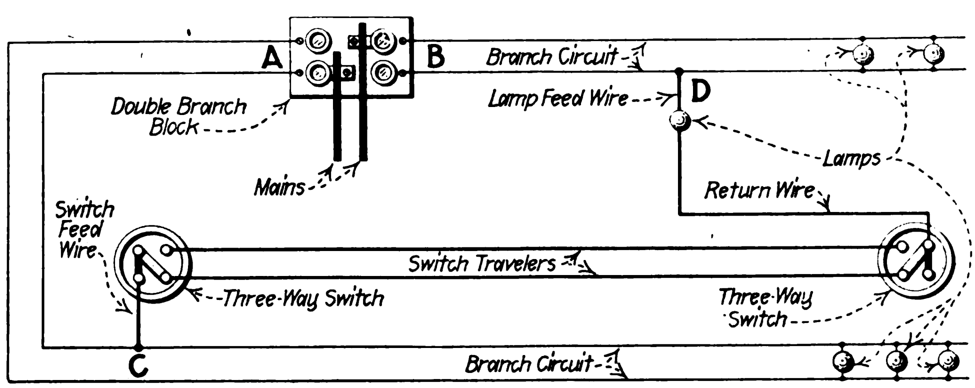


Fig. 9—Showing three-way switches with lamp and switch feed wires improperly connected to the same side (polarity) of the branch circuits.

As will be noted, this provides a convenient arrangement in the circuit lay-out.

Incorrect Connections

Incorrect three-way switch circuit connections are sometimes made in an installation, especially where the locations at which switch installation is made as shown in this illustration, it is said to be "off circuit" and, obviously, will not operate. The most effective way of correcting such a difficulty, especially after the job has been completed, is to reverse the connections at the branch block, either at *A* or at *B*, Fig. 9.

(*To be continued*)

NATIONAL ELECTRIC LIGHT ASSOCIATION CONVENTION

Atlantic City June 13-14, 1918

As announced in our last issue, the thirty-fourth annual convention of the National Electric Light Association, which was held at the Hotel Traymore, Atlantic City, N. J., on June 13, 14 was devoted entirely to electrical matters in their relation to the war. President J. W. Lieb presided. As usual, the delegates were welcomed by the mayor of Atlantic City. In his opening address Mr. Lieb, sounding the keynote of the convention, said:

"This important industry employs 920,000 men, represents $10,750,000,000 invested capital, and annual output of $2,675,000,000. Of these totals the electric light and power industry represents 125,000 men, $3,000,000,000 invested capital, and annual business of $575,000,000. It assumes an importance in our economic structure second only to our great railroad systems."

In the absence of W. H. Atkins, treasurer, his report was read by Frederick Schmitt.

T. C. Martin presented his annual report as secretary.

After Walter Neumuller had read the report of the membership committee President Lieb called upon the sections.

R. J. McClelland, for the Technical and Hydroelectric Section, appointed a nominating committee.

William Schmidt, Jr., reporting for the Accounting Section, announced the following officers for 1918-19: Chairman, Paul R. Jones; vice-chairman, R. W. Symes; treasurer, C. E. Calder; secretary, Frederick Schmitt.

E. S. Mansfield reported as chairman of the Electric Vehicle Section and appointed a nominating committee.

A brief report was also made by E. A. Edkins, chairman of the Commercial Section, and a nominating committee was similarly appointed.

An address by Arthur Wright of London, England, who was in this country recently, on "War by Civilians," was then read by Secretary Martin.

E. W. Lloyd opened discussion on "Line Extensions in War Time." W. H. Johnson, T. I. Jones, C. D. Marsh, D. H. McDougall, James T. Hutchins, M. R. Bump, V. E. Bird, L. H. Scherck, H. C. Abell, W. P. Schwabe and J. W. Lieb took part in the discussion.

Thursday afternoon's session was devoted to reports from three committees—the National Committee on Gas and Electric Service, J. W. Lieb chairman; the National Committee on Public Utility Conditions, P. H. Gadsden, chairman; and tric Service. J. W. Lieb is chairman; the National Committee the public policy committee, W. W. Freeman chairman. These reports were followed by a symposium on labor problems of the hour.

Mr. Freeman's report showed the effects of the war upon the public utilities. On the subject of meeting the increased expenses due to the war he said:

"The utilities companies do not ask or desire war profits. They are, however, amenable to the same axiomatic laws as other lines of business and cannot alter the rules of arithmetic in their favor or make their dollars go any further in paying bills than can others. This merely means that rates absolutely must be increased, as necessary, to meet new conditions."

"We are absolutely united in the idea that all other interests and considerations must be secondary to the quickest possible winning of the war," he concluded, "and the victory of the Allies must be complete and final, no matter how long it takes or how much its costs."

Flag Day exercises, with bugle, the reading of "The American's Creed" by Secretary Martin and the unfurling of the flag opened the Friday morning session.

President Lieb announced the appointment of a committee on line extensions as recommended by E. W. Lloyd on Thursday. The committee is: E. W. Lloyd, chairman; R. S. Hale, Alex Dow, H. C. Abell and M. R. Bump.

Past-president Herbert P. Wagner opened the discussion on "The Coal Situation as Affecting Public Utilities." This proved to be the most pointed discussion of the convention. Among those who took part in this animated discussion were Messrs: Torchio, Orrok, Wells, Stuart, McClelland, Bolton, Dow, and Gossler.

This important subject was also discussed at the dinner held at the Traymore on Thursday evening, June 13. At this meeting P. B. Noyes, from the Fuel Administrator's office in Washington, said:

"I would not need the testimony I have seen since coming here with you as to the spirit of this association to say what I have long ago learned, that we have no monopoly of patriotism in Washington. We recognize that there is just as much patriotism in a group like this one assembled here as in any group that could be got together in Washington, no matter who they were, so I shall waste none of your time in a patriotic address, trying to persuade you to do something for the Fuel Administration.

"When I tell people at this time of the year I believe there will be a greater shortage of coal this year than last year, I find that many men are surprised, with eight months before us to prepare for next winter, and they say, why don't you prevent it? As I have studied the problem, there is no other problem that comes to us that could not be solved by American pluck and ingenuity in eight months.

"In the coal business, as most of you realize, we are dealing in a business which has enormous physical proportions. It is beyond anything else that we undertake to do in this country. I made a calculation to illustrate it the other day. The coal movement in the United States is so much larger than the food movement that, for instance, all the wheat that is raised in the country would be moved in twenty-six days of the coal movement. Speaking of the cotton crop, a big crop, with millions of bales, that could be moved in one and one-third days of the time it takes to move the coal supply, at 9 o'clock on the second morning you would have it shipped to its destination. All the grain and the entire crops moved in this country last year, every pound of it, would be moved in fifty-four days, or something less than two months of the coal movement.

"Now, when you start with that idea that you are dealing with such an enormous physical problem that time must be an element, you realize that our railroads, before this war began, were burdened; you know we were having our embargoes, and there has been very little done since that time to increase railroad facilities until very recently. Last year, 1917, we mined and delivered more than 50,000,000 tons in excess of any previous year. This year our increase indicates that we must mine and distribute 100,000,000 tons more than last year if we are to satisfy all the demands for coal.

"Our figures, as compiled during the last three months, carefully, industry by industry, show requirements of over 80,000,000 tons, and I know, and many of you realize, that we must recognize an increasing demand from week to week. There never is a week goes by that something does not come up that shows us we have not got the whole demand. So we must mine 100,000,000 tons more than we did last year; that is, more than 220,000,000 tons in excess of anything mined before this war.

"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."

At the symposium already referred to, which was postponed from late in the afternoon until the evening D. H. McDougall, assistant general manager Toronto (Canada) Power Company and presidenet of the Canadian Electrical Association, gave a description of the work being done in Canada in training returned Canadian soldiers. James T. Hutchings, Rochester Railway & Light Company, Rochester, N. Y., told of the "Rochester plan" for helping co-operatively to man the local munition plants without disturbing labor in other manufacturing plants unduly.

Schuyler S. Wheeler, president Crocker-Wheeler Company, Ampere, N. J., who has but recently returned from France, spoke on employing the blinded soldier in electrical factory and other work.

The committee on Doherty and Billings prize competition reported as follows:

Doherty Medal—H. C. Pollak, Milwaukee Electric Railway & Light Company; subject, "The Electric Range as a Distribution Engineer's Problem."

Billings Prize—G. B. Springer, Commonwealth Edison Company; subject, "Underground Construction."

Honorable Mention—B. H. Blaisdell, Manila Electric Railway & Light Company; subject, "A Kilowatt-hour and the Coal Required to Produce It." Carl Horine, Commonwealth Edison Company; subject, "Electrolytic Chlorine."

W. F. Wells, of the Brooklyn Edison Company was elected president of the asocsiation for the ensuing year.

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HOW EFFICIENT ARE WE?

Perhaps you are reading this under the glow of an electric light. Stop reading and look at it, look at the next one you see. A great deal more efficient than grandmother's tallow dip, isn't it? The transformation of energy that makes it possible is inteesting—enlightening when viewed through the eyes of the conservationist, or efficiency engineer. But efficient as is the electric light, it shows beautifully how inefficient in some respects is our vaulted efficiency. It shows the great need for industrial standardization.

We have been developing the boiler and steam engine for two centuries; to-day we think them perfect. Every pound of coal contains an amount of energy which is available when released—burned under the boiler. Let us assume that the coal is being burned in an "uplifted" power station, where economy and efficiency are in order, waste at a minimum.

The loss begins at the very beginning; one percent. of the coal, unburned, falls through the furnace grate. A further loss of twenty-two percent. follows in the burning, due to heat escaping through the chimney. Radiation from boiler, engine and auxiliary apparatus increases the loss by ten and a half percent. Steam exhaust causes a loss of fifty-seven percent. What is left of the energy contained in the original coal? A little over nine percent. Economizers make little difference.

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, Circular 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.

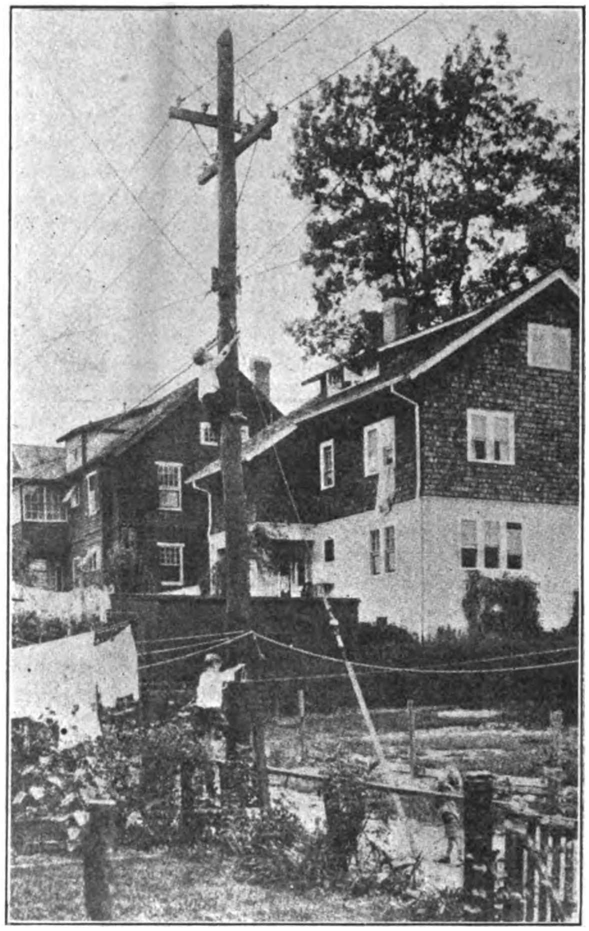


Fig. 3.—Illustration of possible danger to children climbing electric light poles.

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.

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 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.

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.

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.

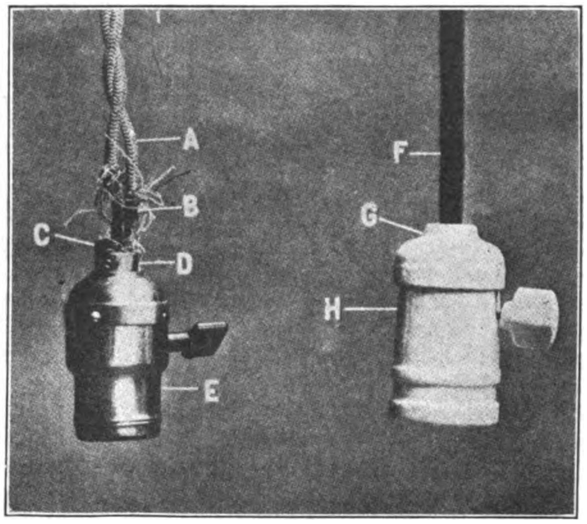


Fig. 5.—Examples of bad and good methods used in portable lighting.

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 ana 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

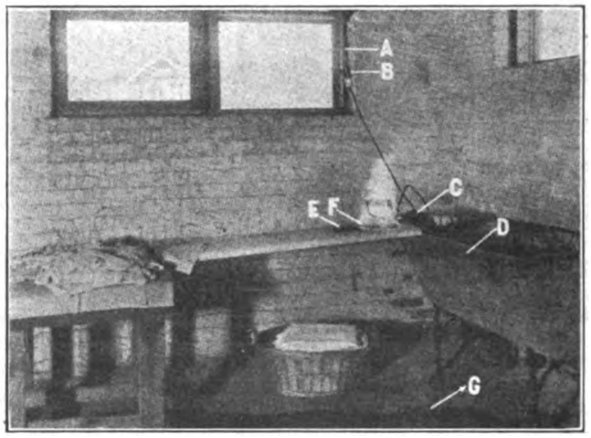


Fig. 6.—An improperly equipped and inadequately protected arrangement.

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.

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.

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.

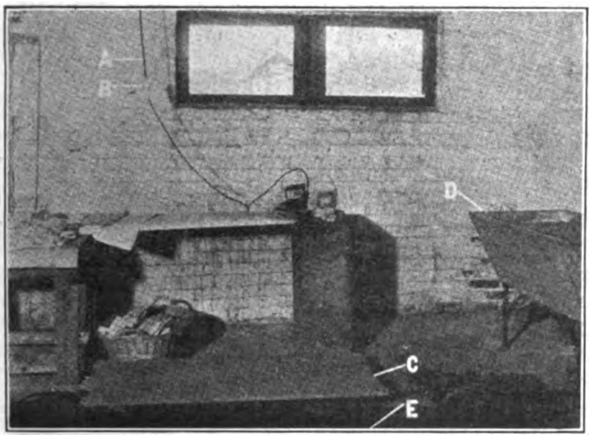


Fig. 7.—A properly equipped and adequate protected arrangement

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 adequately 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.

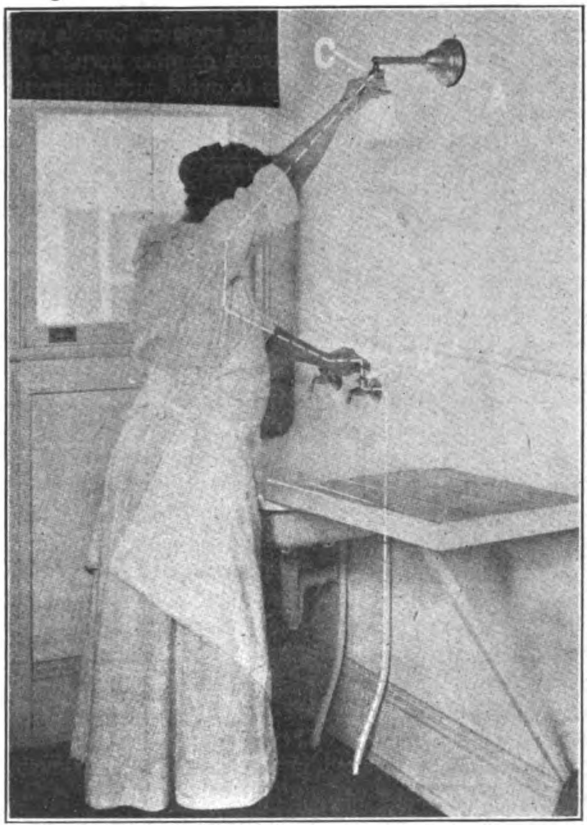


Fig. 8.—Illustration of the possible danger from shock by the passage of electricity from the metallic undergrounded fixture C. (see insulating ring at base of fixture A,) through the body to the grounded water faucet at B.

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.

tion 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

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

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, deprecia-

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.

(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.

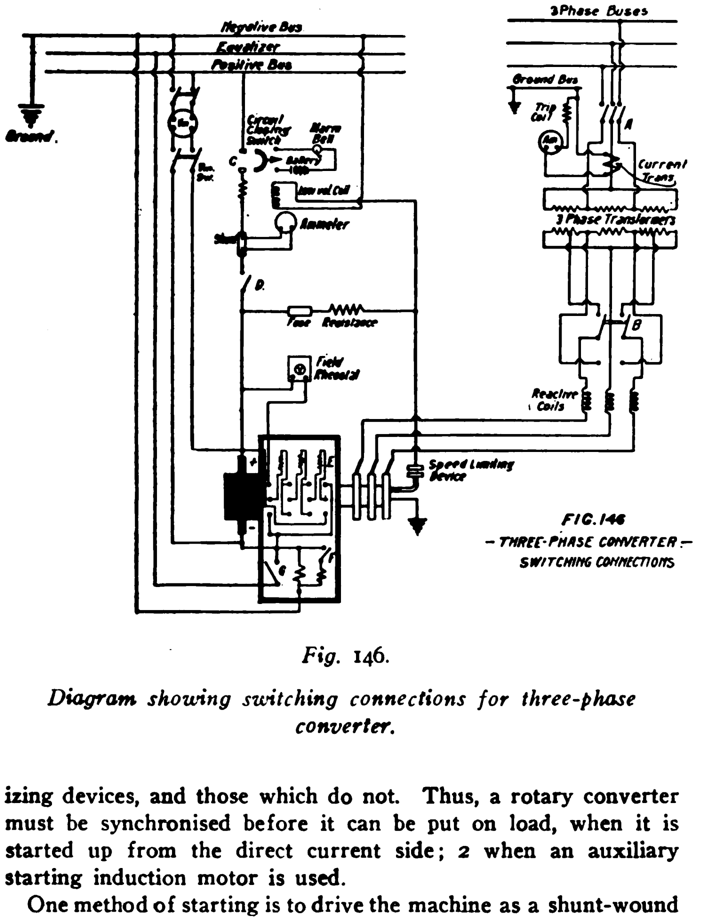


Fig. 146.

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

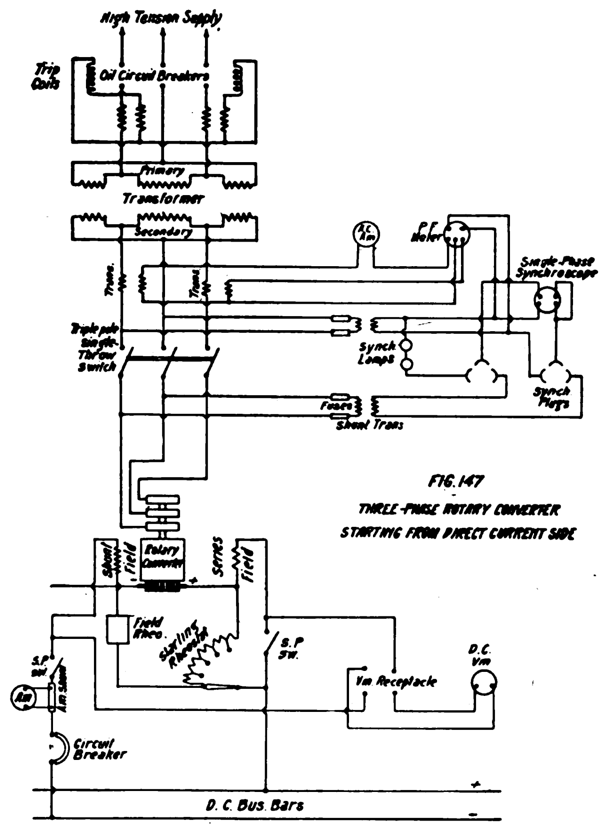


Fig. 147.

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.

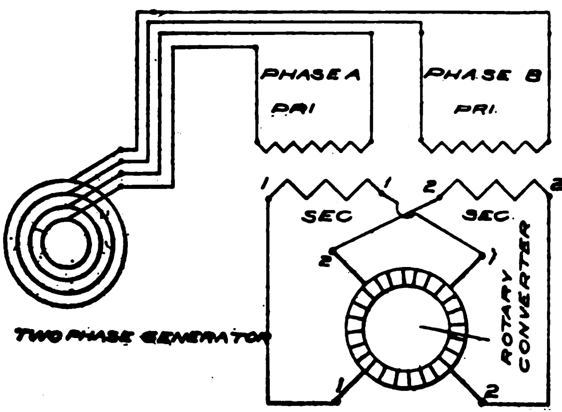


Fig. 148—Rotary converter and transformer, polyphase connections, two phase diametrical.

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

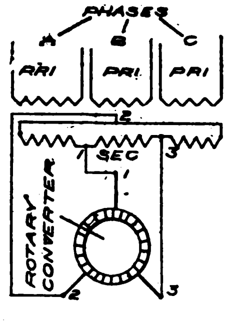


Fig. 149

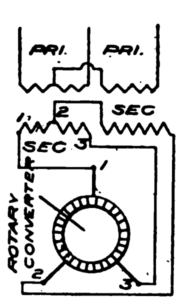


Fig. 150

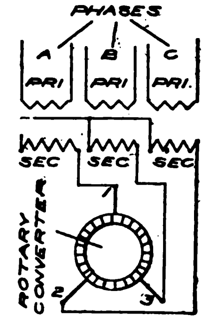


Fig. 151

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.

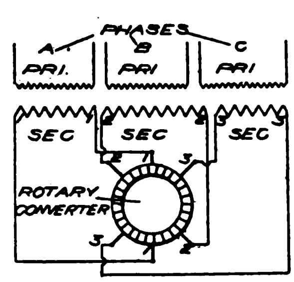


Fig. 152

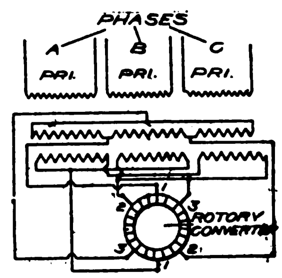


Fig. 153

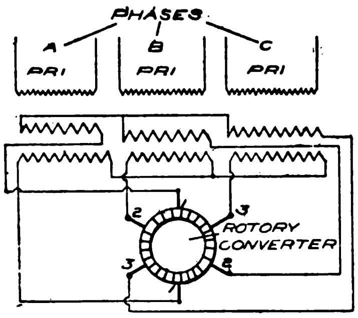
Fig. 152—Rotary converter and transformer with six-phase diametrical connection. Fig. 153—Same with six-phase double delta connection.

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:



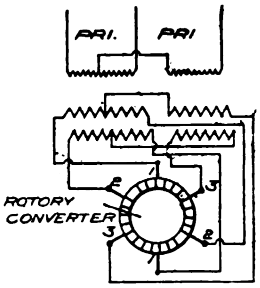


Fig. 154 *Fig.* 155

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.

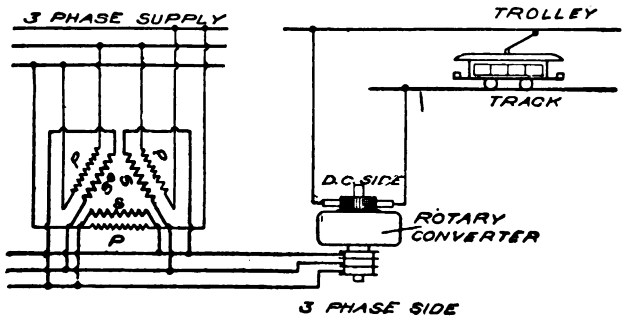


Fig. 156—*Three-phase transformer delta connected supplying three-phase current to rotary converter, direct current side connected for street railway service.*

(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 Amercan 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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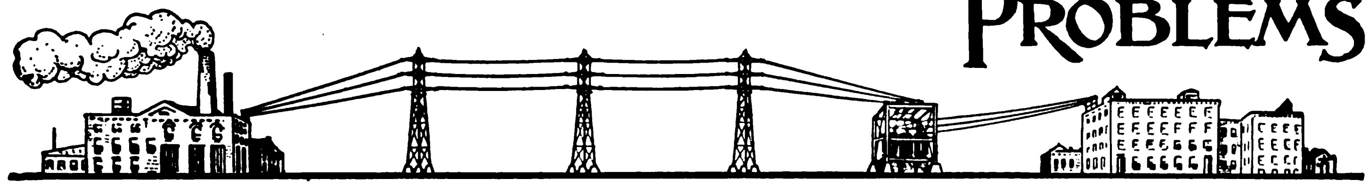
The "Liberty Ball," an armored tractor with a revolving turrent, is now offered as a possible quick method of driving the enemy to the point of suing for peace. A steel model of this device is on exhibition at the Ordnance Department at Washington. The full sized ball is 8 ft. high, has an outside revolving 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.

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:

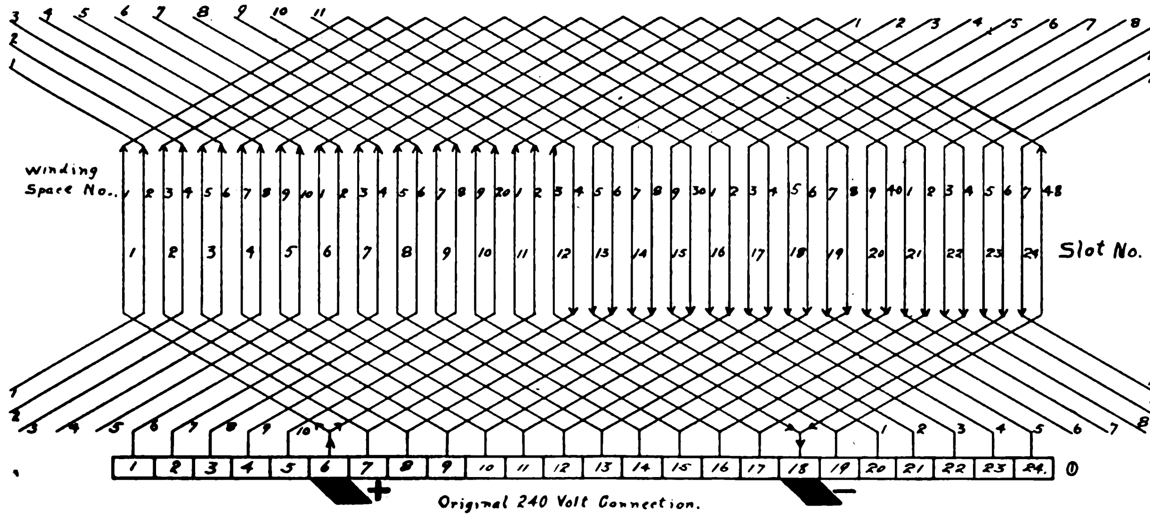


Fig. 1.

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.

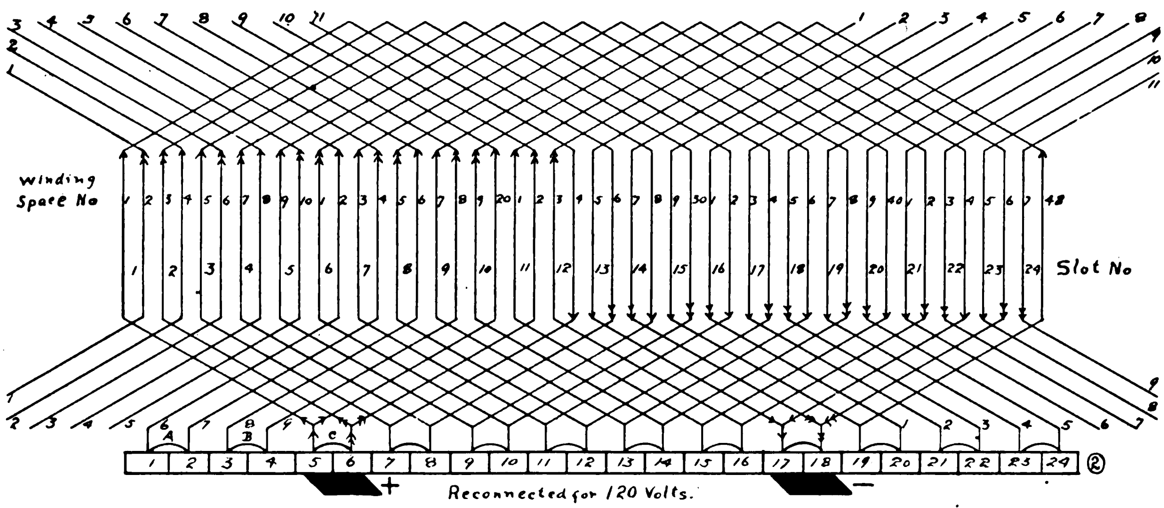


Fig. 2.

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. 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

5	9 and 24	5 and 12
6	11 and 26	6 and 13
7	13 and 28	7 and 14
8	15 and 30	8 and 15
9	17 and 32	9 and 16
10	19 and 34	10 and 17
11	21 and 36	11 and 18
12	23 and 38	12 and 19
13	25 and 40	13 and 20

The winding in Fig. 3 is connected as follows:

Beg. of Coil No.	To bar No.	End of coil	To bar No.
1	28	1	12
2	29	2	13
3	30	3	14
4	31	4	15
5	1	5	16
6	2	6	17
7	3	7	18

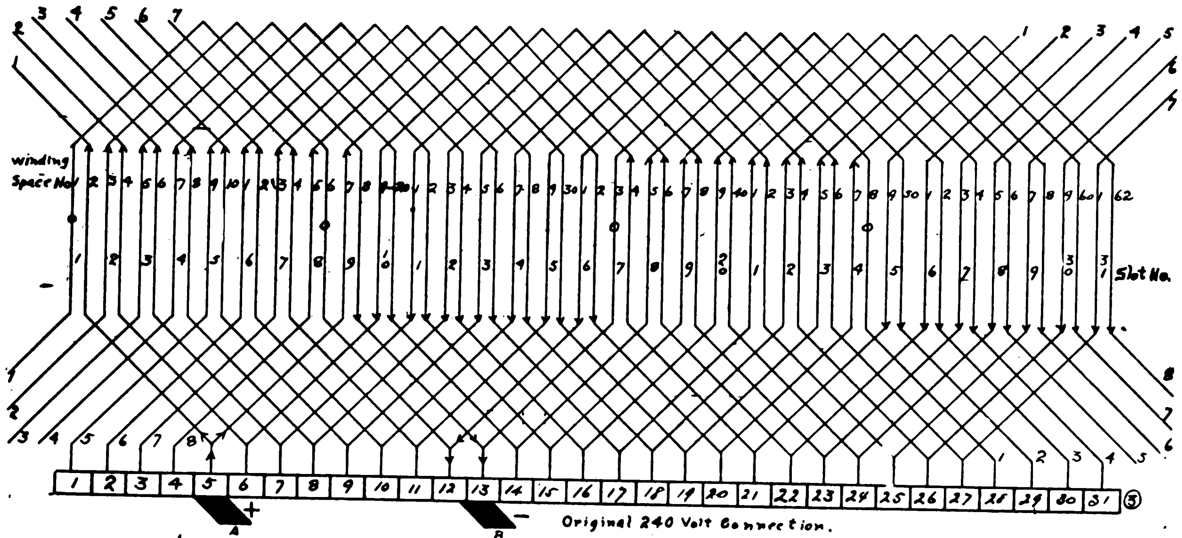


Fig. 3.

14	27 and 42	14 and 21
15	29 and 44	15 and 22
16	31 and 46	16 and 23
17	33 and 48	17 and 24
18	35 and 50	18 and 25
19	37 and 52	19 and 26
20	39 and 54	20 and 27
21	41 and 56	21 and 28
22	43 and 58	22 and 29
23	45 and 60	23 and 30

8	4	8	19
9	5	9	20
10	6	10	21
11	7	11	22
12	8	12	23
13	9	13	24
14	10	14	25
15	11	15	26
16	12	16	27
17	13	17	28

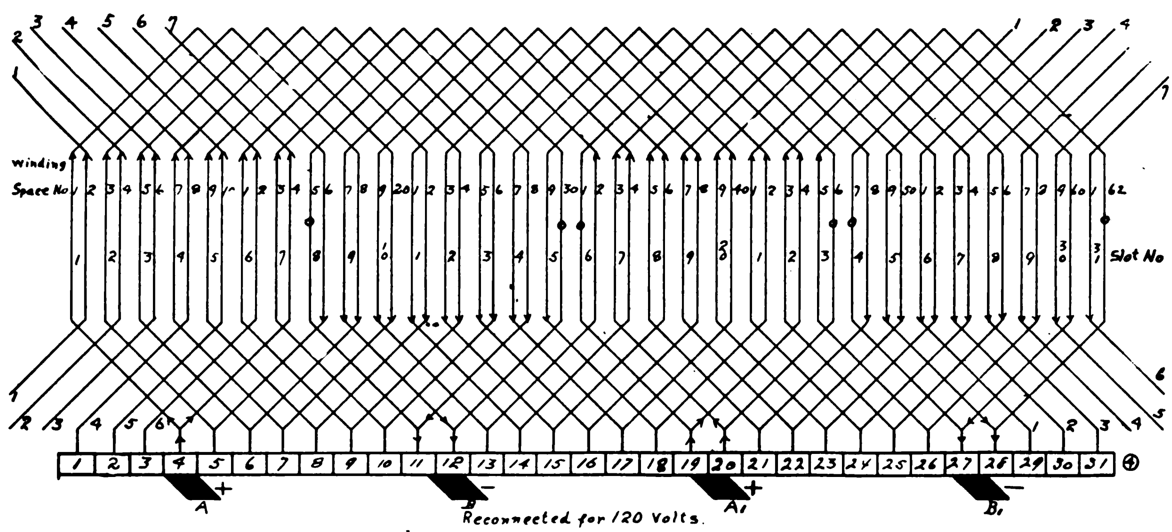


Fig. 4.

24	47 and 62	24 and 31
25	49 and 2	25 and 1
26	51 and 4	26 and 2
27	53 and 6	27 and 3
28	55 and 8	28 and 4
29	57 and 10	29 and 5
30	59 and 12	30 and 6
31	61 and 14	31 and 7

18	14	18	29
19	15	19	30
20	16	20	31
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

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:

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
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:

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

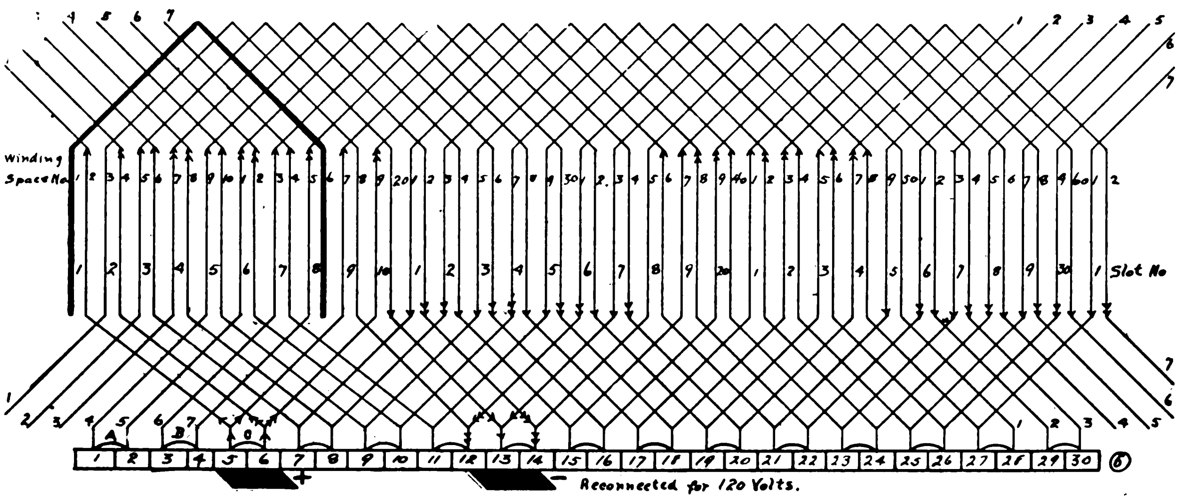


Fig. 5.

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.

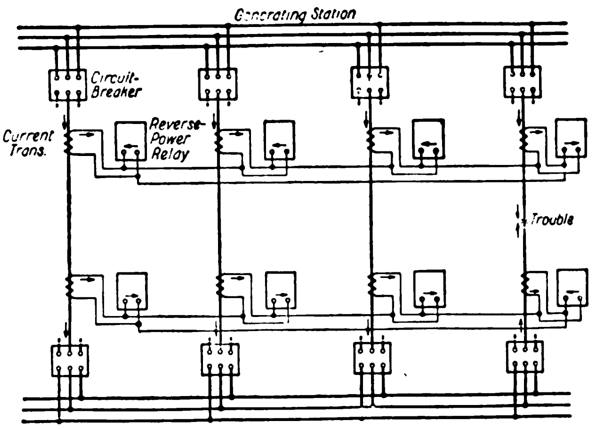

Fig. 1—Schematic diagram of cross-connected relay system (connections shown for only one phase—voltage and trip circuits omitted) arrows show direction of power with short circuit on right feeder as shown.

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

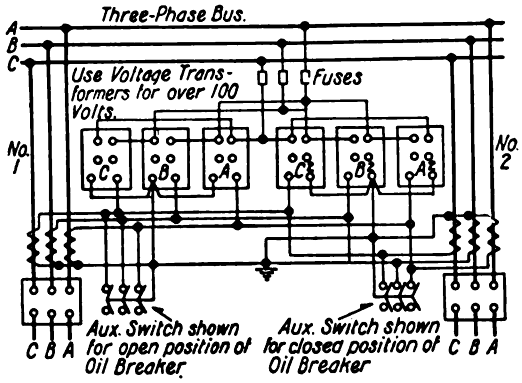

Fig. 2—Diagram of cross-connected relay system—connections shown for three-phase circuit complete except for trip cirsuit

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

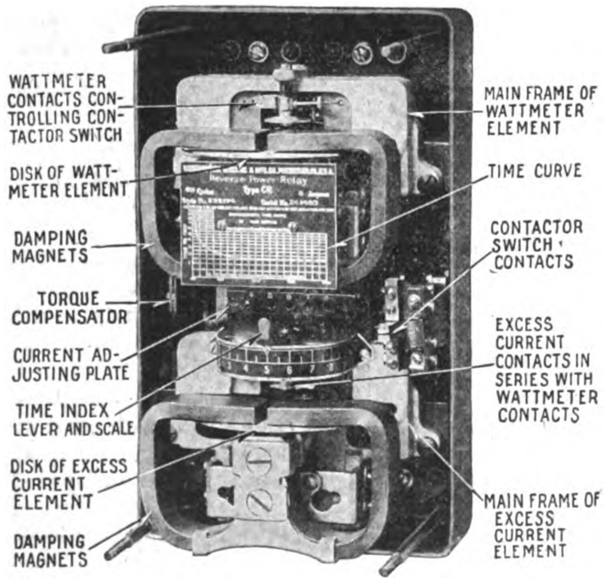

Fig. 3—Type CR relay, cover removed.

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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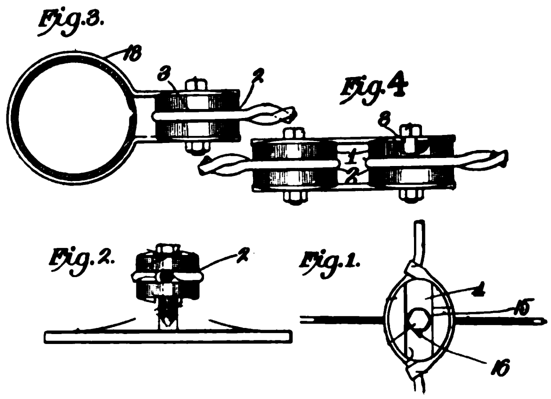
ELECTRIC REGULATOR

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.

BUY THRIFT STAMPS WITH YOUR QUARTERS

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 hydro-electric 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.

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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.

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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

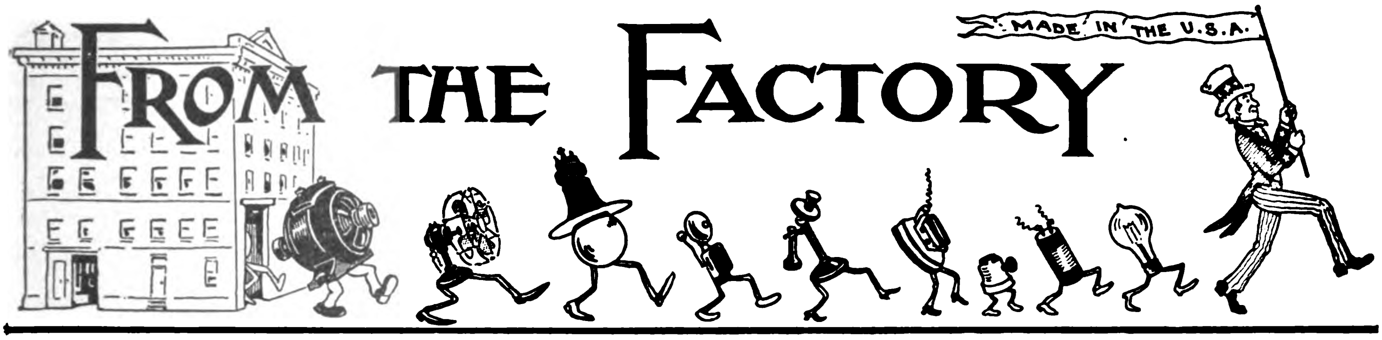
A new carburetor that eliminates any danger of stalling the engine of an airplane or automobile under any condition, provided gasoline flow is not interrupted. It adapts itself to any situation automatically. Uses gas economically. Official tests show 40 miles to gallon of gasoline in a Ford car, 32½ 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

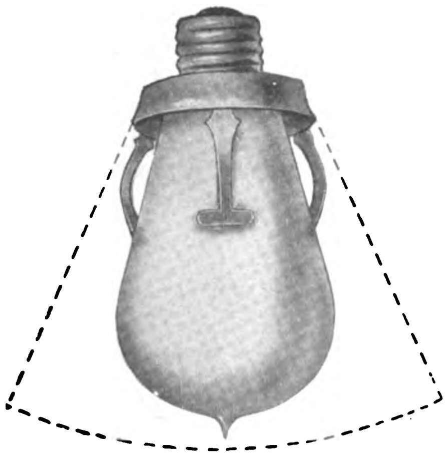
Sanders process is a most simplified method, doing away with towers and use of sulphuric acid. Now ready for development.

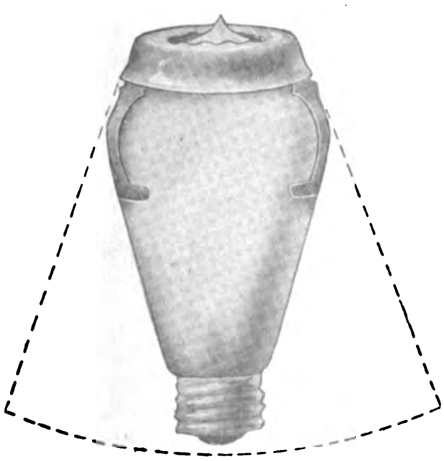


Short Stories About Electrical Goods Offered By Manufacturers

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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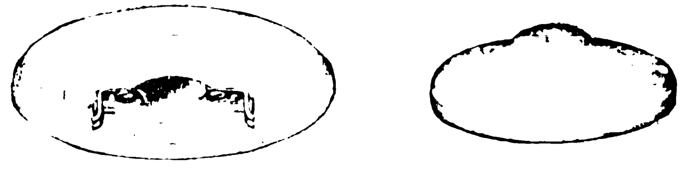
LACO-DALITE GLASSWARE

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 $3\frac{1}{4}$ 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 $3\frac{1}{4}$ in. outlet boxes are $3\frac{5}{8}$ in. in diameter, with elongated holes for supporting screws spaced $2\frac{3}{4}$ in. on centers.



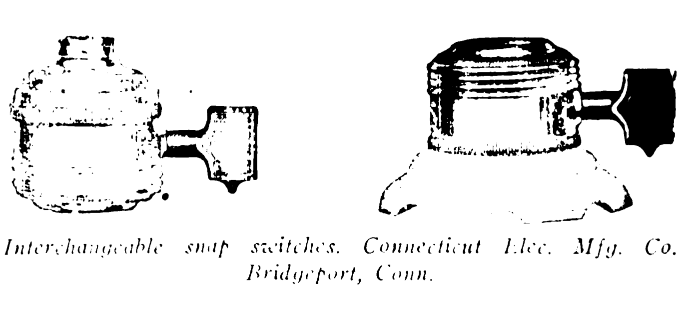
Fuseless rosettes for outlet boxes. Bryant Electric Co. Bridgeport, Conn.

For 4 in. outlet boxes they are $4\frac{5}{8}$ in. in diameter with holes for supporting screws spaced $3\frac{1}{2}$ in. on centers. The design of these rosettes is symmetrical and attractive.

✤ ✤ ✤

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, 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.

Four-heat grill. Landers, Frary & 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; 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.

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

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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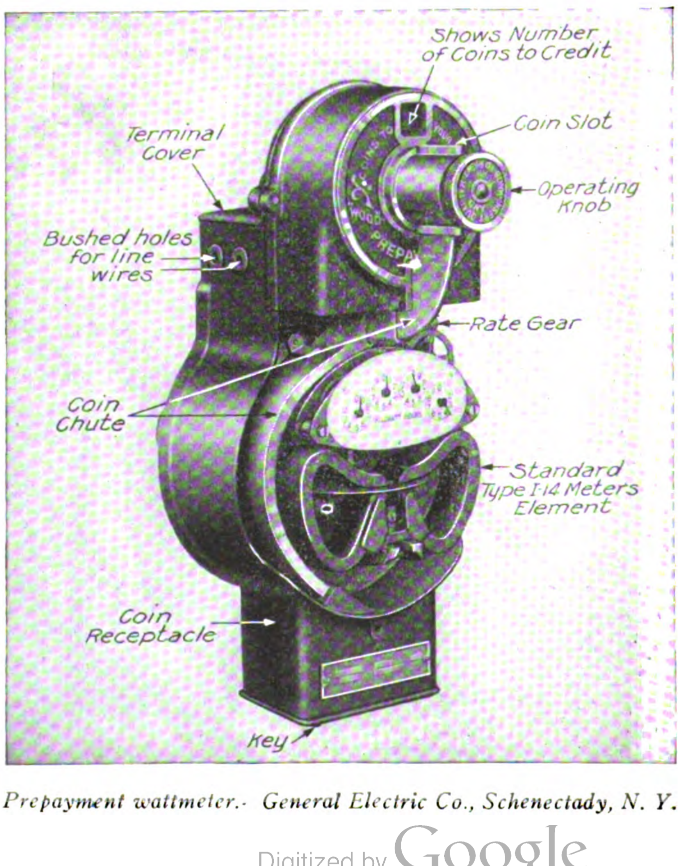
AUTOMATIC ELECTRIC TOASTER

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.

✦ ✦ ✦

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.

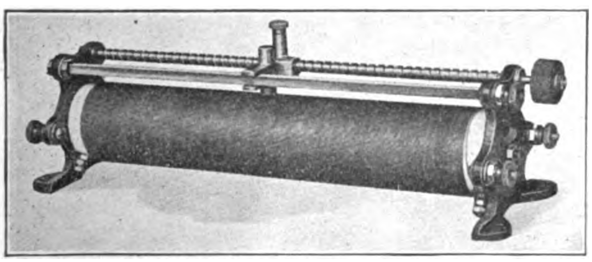
The insertion of the first coin and turning of the knob automatically closes the controlling switch. (Twenty coins is the maximum for deposit, though the coin box will hold about one hundred.) When energy to the value of the deposit has been recorded the switch is automatically opened until another coin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

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 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.



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

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.

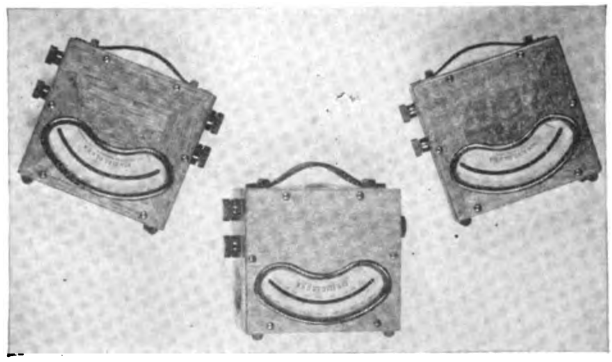
They have been developed by H. G. Crane, Brookline, Mass.

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 3¼ 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.

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.

CURRENT-LIMIT AUTOMATIC CONTROLLER FOR MOTORS

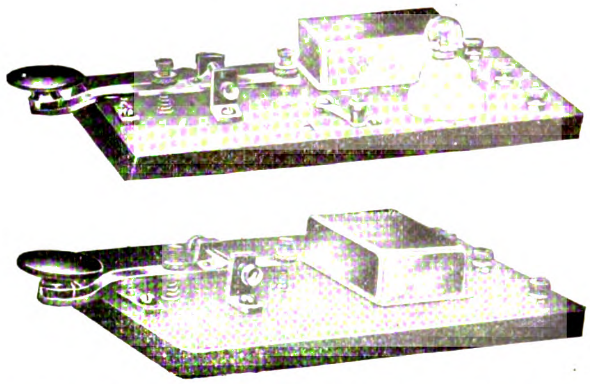
An automatic controller consisting of a number of lock-out accelerating switches having series-wound coils has been placed upon the market by the Industrial Controller Company of Milwaukee, Wis. The rate at which the motor accelerates up to full speed is limited by the current in the armature—under light 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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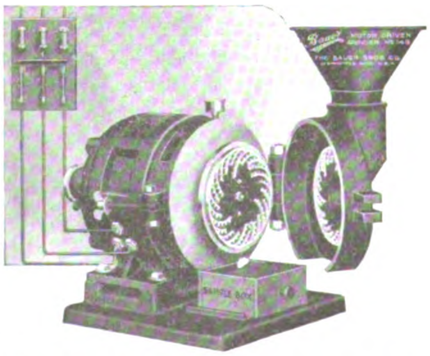
ELECTRIC-DRIVEN LABORATORY GRINDER

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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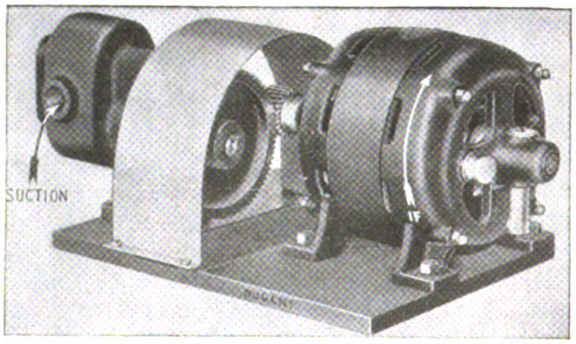
MOTOR DRIVEN PUMP *for* HANDLING OIL

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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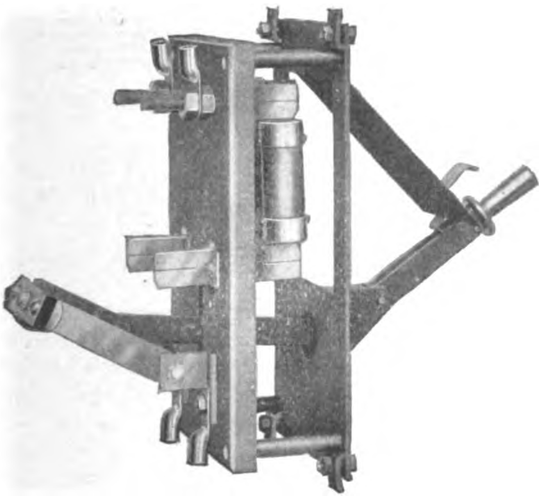
THREE-PHASE CONDUCTOR SUPPORTS

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

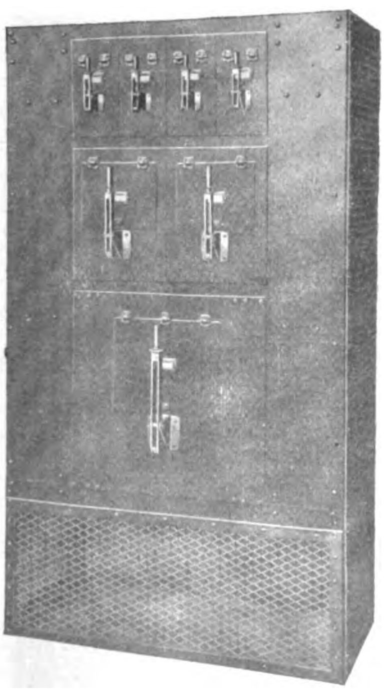
These illustrations typify a line of dead front panel switches made by the General Electric Co., of Schenectady. Primarily the panels are intended as distributing panels for light and power, and for generator and feeder panels for small lighting and power plants, but they present an important safety 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.

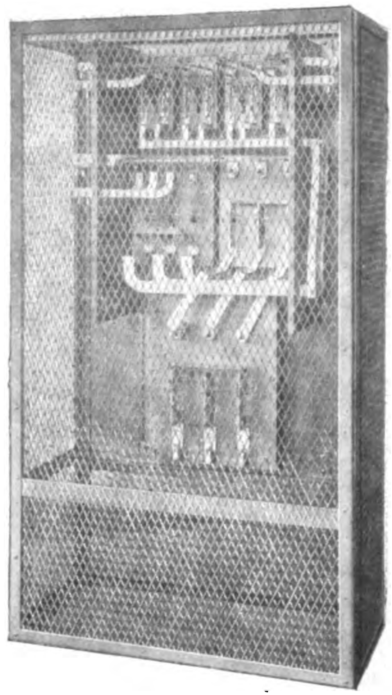
The operating handle has the same general appearance as an oil circuit breaker handle, and is so arranged that it is in the vertical position when the switch is "on" and at an angle of 60



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.

* * *

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.

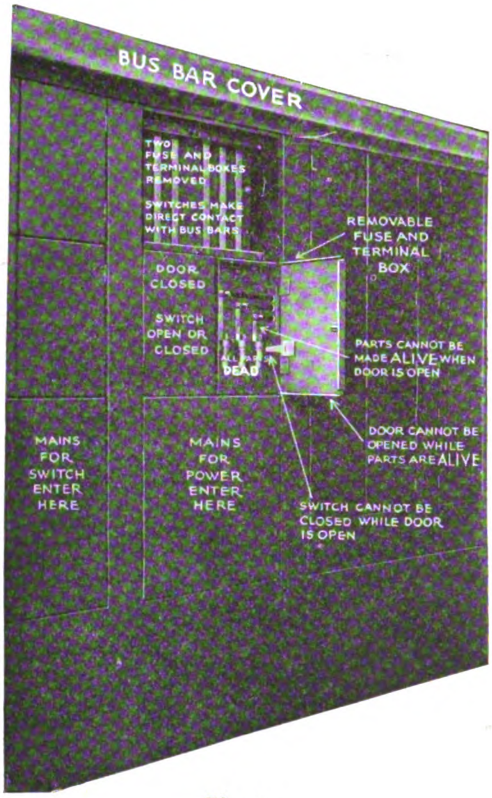


Fig. 1

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

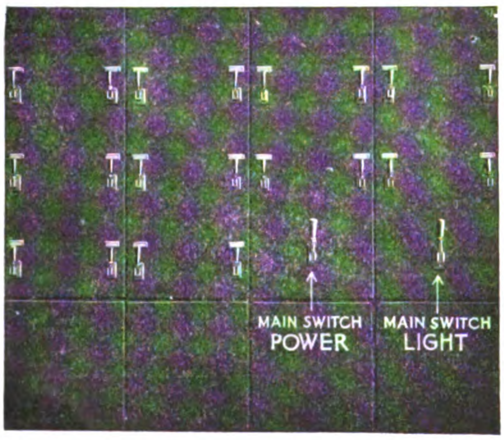


Fig. 2

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-

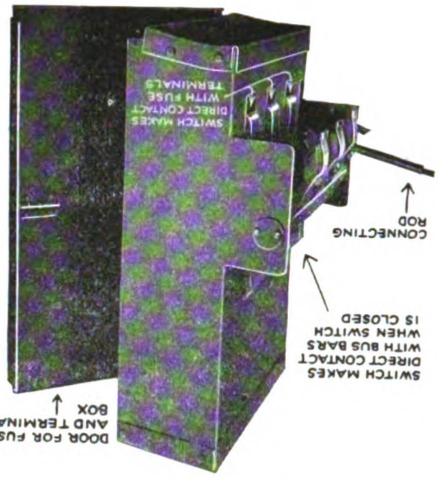


Fig. 3. Autolock switchboard. Krantz Mfg. Co., Brooklyn, N. Y.

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.

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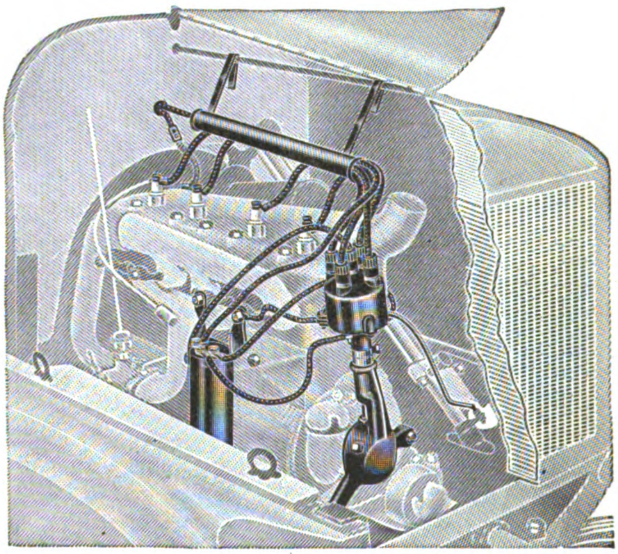
VIBRATOR-LES COIL IGNITION

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.

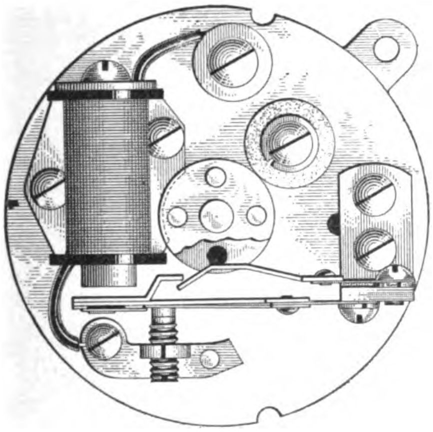
The system consists of an elevating gear bracket upon which a high tension distributor is mounted, which distributor contains rather unusual mechanism to cause a non- vibrating coil to properly function on a Ford magneto.



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 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.



Details of Vibrator-les coil ignition.

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.

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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.

THE CLEARING HOUSE

Advertisements on this page 5 cents a word. No advertisement accepted for less than $1.00. Electrical Engineering reserves the right to open all letters addressed in its care und agrees to forward only answers that are germane to the product or subject advertised.

DIRECTORY OF CONSULTING ENGINEERS ARCHITECTS and CONTRACTORS

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Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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PHOTOMETER Standards
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Weston Elec. Inst. Co., Newark, N. J.

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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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Palmer Electric & Mfg. Co., Boston, Mass.

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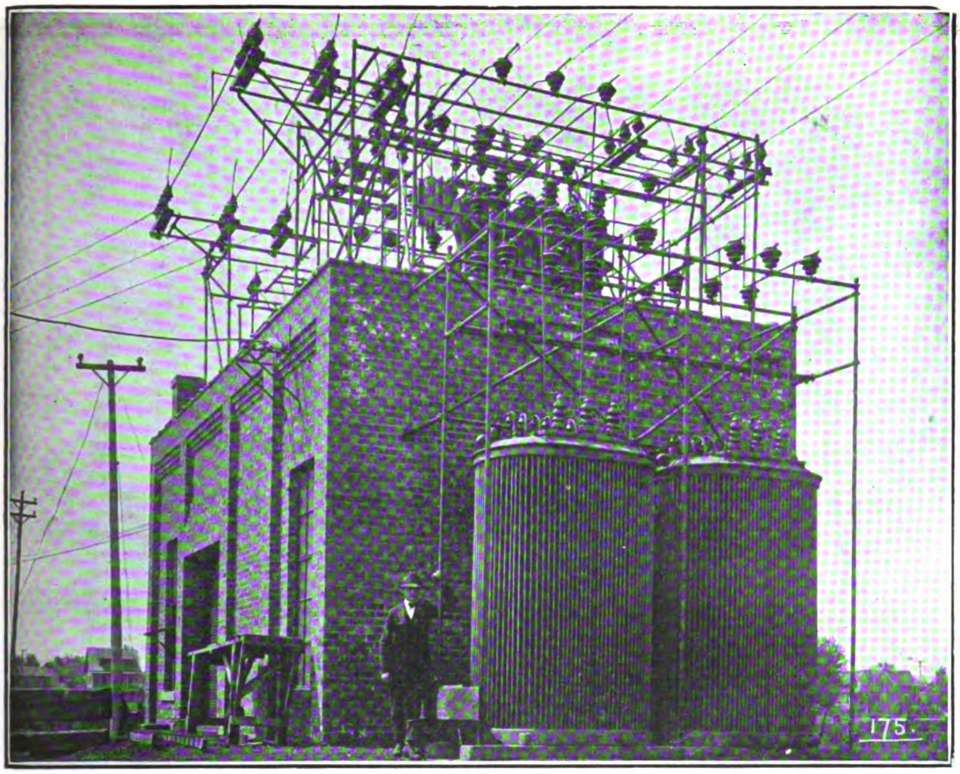

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ISSUED MONTHLY BY WM. R. GREGORY CO.
1642 Woolworth Bldg., New York
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CHAS. B. THOMPSON, President
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Volume 52 AUGUST 1918 Number 2

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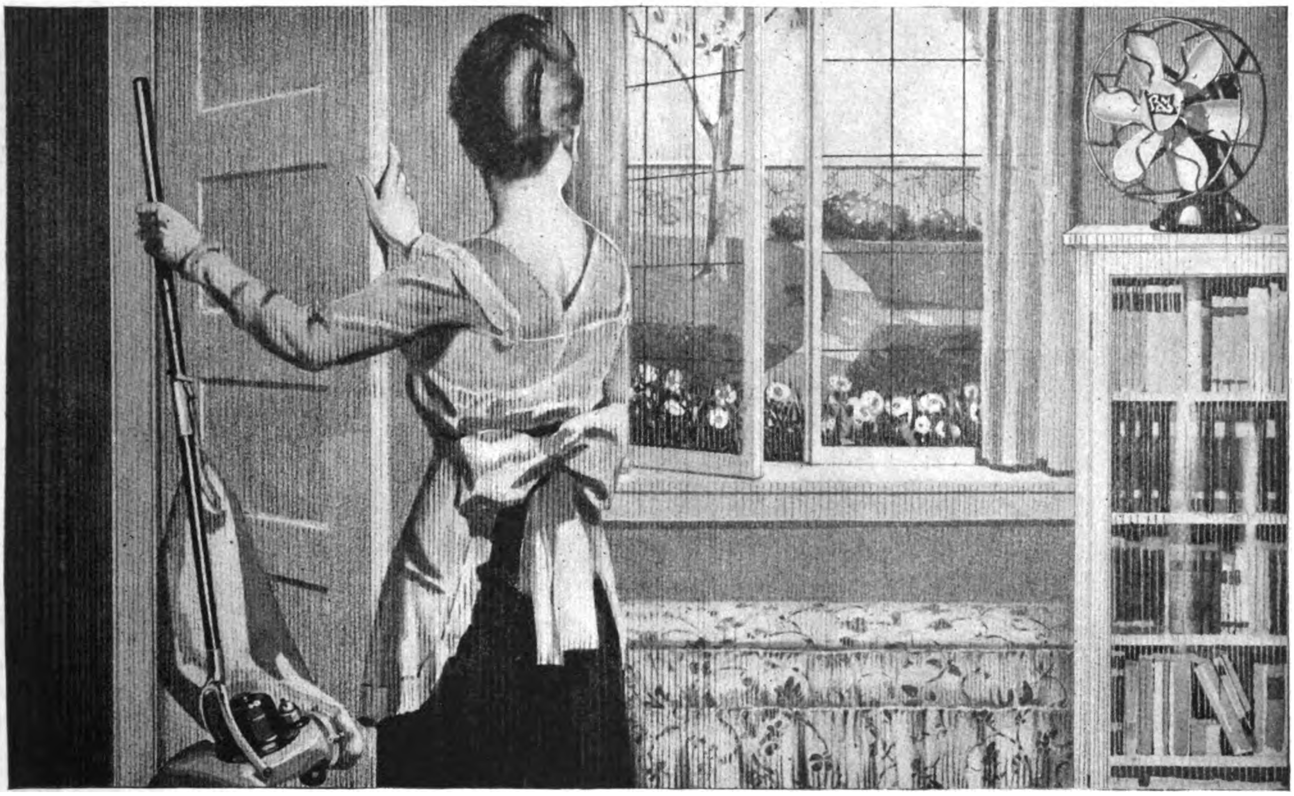

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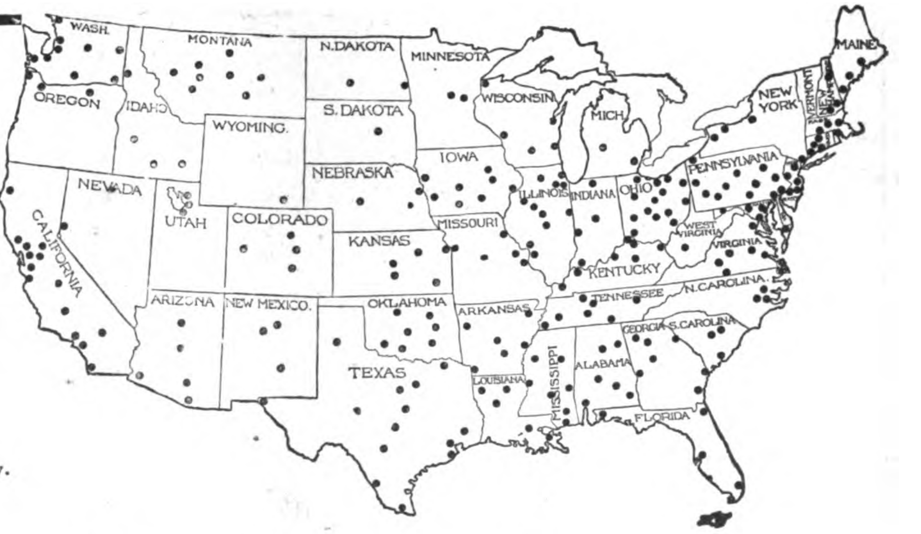

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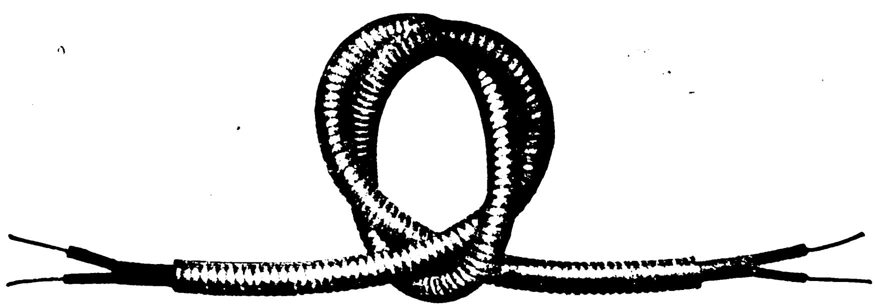

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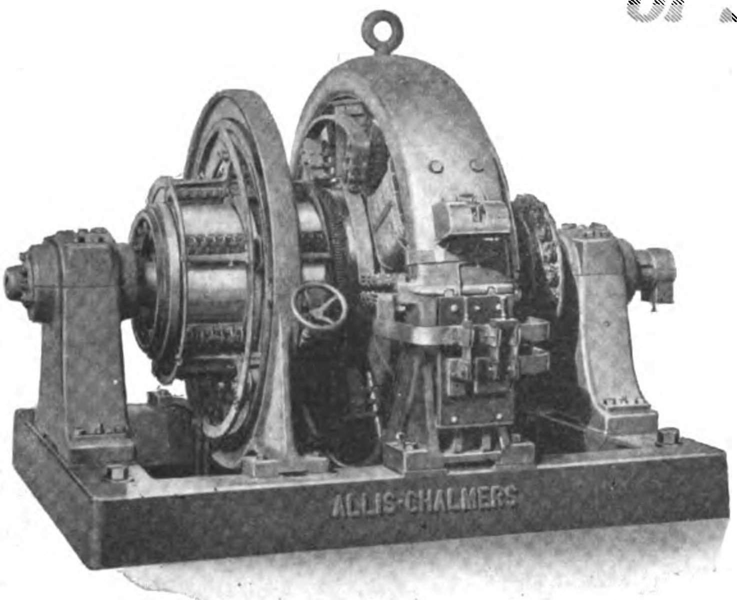

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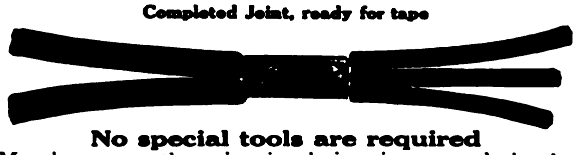

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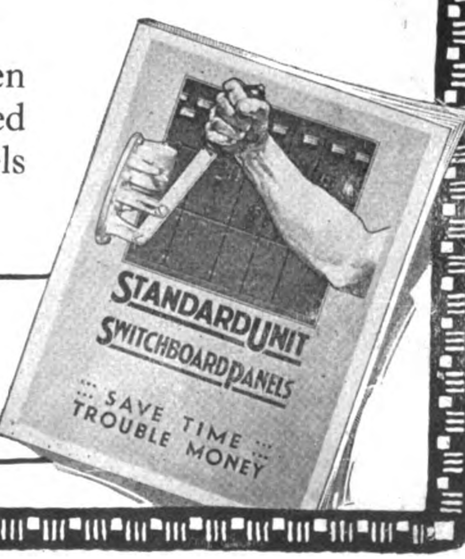

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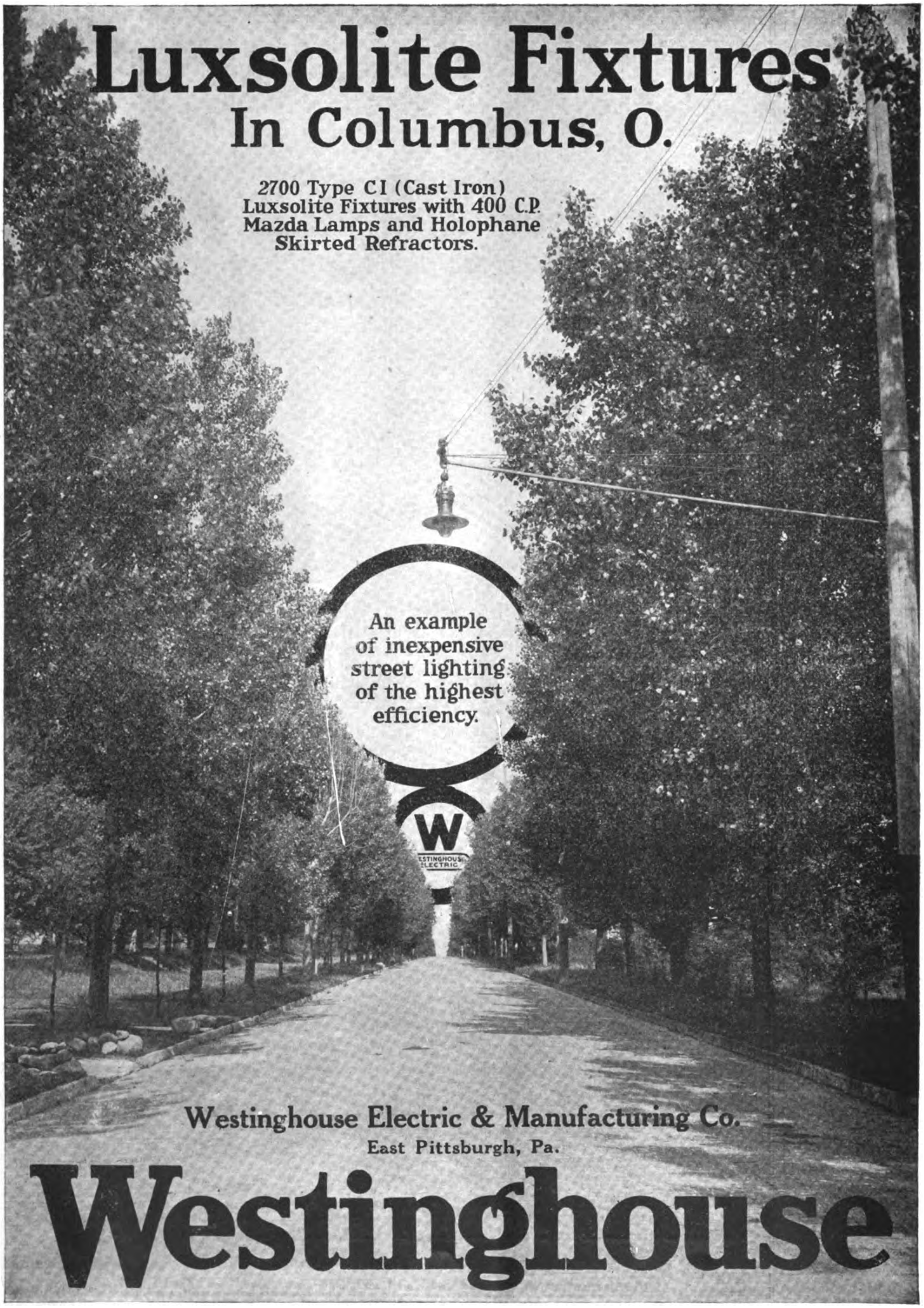
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Wm. R. Gregory Co., New York

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.

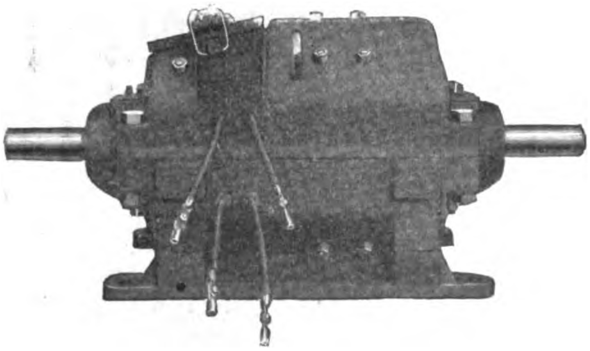
General Application of Alternating Current

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.

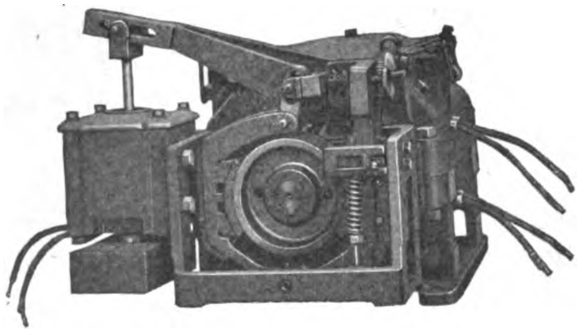
The equipments have been laid out on the lines of standard land practice, for obvious reasons. The alternating current is generated at 220 volts, 3-phase, 60 cycles and the distribution is on a three-wire system. As in the "La Brea," the pump motors are all operated from the engine room. This for two 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.

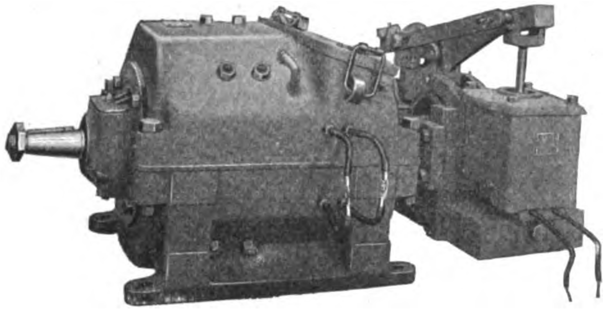
Imbued with the successful performance of the "La Brea" and the detailed investigations for subsequent oil tankers, certain shipbuilders have now turned to the application of



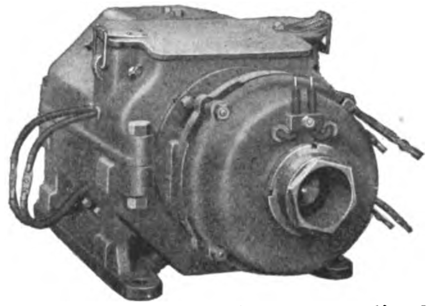
Side view of CO-1800 motor



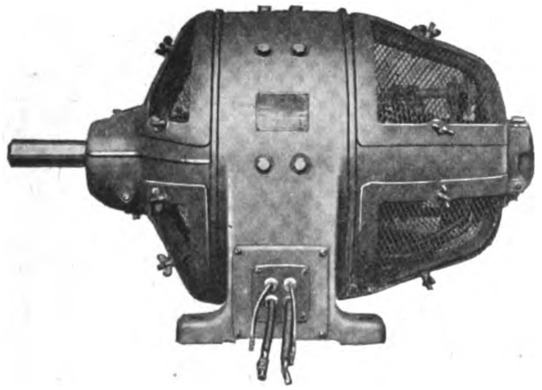
Motor equipped with full torque shoe brake



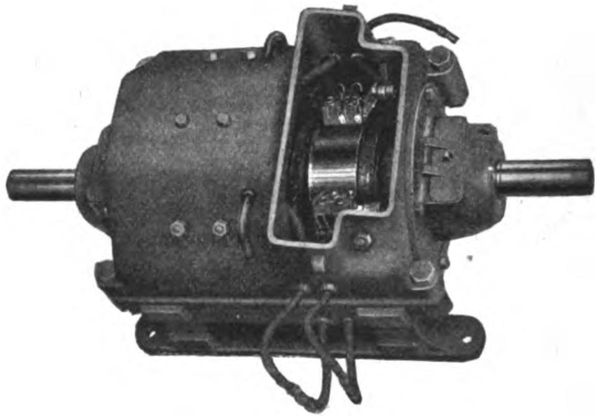
Side view of motor equipped with shoe brake



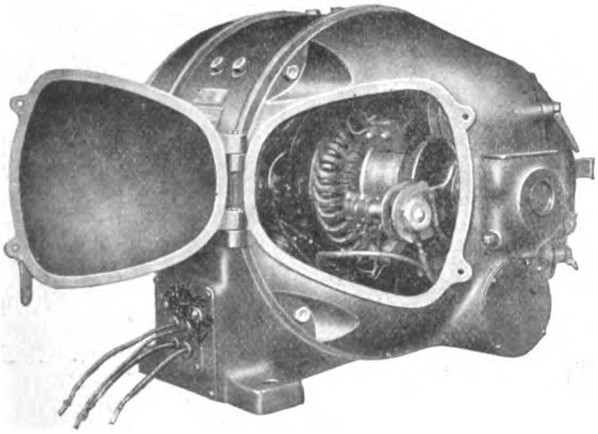
Motor equipped with one-half torque disc brake



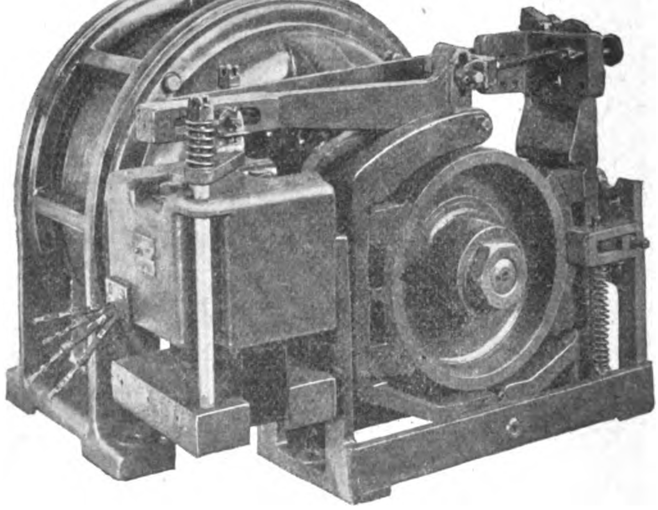
Shunt-wound motor with attachable semi-enclosing hole covers



Motor with hand hole cover removed

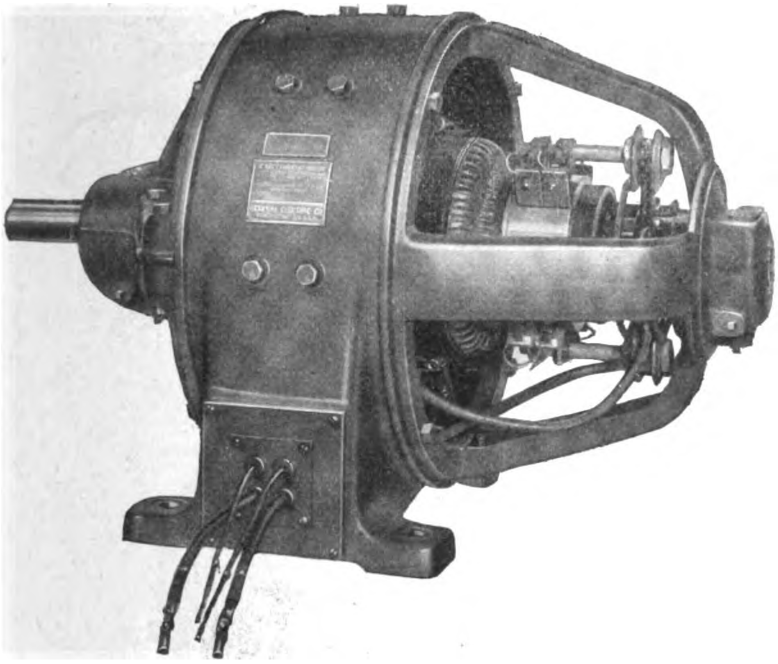


Type R C motor, totally enclosed

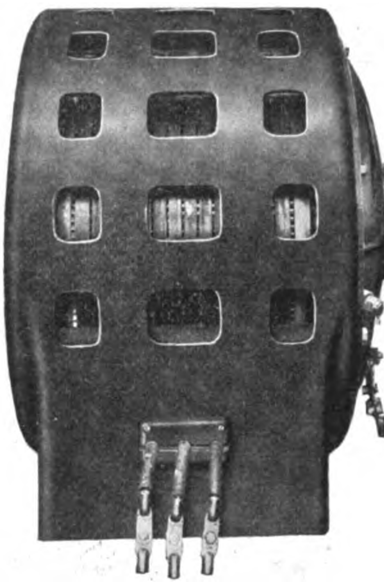


Brake on type ITC-5011 induction motor

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.

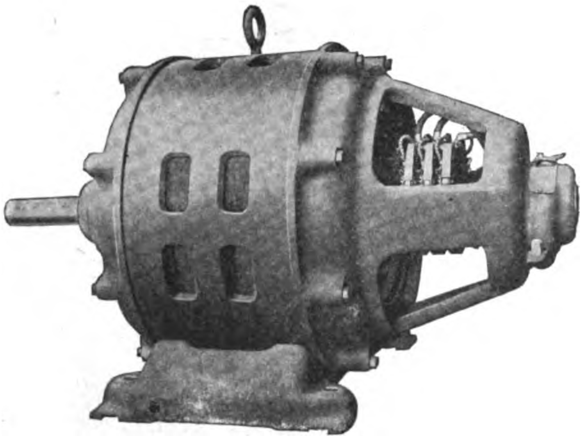
Just one illustration will apply to most of the steam auxiliaries. Deck winches are used for loading and unloading the vessel. The work is intermittent: while the vessel is under way the apparatus is not in use. Steam supply and exhaust pipes must be lead throughout the vessel and carefully covered to 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

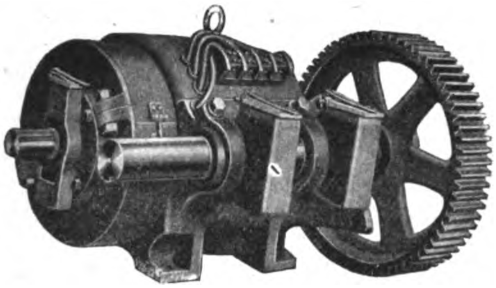
The layman's query: Why transform mechanical power into electrical power and back again into mechanical power? is answered universally in the employment of electrical energy as a means of increasing efficiency. The reasons for applying electricity to the propellers of a ship may differ in detail, but 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.

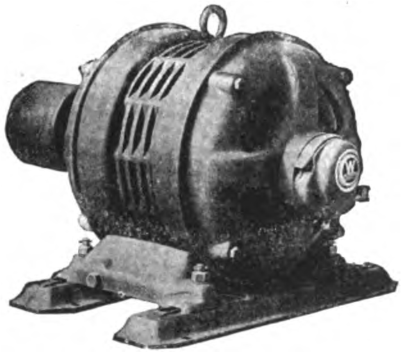
The electrical gear combines inherently a wide range of speed reductions and reversal by the simple change of connections. For high powers and two or three continuous operating speeds the electric gear has no competition from the viewpoint of size, weight, and efficiency. This has been clearly set forth 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.

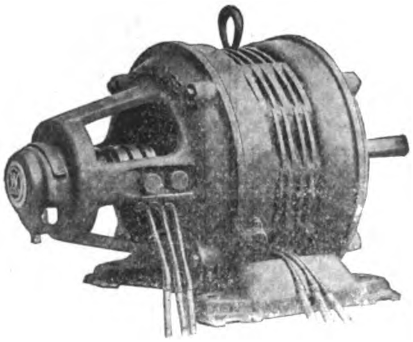


Direct-current, enclosed type varying speed motor with back gear for crane and hoist service

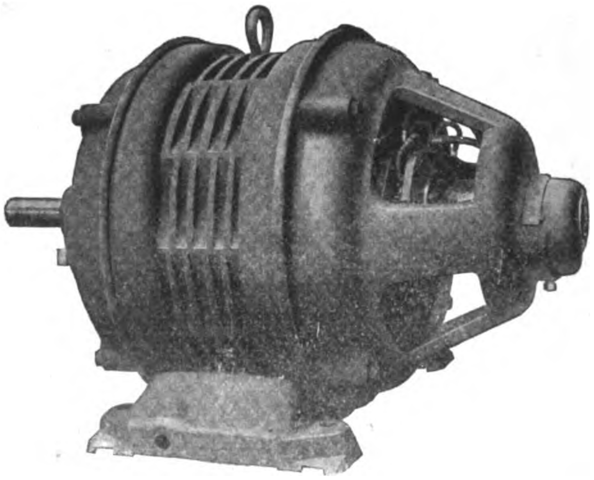


Alternating-current, squirrel-cage motor for constant speed continuous service, 25 hp. and smaller

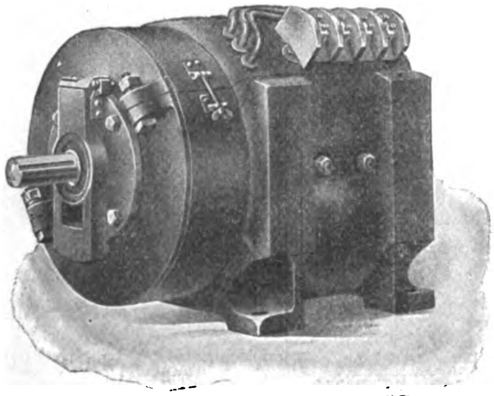
Alternating-current, squirrel-cage motor for constant service, 25 to 125 hp.



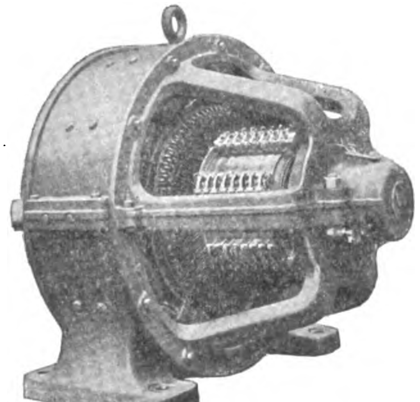
Alternating-current, wound rotor motor for intermittent service, 25 hp. and smaller.



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

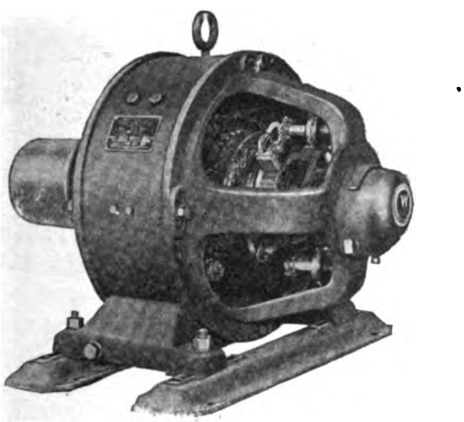


Direct-current, enclosed type, varying speed motor for crane and hoist service

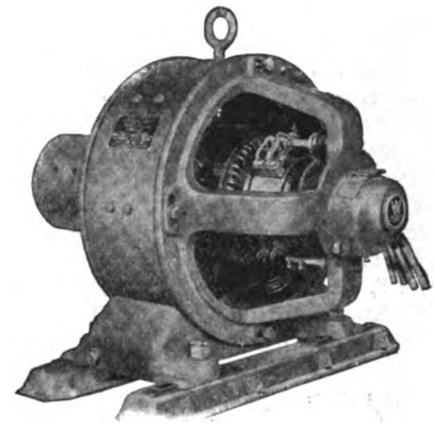


Direct-current, 125 hp., constant speed motor

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

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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.

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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.

THREE AND FOUR-WAY SWITCH CIRCUITS

By Terrell Croft

(*Continued from page 21, July issue*)

Cottage Wiring

A wiring lay-out for a two-story-and-attic cottage in which a three-way switch circuit is incorporated, for the simultaneous control of both of an upstairs and a downstairs hall light is shown in the sectional view of Fig. 10. This lay-out is probably typical of the average small-residence three-way circuit connection. It will be noted that the switch-feed wire on the first story is taken from a "jumper" wire, *J*, from the single-pole switch-feed wire directly to the left. This construction is much more economical than that involved when a special feed is run to the three-way switch. Other typical installations are illustrated in the sectional drawings of Figs. 11, 12, 13 and 14.

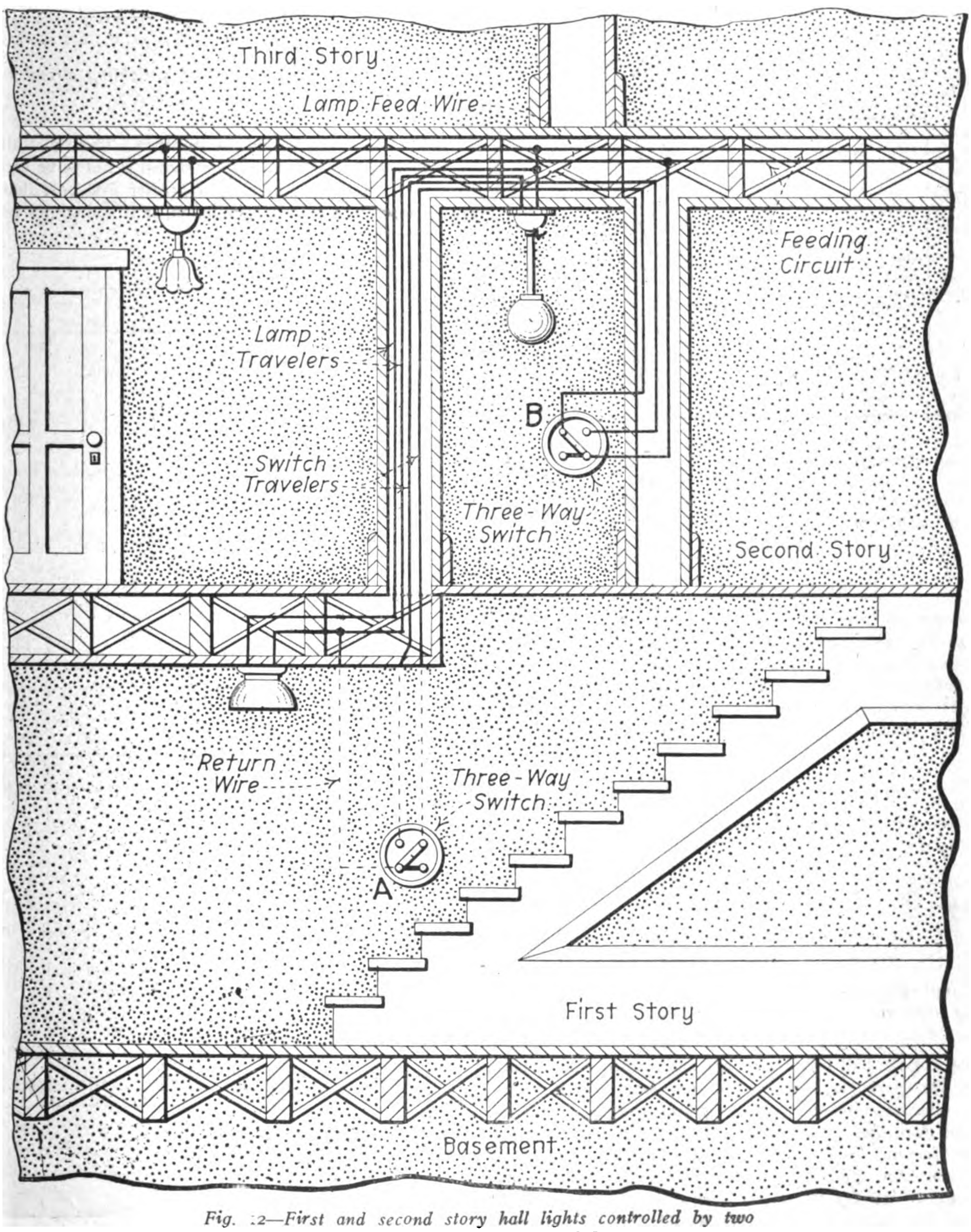

Fig. 12—First and second story hall lights controlled by two three-way switches A and B.

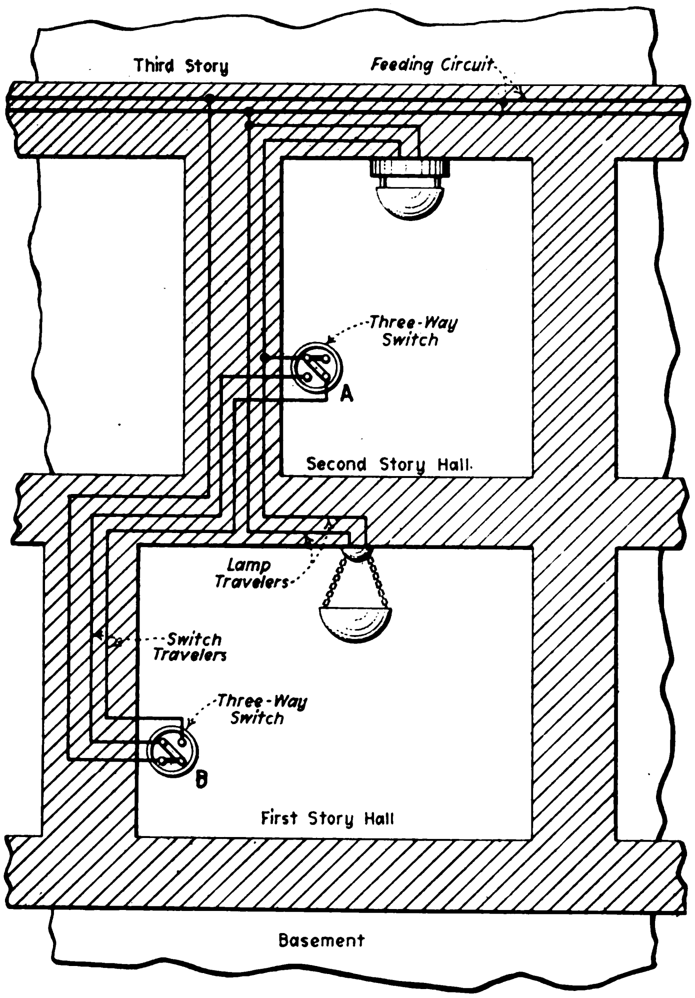

Fig. 13—Hall-lighting and three-way circuit fed from space between second and third stories (three-way switches at A and B.)

Unusual Wiring

A rather unusual case of three-way switch wiring is illustrated in Fig. 15. It was necessary in this building to so wire the hall-light circuits that they could be controlled from two locations by three-way switches and that the hall-light energy could be metered separately from the energy used by the tenants of the first and second stories. In other words, the owner de-

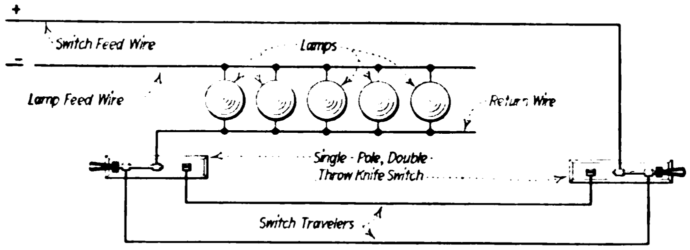

Fig. 17—Single-pole, double-throw knife, switches used instead of three-way switches for two-location control.

sired to pay for the hall lighting energy and wished each tenant to pay for the energy he used on his own floor. An arrangement was effected with the central station whereby the hall lighting was furnished at a flat rate, eliminating the necessity of a meter for this portion of the load. This condition very materially simplified the problem, inasmuch as it was then only necessary to so connect the meter series coils in the branch circuits that the hall lighting current would not feed through them. If the circuits of Fig. 15 are traced out it will be evident that the energy for the hall lights does not pass through any meter.

Two-Location Control

Two-location control of a lighting circuit may be effected by the use of four-way switches (as illustrated in Fig. 16) instead of three-way switches, if the switch travelers are connected to dia-

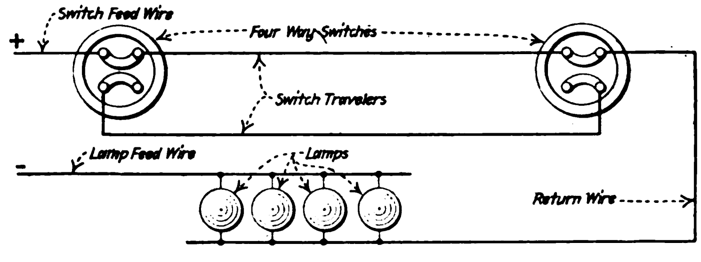

Fig. 16—Two-location control of a lighting circuit using four-way switches.

gonal binding posts within the switches. This illustration is self-explanatory. While the system shown is not to be recommended generally, because it involves a greater first cost than does the usual three-way switch installation, it is sometimes necessary to

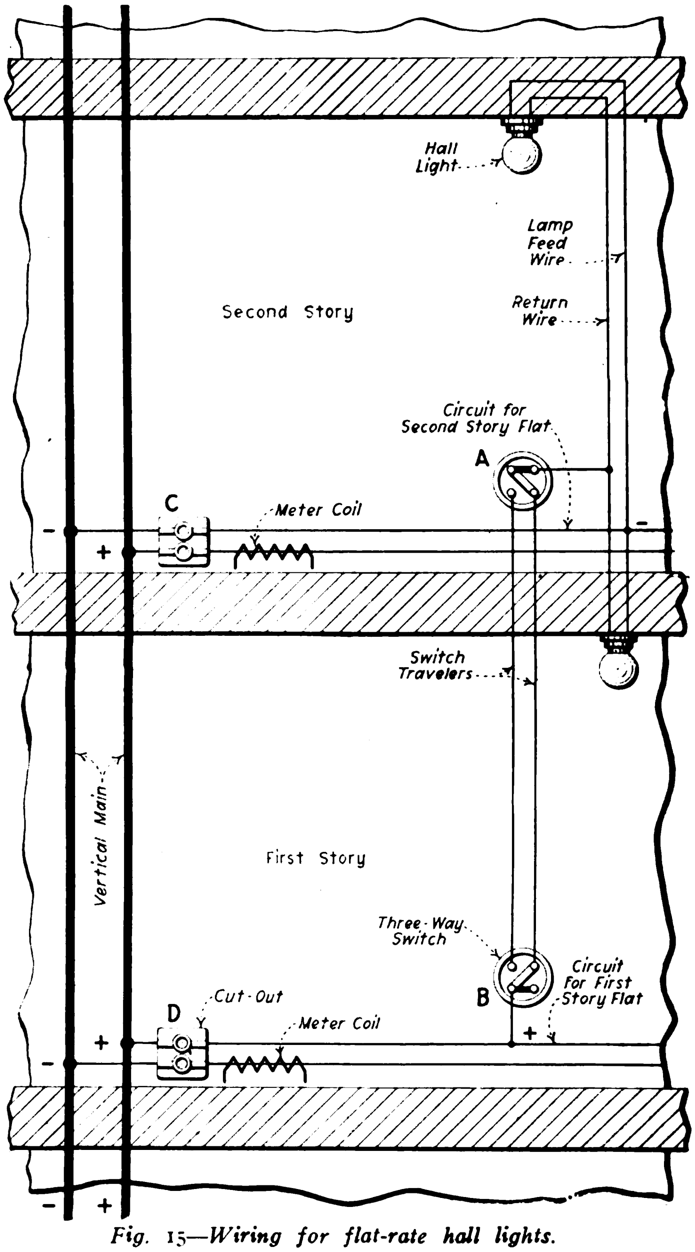

Fig. 15—Wiring for flat-rate hall lights.

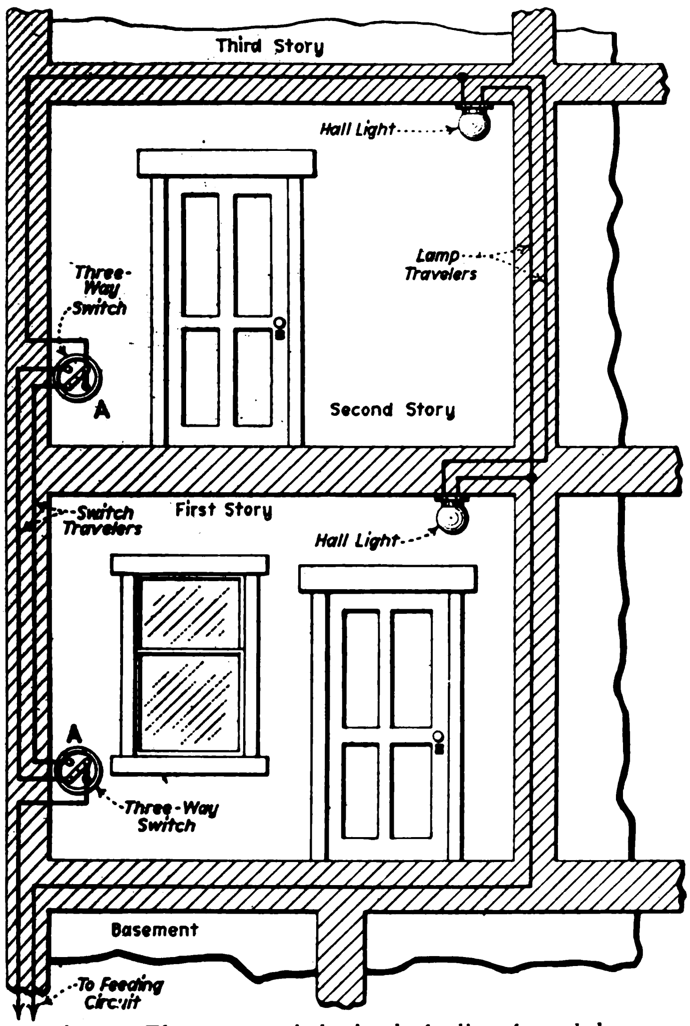

Fig. 14—Three-way switch circuit feeding from below.

use four-way switches as shown when three-way switches are not available.

Single-pole, double-throw knife switches provides a means of controlling a lighting circuit from two different locations when three-way switches or four-way switches are not available. The connection diagram for such a two-location control is given in Fig. 17. In the circuit shown in this illustration but one polarity is present at either of these single-pole double-throw knife switches. This renders the wiring practically equivalent to that required for single-pole switches.

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AUTO TRANSPORTATION IN FRANCE

What the motor truck and car can accomplish as a means of wholesale transportation is being demonstrated daily in France by the American Red Cross fleet of 634 vehicles. These not only handle an average of 2,500 tons of freight monthly at fourteen ports, move nearly a thousand tons per week from the Paris stations and the Seine landings but transport supplies, workers, refugees and wounded in all sections of France not omitting those parts under shell fire. If a hospital suddenly wires in that it needs emergency supplies, if a car or truck will get them there quicker than will a train, the load goes with a Red Cross driver. If a German drive threatens a village, Red Cross trucks are there to move the civilians and their belongings to a point of safety or hasten them to refugee trains waiting at distant stations. The ambulances may assist with wounded soldiers on their way back to base hospitals or may answer a call from a bombing raid to help uncover and remove the wounded. Trucks, ambulances and cars all serve at times as passenger vehicles. In two months they answered 2,528 calls to move people in Paris alone—many of them being refugees to be taken from one railroad depot to another. In a single week there were 233 city calls, 130 for journeys outside of Paris and 47 cars were sent for prolonged duty near the Army lines.

Of the fleet, 385 are trucks and ambulances, 246 ordinary cars and 22 motor bicycles. To keep the fleet moving, the Red Cross maintains two large garages and an automobile park in Paris. Fifteen other garages meet the needs of the port and other transportation services. Complete machine shops with skilled mechanics are maintained at the chief garage.

Speed in handling goods at the ports is an essential and the Red Cross drivers are rather proud of moving 300 tons from one landing in a single day. A single cargo of 38,000 cases weighing 980 tons was handled with similar speed by the gasoline transportation corps. The goods platform at Paris may contain 15,000 cases at a time.

Over 80 percent. of the Red Cross supplies have to pass through the capital on their final journey of relief. Practically every article shipped via Red Cross from America, whether a baby's sock, a case of bandages or a complete hospital equipment is handled at some point in one of these cars.

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ENGINEERS' SERVICE DIRECTORY

The American Association of Engineers is again taking a step in a new field of society service. Instead of the commonly known membership list or year book, it is compiling an Engineers' service directory of all its members for distribution in July. This will be in keeping with all other activities of the association, which is now recognized for its national service to technical men. Such space as may be permitted will be given to the experience of each member, in such form as the laymen may use to select an engineer with special experience.

For example: Doe, John—431 Broadway St., Milwaukee, Wisc., Grad Cornell Univ., Civ. & Mech. Engr. Design Brdgs. 4 Yr. Design, Constn. & Sales Heat. & Vent. Mchy. 5 Yr.

The information will also be classified. This will be carried to about the same extent as is done in a material or equipment directory, to place the employer in touch with a number of men whose general qualifications fill his demands. He can then obtain any further information desired, either through the association, or through correspondence with the men personally.

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MODERN ROMANCE

A Poetical Youth with a Practical Girl
Fell madly in love, and with heart all awhirl
He cried, "Let us fly to some spot far away
From the city's wild rush and frivolities gay;
To the sweet, quiet country, where rustic delights
Shall gladden our days and make happy our nights,
In a wee little cottage"—
        But here he switched off,
For the Practical Girl, with a sniff and a scoff,
Laughed, "Wee little nothing! No *sir,* not for mine
The roses that ramble and vines that entwine.
Imagine the dusty old stove! And the tubs
For doing the washing and family scrubs!
Just think of the kerosene lamp! And the broom
That raises more dirt than it sweeps from the room!
This 'love in a cottage' *sounds* awful romantic,
But slaving and drudging would sure drive me frantic.
Electrical service gets rid of all that:
There's more time for love in a wee city flat!"

—Frederick Moxon in *Edison Monthly.*

A KILOWATT HOUR AND THE COAL REQUIRED TO PRODUCE IT

This is the gist of a paper read by B. H. Blaisdell before the Manilla Section of the National Electric Light Association. It appeared in a recent issue of the association bulletin.

In the first place what is a kilowatt-hour? It is the unit by which electrical energy is measured, as the yard or meter is the unit for measuring cloth and the pound or kilo is the unit for measuring meat and potatoes.

While most of us have a fair idea of how much we shall get when we ask the storekeeper for a meter of cloth or a kilo of potatoes, few of us have any conception of how much a kilowatt-hour is. To us it is thirty centavos' worth of electrical energy.

The reason for this is clear. We can see with our eyes a meter of cloth or a kilo of potatoes, but we cannot see a kilowatt-hour of electrical energy. However, we can appreciate the value of a kilowatt-hour by observing what it can do. For instance, if an ordinary 40-watt metallic filament lamp is put in a socket and the switch is turned on, electrical current will immediately pass through the filament, heating it to incandescence, or in other words, lighting it. While the lamp is lighted electrical energy will be consumed. To consume one kilowatt-hour of electrical energy the lamp must be lighted for twenty-five hours. Putting it another way, we can light the lamp at 6:30 p. m., read the evening paper, eat our dinner, and enjoy the company of family and friends or read a book until 10:00 p. m. when the light is turned off on going to bed. This performance can be repeated for the seven evenings in a week and the total consumption of electrical energy will be one kilowatt-hour.

The power plant is the factory for producing kilowatt-hours of electrical energy, and this requires coal, which amounts to over 75 percent. of the total cost of production.

What is coal? Geologists tell us it is compressed and mineralized vegetation. Thousands of years ago before man existed, this earth was covered for the most part with dense forests and vegetation, which flourished and decayed for thousands of years, forming great peat bogs. During successive geologic ages these peat bogs were tilted, upheaved or submerged by volcanic action on the earth's crust, which was subjected to great pressure through overlying strata of earth and to great temperature due to the molten condition of the earth's interior. The pressure squeezed the moisture out of the peat and the high temperature drove off more or less of the volatile combustible constituents and thus were formed various grades of coal, such as lignite, bituminous and anthracite. The first named, lignite, still contains much moisture and volatile combustible matter, bituminous coal less of these, while anthracite is almost wholly fixed carbon.

Coal is not common rock, for a piece no larger than my fist has stored in it the power of doing work far greater than we mortals possess. I do not believe there is a person here even though he is a crack baseball player, who can throw a lump of coal the size of his fist straight up over 75 feet but this lump of coal has stored within itself power sufficient to throw its own weight straight up 2,000 miles.

There is no mystery about the amount of heat energy in coal, and this factor is determined daily in the Manila Testing Laboratory, in order that the price paid for a ton of coal is in accord with the heat energy it contains. * * * Coal possesses potential energy and it is only necessary to raise the temperature of a small portion of the coal on the grate bars sufficiently in contact with air and its oxygen, to start the conversion of the potential energy of the coal into chemical energy, as manifested by combustion. The chemical energy liberates the heat energy, which in turn raises the entire fuel bed to incandescence and the product of combustion to the flame temperature. The products of combustion in transit through the boiler transmit the greater part of their heat through the boiler plate to the water within the boiler. The water absorbs heat until it is converted into steam under pressure. Steam under pressure possesses potential energy or power to do work, if it is given an opportunity to expand. Thus we have the potential energy of coal converted by combustion in the furnace into heat energy and then converted back into potential energy in the form of steam under pressure in the boiler. From the boiler the steam is conducted through pipes to the turbine where it is given an opportunity to expand and in so doing its potential energy is converted into mechanical energy in driving the turbine. The electric generator being connected to the turbine is driven by it, and thereby the mechanical energy exerted by the turbine is converted into electrical energy in the generator. The electrical energy so generated is transmitted by means of wire and cable to the switchboard, where it is distributed to the various feeder circuits that spread out in all directions about the city of Manila.

While philosophy teaches us that energy like matter can neither be created nor destroyed, it does not follow that in combustion of coal all the heat energy can be converted into electrical energy.

Unfortunately under the present system of electric power generation, only a very small percentage of the total heat liberated in the combustion of coal is accounted for in the electrical energy produced. The greater part of it, while not lost to the universe, escapes beyond our power to reclaim it for a useful purpose.

Following our subject more closely, how much coal does it take to produce one kilowatt-hour of electrical energy? In the Meralco plant it will take a piece weighing approximately three pounds. By the process of combustion the potential energy in the coal is liberated in the form of little heat units, which are veritable demons for getting away on every possible occasion, and it is the personal duty of every power plant employee to do his utmost to coax and to force the wily little heat units to travel in the straight and narrow path that leads to conversion into the light of the electric lamp.

Notwithstanding the efforts of the operating engineers, as well as of all the employees of the power plant, in the interest of fuel efficiency, only 10 percent. of the total heat contained in coal ever reaches the switchboard, as electrical energy. The remaining 90 percent. falls by the wayside and is lost so far as being of any use to man.

This awful waste is inherent in the present system of generating power. Scientists, inventors, engineers and manufacturers the world over, are endeavoring to discover a more economical method of converting the potential energy of coal into useful work, and no doubt the problem will be solved successfully some day.

I do not mean to imply that there is no opportunity for power plant employees to improve the fuel efficiency of a plant and thus save the company large sums of money. There are scores of ways of capturing a few extra heat units in coal. If by some means we can convert 11 percent. instead of 10 percent. of the total heat of coal into electrical energy, it will reduce the coal bill about 10 percent., which is something that would please any manager.

It may be interesting to you to learn in what manner the 90 percent. of heat in coal gets away from us, and the means employed for preventing even more from escaping. I will attempt to account for the 100 percent. of heat energy it contains.

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 furrace. 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.

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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.

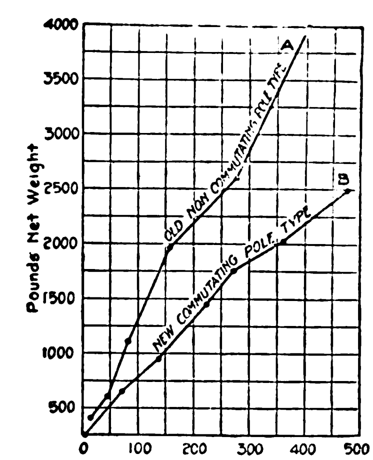

Fig. 1—Relation between weight and torque for commutating-pole and non-commutating pole motors.

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

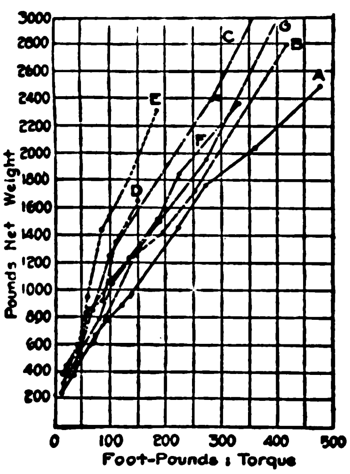

Fig. 2—Relation between weight and torque for present lines of motors, A, B, C,—various makes of apparatus.

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.

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 ap-

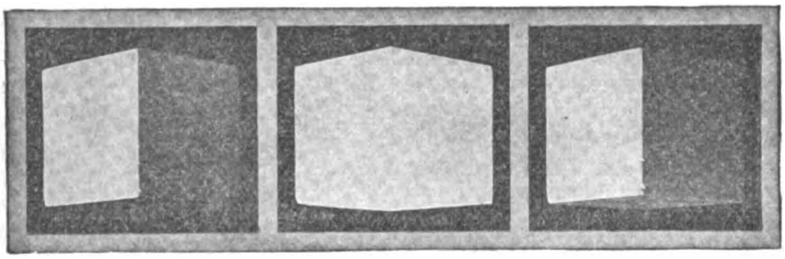

Fig. 13. A white cube lighted from various directions

plying 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 $0.37 \times 1/3\ (0.63—0.37) = 0.456$ 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.

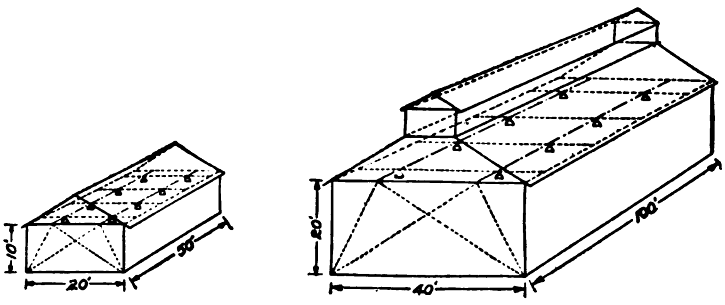

Fig. 14—Three-way switch circuit feeding from below.

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%
Reflection Factor: 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	.51	.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.

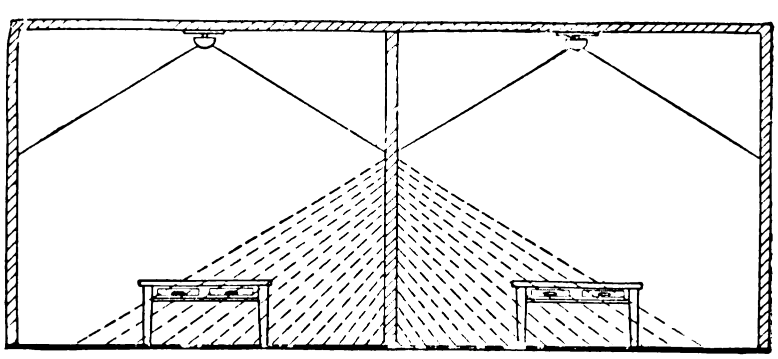

Fig 15. The coefficient of utilization is dependent upon room proportions. The light striking the partition is largely lost

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 Lehgth, 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.

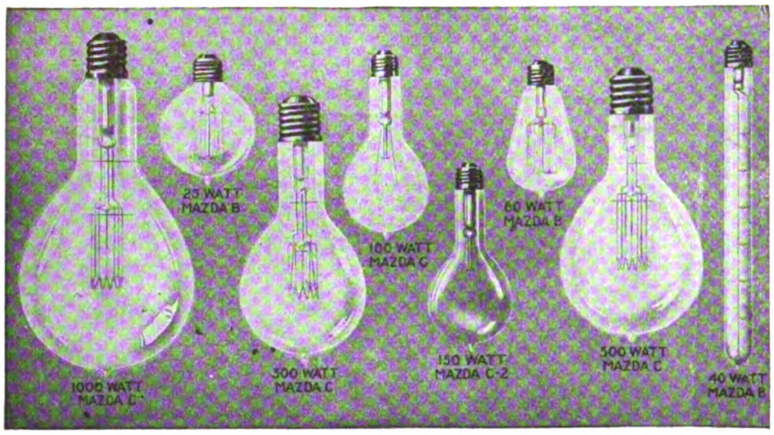

Fig. 16. Typical mazda lamps

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-

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 helpfui 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.

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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."

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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. POGGE. 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 tempratures 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.

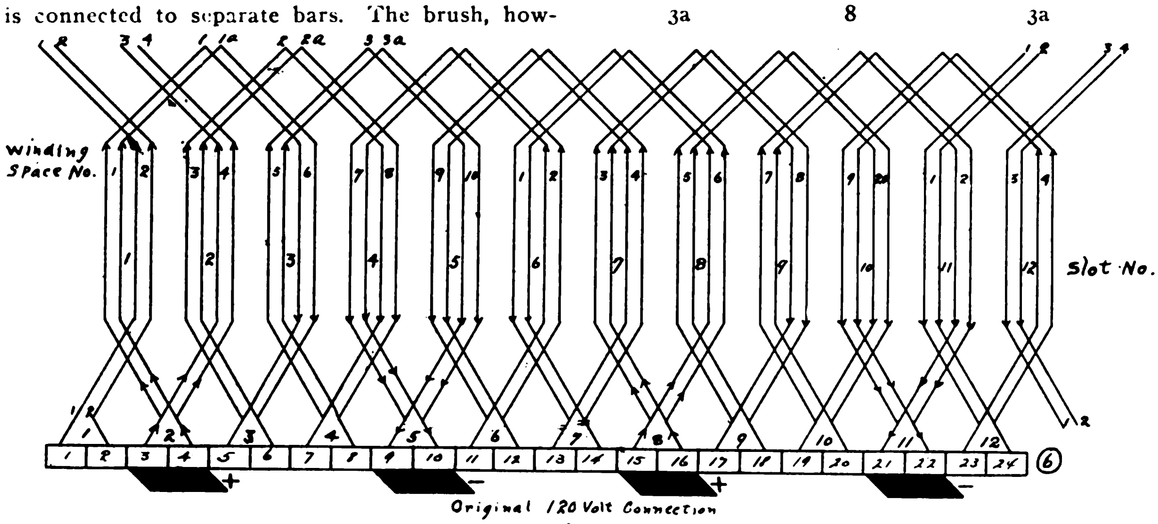
POWER PLANT, LINE AND DISTRIBUTION PROBLEMS

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.



Original 120 Volt Connection

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.

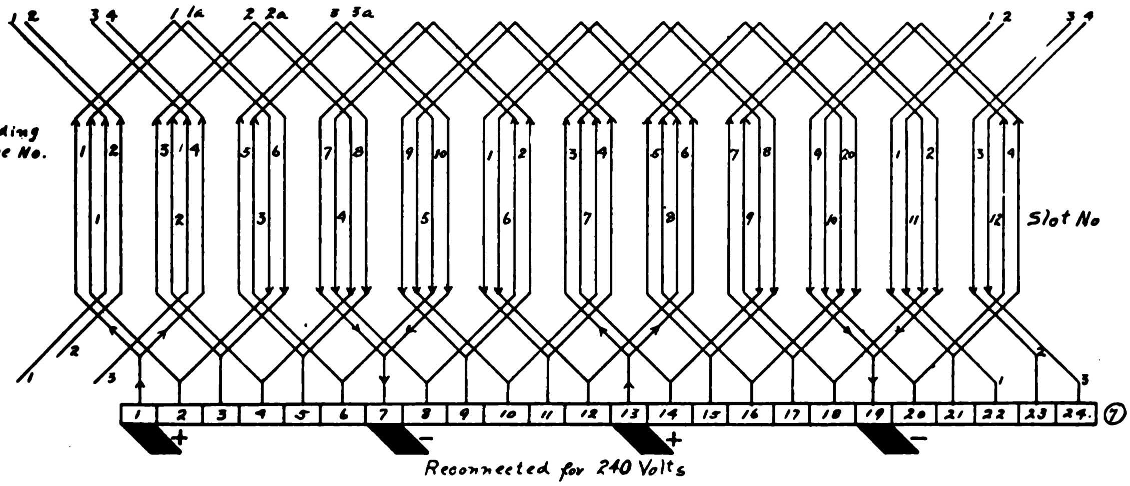


Fig. 7.

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.

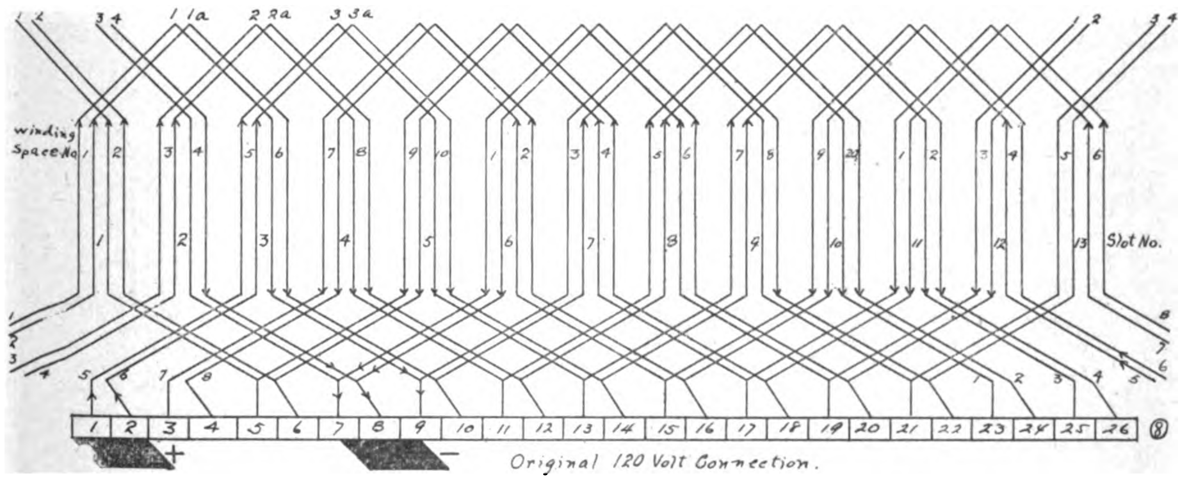


Fig. 8.

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 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

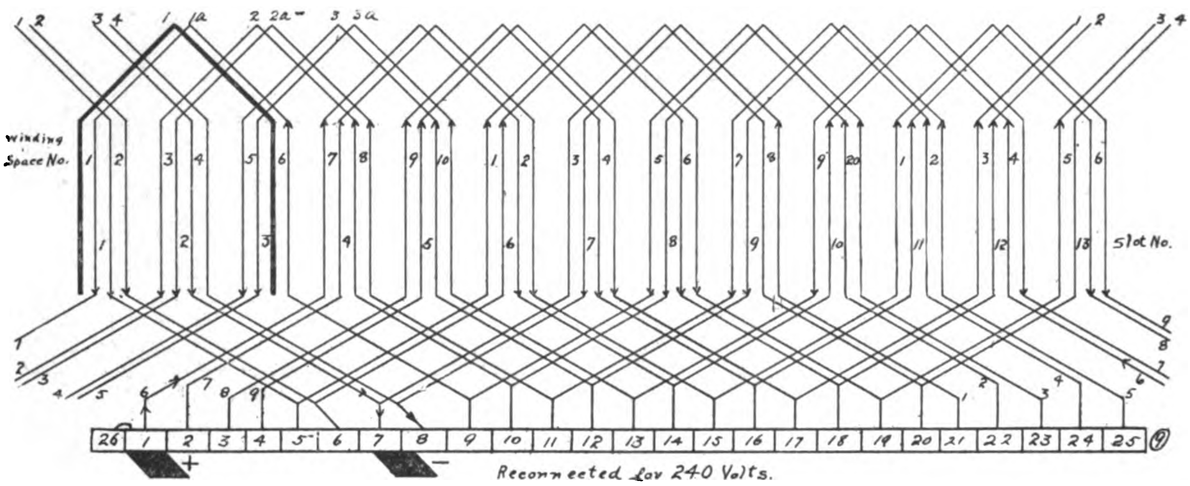


Fig. 9.

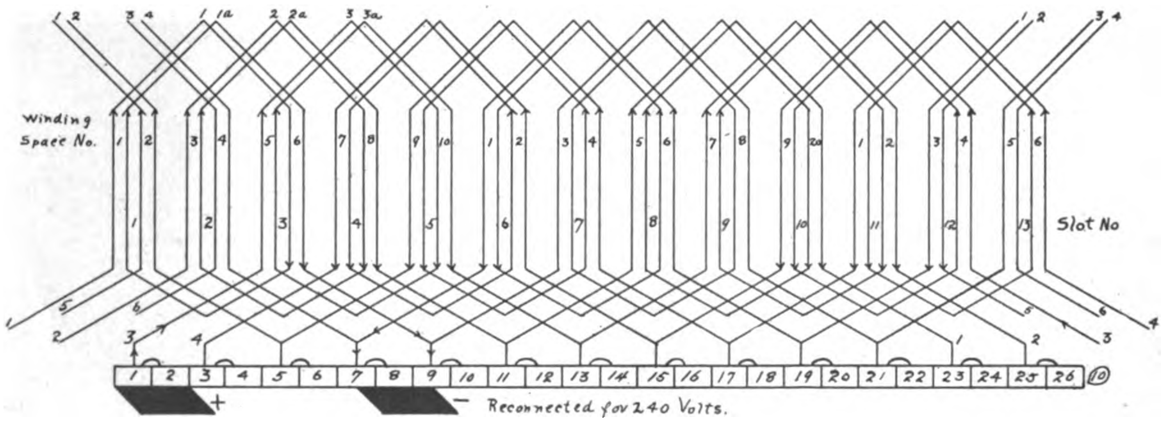


Fig. 10.

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.

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.

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.

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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.

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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.

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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 primarly 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 capacity 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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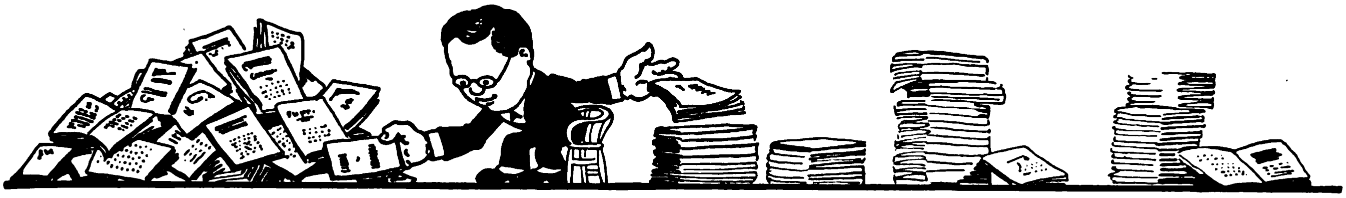
POWER PLANT EFFICIENCY

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 elctromotive 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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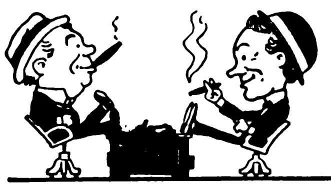
NEW MOTOR BOOKS

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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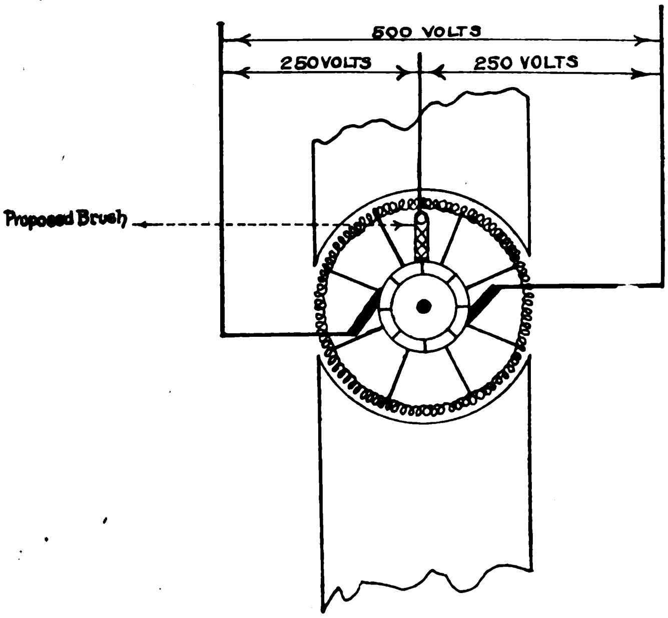
Antomotive Electric Association held its third semi-annual meeting at Lake Placid Club, Essex County, New York, July 10-12. The attendance was the largest of any meeting held thus far, every member company being well represented. Consideration was given to the question of extending the membership. The 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.

* * *

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.

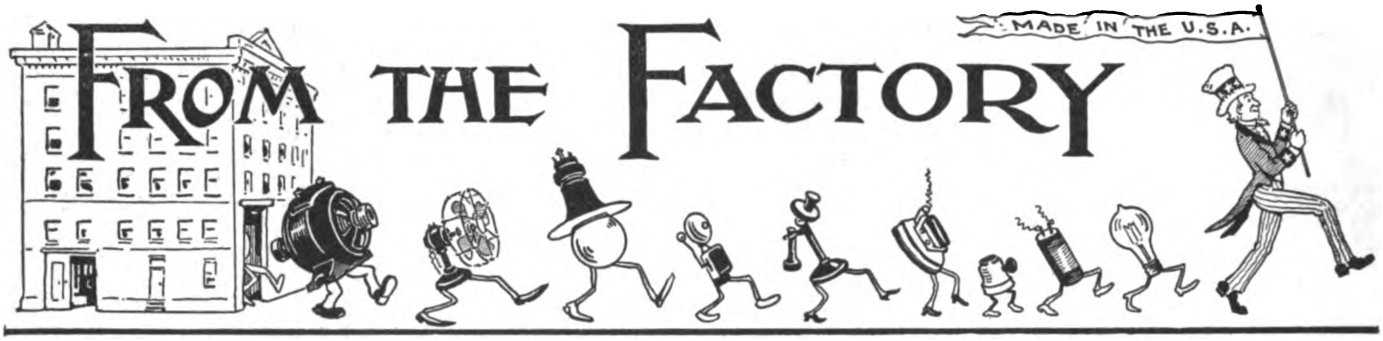
If the output of the transformer is to be, say, 120 watts, the input will need to be in excess of this. If the efficiency of the transformer is assumed to be 50 percent., the input will be 240 watts for an output of 120 watts. If the input is 240 watts and the applied pressure is 110 volts, the current 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 $137 \times 0.026 = 3½$ 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.

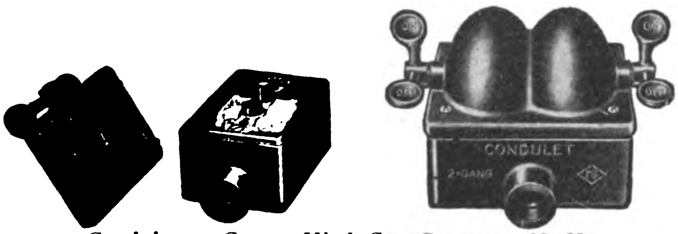
F. E. Austin, Hanover, N. H.



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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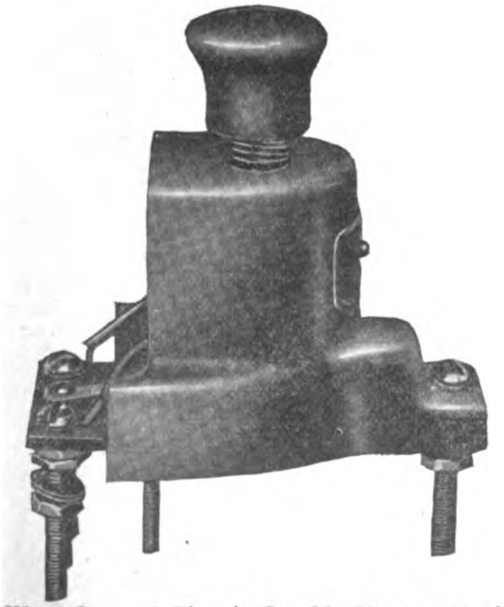
CUT-OUT FOR FARM LIGHTING SYSTEMS

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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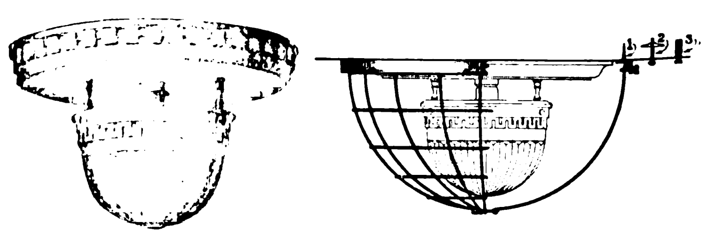
PROTECTIVE GUARD *for* LIGHTING UNITS

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.

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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.

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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

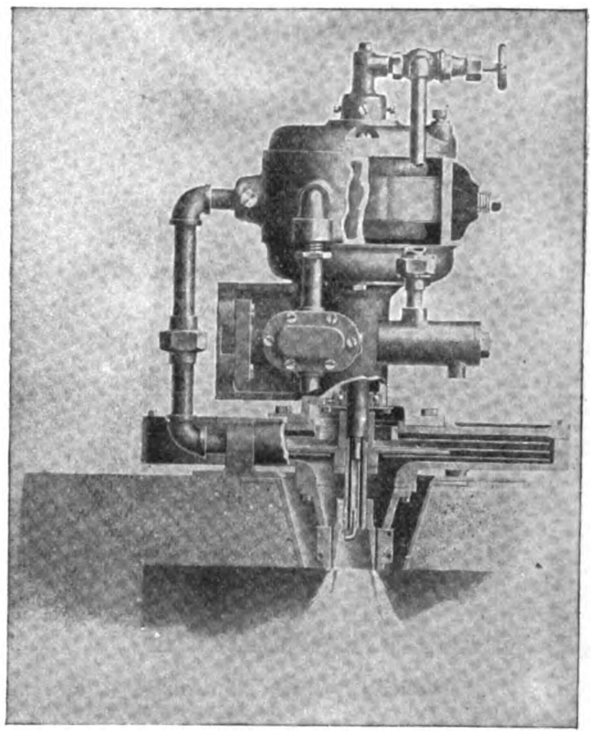
In order to prevent a recurrence of the fuel conditions of the past winter, much study is being given to the fuel situation.

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.

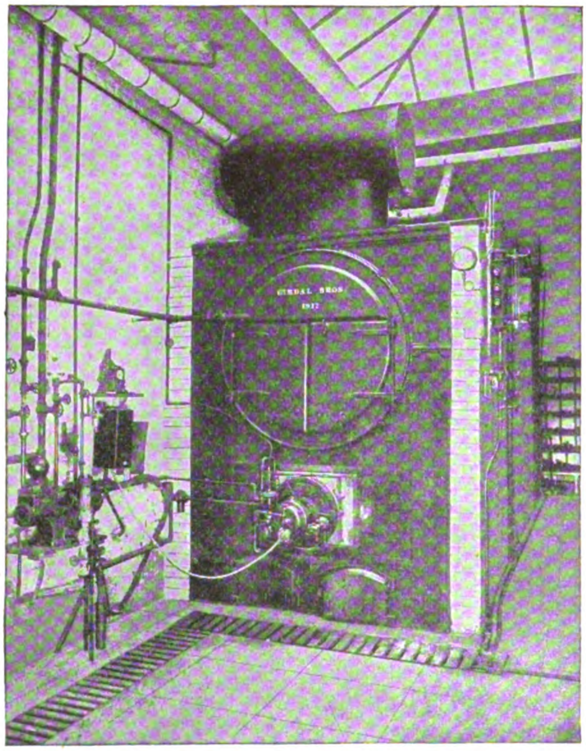
burner should require no adjustments after installation, and should operate over long periods of time without attention. When properly installed a successful burner carries a very low fire hazard.

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.

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.

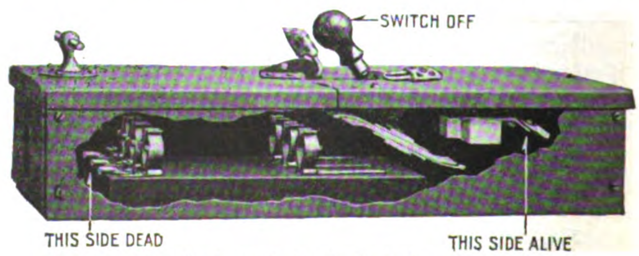
As in the case of other apparatus, the buzzer has undergone marked changes from the crude form employed on bell circuits. The aim has been to obtain a greater rate of vibration from the armature, so that the interruptions would be of a higher order. This has called for delicate adjustments and good contacts, 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.

SAFETY SWITCH

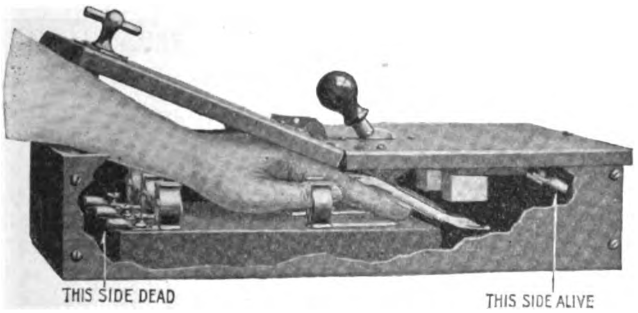
In many steel mills, factories, mills, and similar industries where most of the workmen have little knowledge of electricity, it is desirable to use switches having no live parts exposed or accessible in the ordinary operation of the switches or when replacing fuses.

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" position 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.



Shows how it is impossible to touch live parts.

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.

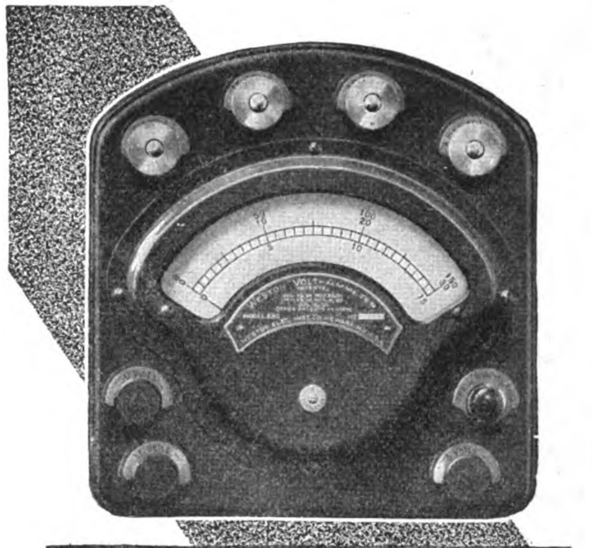
✤ ✤ ✤

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.

✤ ✤ ✤



THE CLEARING HOUSE

Advertisements on this page 5 cents a word. No advertisement accepted for less than $1.00. Electrical Engineering reserves the right to open all letters addressed in its care and agrees to forward only answers that are germane to the product or subject advertised.

FOR SALE

FOR SALE—Steam Engine for sale: 200 to 380 hp. Harrisburg cross compound automatic engine on sub-base. Cylinder 14 in. x 26 in. x 18 in. Wheel 72 in. x 30 in. face. First-class operating condition. Dimensions 8 ft. x 12 ft. Sell right for quick sale. Address: J. F. Foster, 294 Washington St., Boston, Mass.

FOR SALE—Second-hand central energy lamp telephone system, with Kellogg switchboard, now wired for 40 phones, ultimate capacity 100 phones; 5 wall and 25 desk telephone instruments. Ideal for a factory. Fish & Horton, 133 Mill Street, Rochester, N. Y.

GOOD PAYING BUSINESS—Electric retail and contracting, in Western Michigan for sale. Stock runs about three thousand ($3000). Can reduce to one thousand dollars ($1000) in three months. One competitor. Must make change on account of son's health. Will consider any opening in the Southwest in the electrical business. I am 42 years old. I have spent 12 years in my present location, 3 in the office of Power Co., and 9 in a plant where I filled positions from oiler to first assistant engineer. Address: C. N. care of ELECTRICAL ENGINEERING, 1642 Woolworth Bldg., New York City.

HELP WANTED

ELECTRICAL testers wanted for A.C. and D.C. machines. Must have some electrical experience. Technical or trade school graduate preferred. No age limit. Salary $16 per week and up, depending upon capability. Address: Employment Department, Diehl Manufacturing Company, Elizabeth, N. J.

MISCELLANEOUS

DEBTS collected everywhere, quickly! Established 25 years, same address. William H. Dodd, 87 Nassau St., New York City.

Immediate Delivery

50 KW. 125 volt, G.E. generator, 6 pole 280 RPM. direct connected to a 13 x 12 G.E. ideal engine.

10 KW. 125 volt, G.E. generator, direct connected to an 18 HP. Metz & Weiss kerosene engine.

400 KVA. 3 phase, 60 cycle, 480 volts, Westinghouse alternator. 400 RPM.

125 KW. 3 phase 60 cycle, 2300 volts, G.E. alternator.

75 KW. 3 phase, 60 cycle, 440 volts Westinghouse alternator.

2-100 HP. 110 volt, Holtzer-Cabot D.C. motors.

Large stock of smaller sizes.

JOSEPH MYERSON
270 Commercial Street
BOSTON, MASS.

ELECTRICIAN WITH FAMILY

In a beautiful, up-to-date Western New York village with good schools and churches, there is an opening for an experienced electrician to secure permanent employment on Government work.

This is a particularly splendid opportunity for a man with family of young children who desires for them the benefits of outdoor country life with city advantages.

After a month's work, mutually satisfactory to the man and company, moving expenses of family will be paid.

State experience, age, nationality, size of family, wages expected and send character references with first letter. Address P. S. C., care ELECTRICAL ENGINEERING, 1642 Woolworth Building, New York City.

FOR SALE

GAS ENGINES

For Natural Gas—Illuminating Gas or Distillate

1 100 H. P. Weber Engine
2 150 H.P. Rathbun Jones Engines

For Producer Gas

2 100 H.P. Rathbun Jones Engines
Smith Gas Producers

All machines perfect condition

A. H. COX & CO., Inc.
307-309 First Ave. So. Seattle, Wash.

ENGINE AND DYNAMO FOR SALE

Nash 30 hp. Gas Engine, with General Electric double generator, 160 volts direct, 60 cycle, alternating switchboard, air compressor, air tanks. Excellent condition, suitable for testing purposes or isolated plant.

S. S. HEPWORTH CO.,
2 Rector St., New York City.

FOR SALE

40-K. W. Generator Garwood Type
3-Wire System. 125-250 Volts
Speed 275 Revolutions.
Switch Board 1-panel with instruments marble type.
All in first class condition
Address:
THE PASTIME AMUSEMENT CO.,
17 S. High St., Columbus, Ohio

Air Compressor Operators Wanted

MEN with practical mechanical training, capable of operating and making minor repairs and adjustments to Ingersoll-Rand motor driven Compressors. In large shipyard near Philadelphia. Salary $35.00 per week for eight hour shift.

Apply "R. B. C." Box 10
care of ELECTRICAL ENGINEERING
Woolworth Building New York City

DIRECTORY OF CONSULTING ENGINEERS ARCHITECTS and CONTRACTORS

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Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GLOBES, SHADES, Etc.
General Electric Co., Schenectady, N. Y.

GRAPHITE
Dixon Crucible Co., Jos., Jersey City

HAND LAMPS, Electric
Southern Electric Co., Baltimore, Md.

HANGERS, Cable
Standard Underground Cable Co., Pittsburgh, Pa.

HEATING Apparatus, Elec.
General Electric Co., Schenectady, N. Y.
Russell Electric Co., Chicago, Ill.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

HOISTS, Electric and Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

HYDRAULIC MACHINERY
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

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Weston Elec. Inst. Co., Newark, N. J.

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General Electric Co., Schenectady, N. Y.
Norton Electrical Inst. Co., Manchester, Conn.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Inst. Co., Newark

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Locke Insulator Co., Victor, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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International Insulating Corp., New York City
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Okonite Co., The, New York City
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Southern Electric Co., Baltimore, Md.
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Samson Cordage Works, Boston, Mass.
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Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Flaming Arc
General Electric Co., Schenectady N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LAMPS, Incandescent
General Electric Co., Schenectady N. Y.
National Lamp Works, Nela Park Cleveland, Ohio
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Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Westinghouse Lamp Co., N. Y. City

LAMPS, Miniature
General Electric Co., Schenectady N. Y.
Southern Electric Co., Baltimore, Md.

LANTERNS, Electric
Southern Electric Co., Baltimore, Md.

LIGHTNING ARRESTERS
Delta-Star Electric Co., Chicago, Ill.
General Electric Co., Schenectady N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LINE MATERIAL
General Electric Co., Schenectady N. Y.
Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

LUBRICANTS
Calebaugh Self-Lubricating Carbon Co. Inc., Philadelphia, Pa.
Dixon Crucible Co., Jos., Jersey City
Galena Signal Oil Co., Franklin, Pa.

MACHINERY GUARDS Perforated
Erdle Perforating Co., Rochester, N. Y

MAGNET WIRE
American Steel & Wire Co., N. Y. C.
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Roebling's Sons Co., John A., Trenton N. J.
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co. New York City

MECHANICAL STOKERS
Westinghouse Machine Co., E. Pittsburgh, Pa.

MERCURY RECTIFIERS
Cooper-Hewitt Electric Co., Hoboken N. J.

METAL, Perforated
Erdle Perforating Co., Rochester, N. Y

METAL PUNCHING
Erdle Perforating Co., Rochester, N. Y

METALS
American Platinum Works, Newark

METERS
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General Electric Co., Schenectady, N. Y.
Norton Elec. Inst. Co., Manchester, Conn.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

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Galena Signal Oil Co., Franklin, Pa.

OZONIZERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

PAINTS, Insulating
General Electric Co., Schenectady, N. Y.
McGill Mfg. Co., Valparaiso, Ind.
Standard Underground Cable Co., Pittsburgh, Pa.

PANELBOARDS
Adam Electric Co., Frank, St. Louis
Columbia Metal Box Co., N. Y. City
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

PERFORATED METALS
Erdle Perforating Co., Rochester, N. Y.

PHOTOMETER Standards
Electrical Testing Laboratories, New York City

PINS, Iron
Southern Exchange Co., The, N. Y. C.

PLATINUM
American Platinum Works, Newark.
Baker & Co., Newark, N. J.

PLUGS, Flush & Receptacles
Adam Electric Co., Frank, St. Louis
Benjamin Elec. Mfg. Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

POLES, Ornamental Street
Brady Elec. & Mfg. Co., New Britain, Conn.

POLES, Brackets, Pins, Etc.
Brady Elec. & Mfg. Co., New Britain, Conn.
Southern Exchange Co., The, N. Y. C.
Western Electric Co., New York City

POT-HEADS
Brady Elec. & Mfg. Co., New Britain, Conn.
Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.

PRODUCERS, Gas
Westinghouse Machine Co., E. Pittsburgh, Pa.

PUMPS
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Roebling's Sons Co., John A., Trenton, N. J

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General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

REELS
Minneapolis Elec. & Cons. Co., Minneapolis, Minn.

REFLECTORS
Erdle Perforating Co., Rochester, N. Y.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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Dixon Crucible Co., Jos., Jersey City

RESISTANCE UNITS
Dixon Crucible Co., Jos., Jersey City
General Electric Co., Schenectady, N. Y.

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General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

ROSETTES
National Metal Molding Co., Pittsburgh, Pa.

SCREENS AND SIEVES, Perforated
Erdle Perforating Co., Rochester, N. Y.

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General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City

SEWING Machine Motors
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.
Wisconsin Elec. Co., Milwaukee, Wis.

SOCKETS and Receptacles
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.

SOCKETS, Turndown
General Electric Co., Schenectady, N. Y.

SOLDERING IRONS
General Electric Co., Schenectady, N. Y.
Pittsburgh Elec. Specialties Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

SOLDERING MATERIAL
Alex. R. Benson Co., Hudson, N. Y.

SOLDERLESS CONNECTORS, Frankel
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SOLENOIDS
General Electric Co., Schenectady, N. Y.

STAGE Lighting Apparatus
General Electric Co., Schenectady, N. Y.

STAPLES, Insulating
American Steel & Wire Co., N. Y. C.

STARTERS & CONTROLLERS, Motor
General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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Electric Bond & Share Co., N. Y. City

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National Metal Molding Co., Pittsburgh, Pa.
Western Electric Co., New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

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Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City

SURFACING, Steel and Tin
Erdle Perforating Co., Rochester, N. Y.

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General Electric Co., Schenectady, N. Y.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
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Palmer Electric & Mfg. Co., Boston, Mass.

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National Metal Molding Co., Pittsburgh, Pa.
Southern Elec. Co., Baltimore, Md.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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General Electric Co., Schenectady, N. Y.
Palmer Electric & Mfg. Co., Boston, Mass.

SWITCHES, Knife
Adam Electric Co., Frank, St. Louis
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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Palmer Electric & Mfg. Co., Boston, Mass.

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Palmer Electric & Mfg. Co., Boston, Mass.

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Palmer Electric & Mfg. Co., Boston, Mass.

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Western Electric Co., New York City

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Dossert & Co., New York City
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General Electric Co., Schenectady, N. Y.

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General Electric Co., Schenectady N. Y.
Kuhlman Electric Co., Bay City, Mich
Moloney Electric Co., St. Louis, Mo.
Packard Electric Co., Warren, O.
Pittsburgh Transformer Co., Pittsburgh
Thordarson Elec. Mfg. Co., Chicago
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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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Leffel & Co., James, Springfield, O.
Western Electric Co., New York City
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VACUUM CLEANERS
Western Electric Co., New York City

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Erdle Perforating Co., Rochester, N. Y

WASHING MACHINES Electric
Western Electric Co., New York City

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Erdle Perforating Co., Rochester, N. Y

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Allis-Chalmers Mfg. Co., Milwaukee Wis.
Leffel & Co., James, Springfield, O

WATTMETERS
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WIRES AND CABLES
American Platinum Works, Newark
American Steel & Wire Co., N. Y. C
Detroit Insulated Wire Co., Detroit
General Electric Co., Schenectady N. Y.
Lowell Ins. Wire Co., Lowell, Mass
Moore, Alfred F. Philadelphia, Pa.
Okonite Co., The, New York City
Roebling's Sons Co., John A., Trenton N. J.
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Rome Wire Co., Rome, N. Y.
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Western Electric Co., New York City

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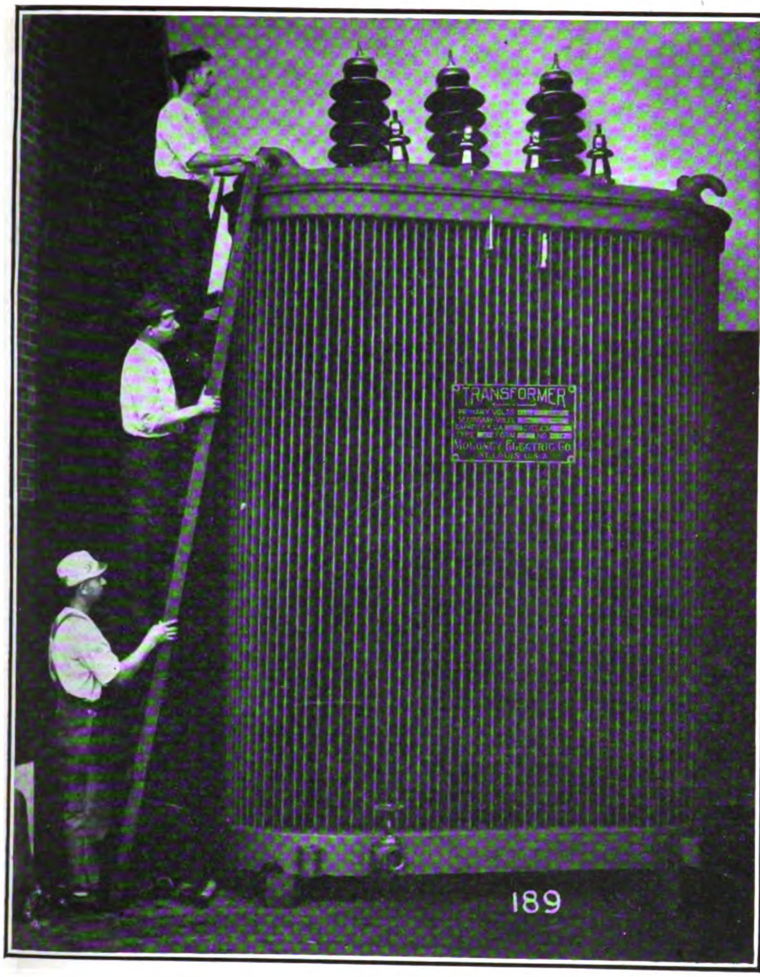


MOLONEY TRANSFORMERS

"READY

for a

BIG JOB"

Moloney Electric Co.

ST. LOUIS, MO. WINDSOR, CAN.

OFFICES

New York
Washington
Chicago
Minneapolis
Salt Lake
Seattle
San Francisco
Los Angeles

LOXON LAMP GUARD

THE KEY TO SAFETY

PRUDENCE Sells These Guards for You

"Thousands of lamps are needlessly exposed to breakage and theft—make your bid for this mighty market by offering the simple preventive of "Loxon Guards."

A special key secures the guard in place—only the possessor of the key can get at the lamp.

"Loxon Lamp Guards" are low in cost to the user and remarkably profitable for the dealer, jobber or central station to handle.

Talking "prices" will convince you—ask today for prices and catalogue.

McGill Mfg. Company

39 Oak Street Valparaiso, Ind.

THE NORTON

(D'Arsonval Type)

SWITCHBOARD INSTRUMENTS

NORTON Instruments represent QUALITY, ACCURACY and DURABILITY

Prompt Service and Satisfaction Guaranteed It will pay you to write for Discounts.

Norton Electrical Instrument Co.

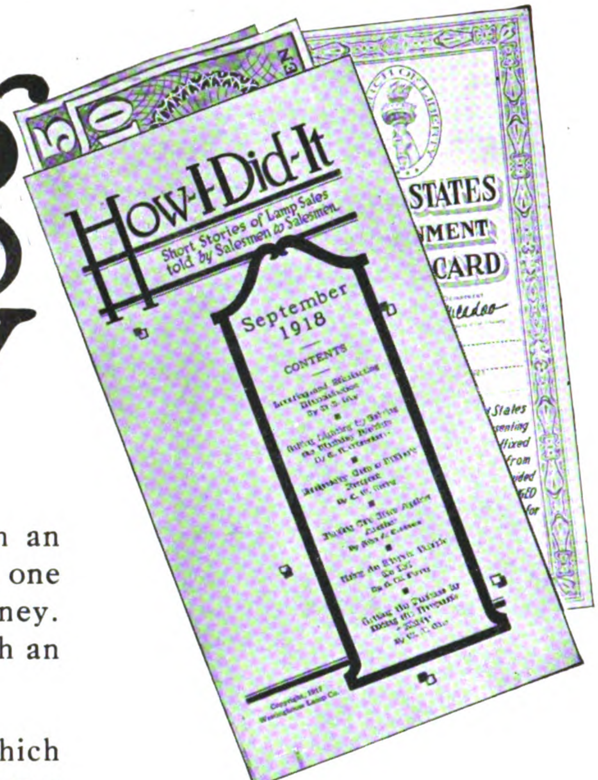
MANCHESTER, CONN., U. S. A.

Volume 52. No. 3 SEPTEMBER, 1918 20 Cents per Copy

Electrical Engineering

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

Finding Money



To "cash in" a second time on an idea that has already paid you one dividend is like finding money. HOW-I-DID-IT offers just such an opportunity to salesmen.

Isn't there some lamp sale which you succeeded in landing because of some cleverly conceived idea or an out-of-the-ordinary sales argument? If so, why not send a story of the sale to HOW-I-DID-IT, and try to collect one of the awards offered every month? It's easier than you imagine.

It doesn't have to be a long story, nor does the style of writing count. It's the idea we want. If the story needs editing we'll take care of that.

To celebrate HOW-I-DID-IT's third birthday and to help meet the high cost of living, the awards have been advanced to

$15.00 in cash and $10 00 in Thrift Stamps for the best story printed in each issue.

$2.00 in cash and $3.00 in Thrift Stamps for every other story which we use.

The second award has been discontinued.

If you have not seen HOW-I-DID-IT, we'll be glad to send you a copy, and will also add your name to our mailing list if desired.

But don't forget to write that story, and send it in at once. The next awards will come in handy in making payment on a Fourth Liberty Loan Bond.

GUARANTEED BY THE NAME

Westinghouse Lamp Co.

165 Broadway, New York, N. Y.

Sales Offices and Warehouses throughout the Country

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

Volume 52 SEPTEMBER 1918 Number 3

In This Issue:

Other Items of Interest:

MEMBER ABC

SUBSCRIPTION PRICE—United States and Possessions, Mexico and Cuba, $2.00 a year. Canada, $2.50 a year. Foreign Countries in Postal Union, $3.00.

CAUTION—Do not pay solicitors, unless they present written authority, with date, from the publishers to collect money.

NOTICE TO ADVERTISERS—To insure insertion, all copy, cuts, etc., for changes of regular advertisements in ELECTRICAL ENGINEERING should reach us not later than the 25th OF THE MONTH preceding date of publication; three days earlier if proof is desired. The first advertising forms close promptly on this date.
NEW or ADDITIONAL advertising not to occupy fixed position, can be inserted in a special form up to the 30th.

Member Audit Bureau of Circulation

Entered at the New York Post Office as Second-class Mail Matter.

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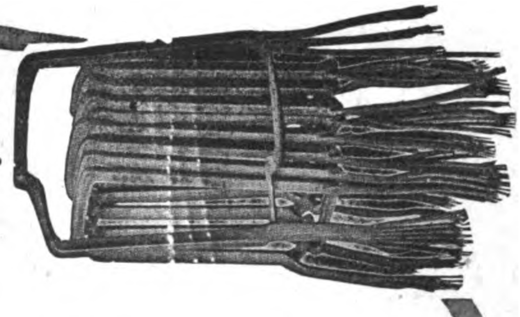
Your Motor is no stronger than its weakest coil



Our experience of 27 years in manufacturing electrical equipment and repair parts qualifies us to assert that the durability and strength of a motor depend on the careful attention given to every detail. The largest mining, street railway and electric companies have long ago discovered that "the best" only is worth while, so they specify

CHATTANOOGA

Armatures, Armature Coils, Fields Commutators

The care which we take in the selection of materials, in insulating and baking and the extremely practical tests which we insist on is your assurance of efficient motor service. **Write today for complete details and you will be better qualified to select dependable motor equipment.**

Chattanooga Armature Works

Chattanooga, Tenn.

Southern Representatives:
THE VAN DORN & DUTTON CO.
THE VAN DORN ELECTRIC TOOL CO.

---

has the insulation warped?

—and caused unreliable service and frequent adjustments of your apparatus? **BAKELITE-DILECTO** withstands a temperature of 300 F. and is impervious to water and acids. We guarante that

BAKELITE - DILECTO

Will Not Warp

It is the perfect insulation for apparatus installed in battery rooms and locations subject to extreme changes of temperature. It does not deteriorate with age and a sheet ⅛-in. thick has a dielectric strength of 100,000 volts. Sheets, rods, tubes and special shapes.

Our catalog and prices will interest you; write for them!

The Continental Fibre Company

Newark, Delaware

CHICAGO—332 S. Michigan Ave. NEW YORK—233 Broadway
SAN FRANCISCO—525 Market St.
LOS ANGELES—411 So. Main St.
PITTSBURGH—316 Fourth Ave.

We are prepared to make small and large

Gray Iron Castings

and do

SPECIAL MACHINE WORK

FOR THE TRADE

Correspondence solicited and prices gladly furnished

THOMASVILLE IRON WORKS

Thomasville, Ga.


The Wasteful
Carbon Shape
The Saving
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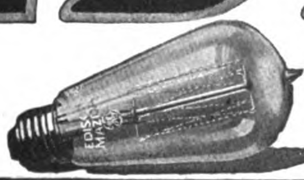

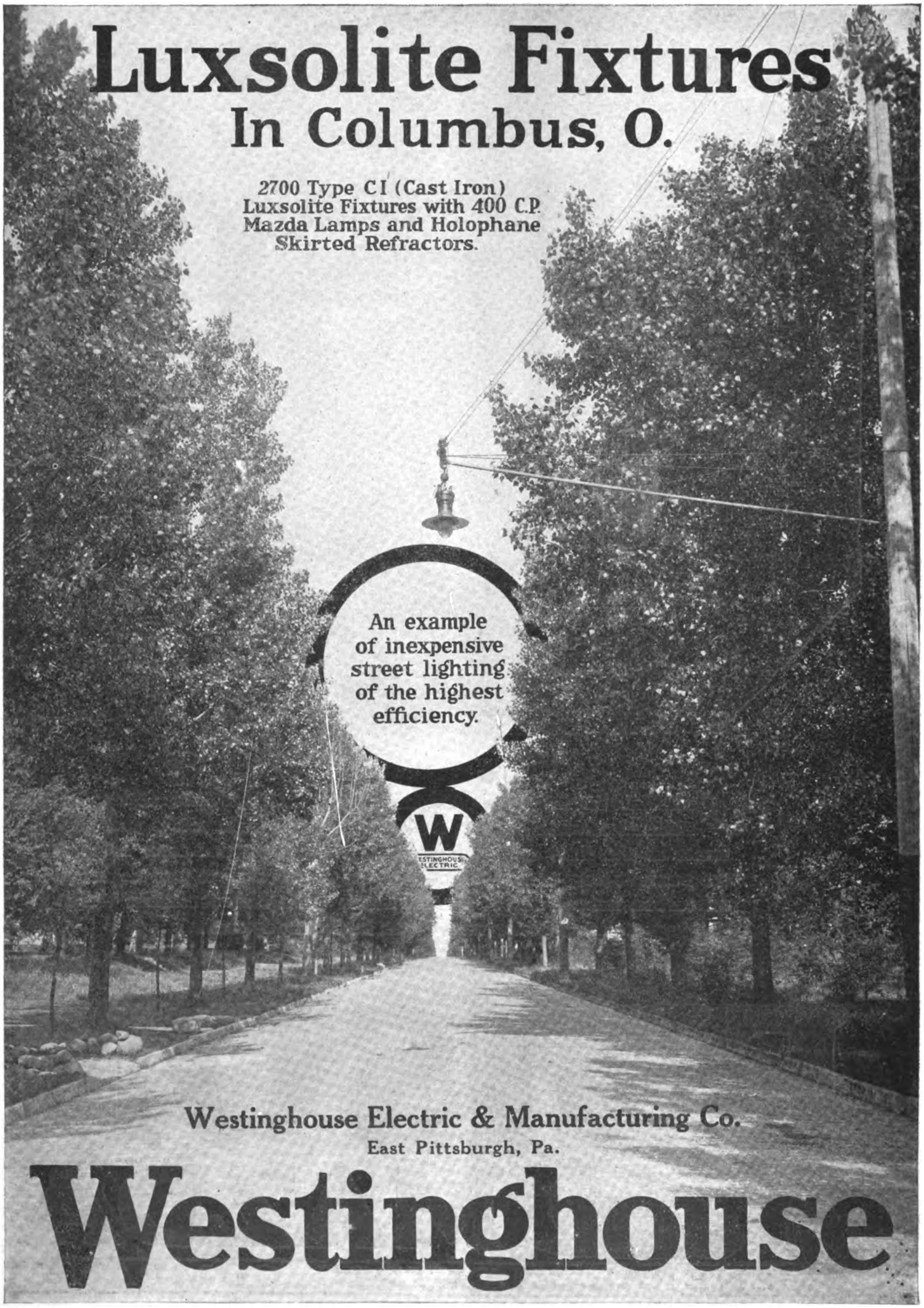
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ELECTRICITY'S PART IN BUILDING AND NAVIGATING OF SHIPS

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 cumulative, 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 3000 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 abount 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 percent. 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 1580 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 tne 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 form 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.

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

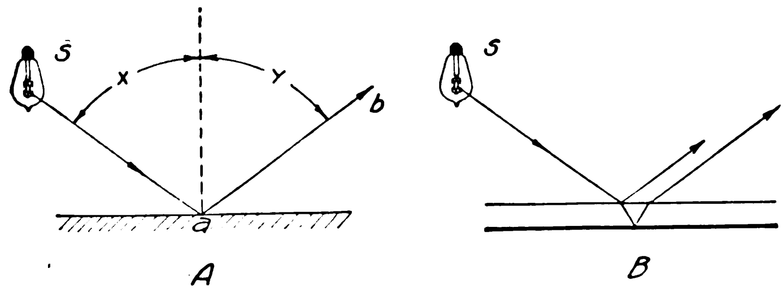

Fig. 1
B—Reflection from mirrored surface
A—Reflection from polished surface

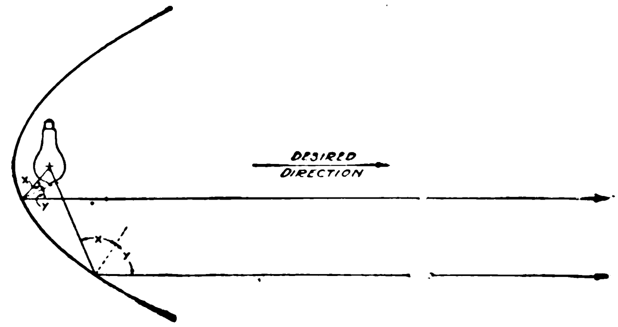

Fig. 2. Accurate light control may be obtained from polished-metal or mirrored surfaces

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,

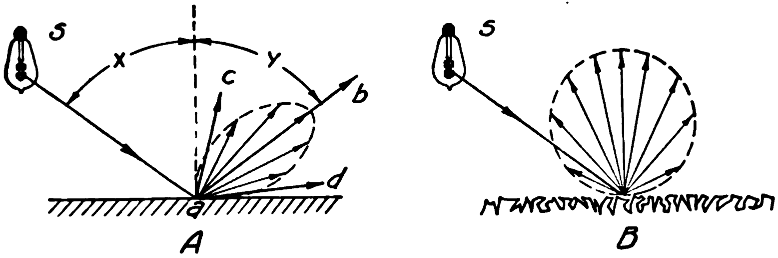

Fig. 3
A—Reflection from semi-mat surface
B—Reflection from rough mat surface

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.

Fig. 4. Typical aluminumized-steel reflector

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 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.**

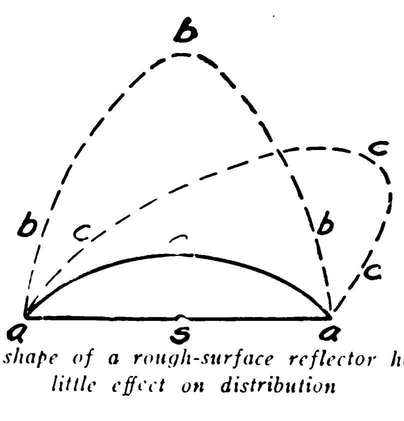

Fig. 5. The shape of a rough-surface reflector has relatively little effect on distribution

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 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.

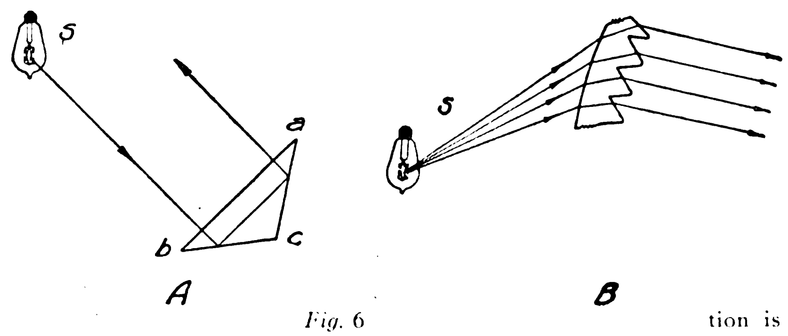

Fig. 6
B—Reflection by prisms
A—Reflection by prism

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 absorption is low and the efficiency of such glassware is of the highest order.

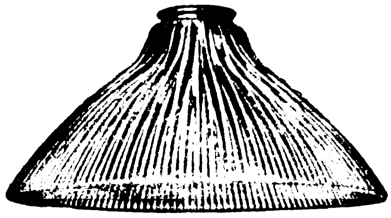

Fig. 7. Typical prismatic-glass reflector

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 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

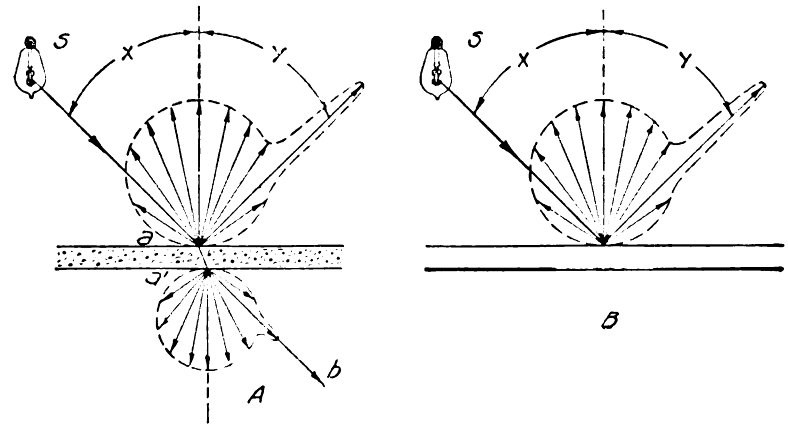

Fig. 8
A—Reflection and transmission by opal glass
B—Reflection from porcelain-enameled steel

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

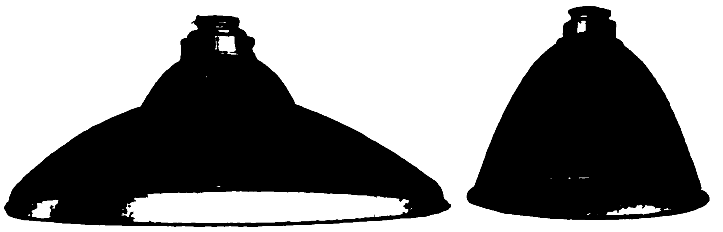

Fig. 9. Dome and bowl shaped porcelain-enameled steel reflectors

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 minimizes the collection of dust and permits easy cleaning; and

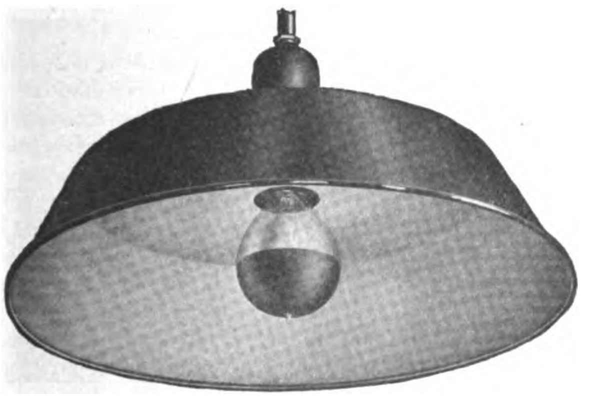

Fig. 10. Metal-cap diffusing unit

(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,

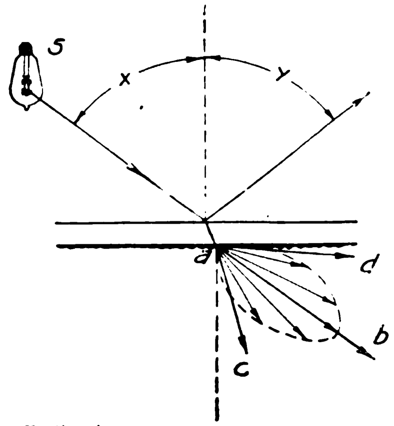

Fig. 11. Reflection and transmission by etched glass

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

By 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	7.05
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
						Σ = 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 3000×10^{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
							Σ = 1220

Table III

AVAILABLE POTENTIAL WATER POWER OF THE UNITED STATES

This gives about 1200×10^{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 cm². 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.

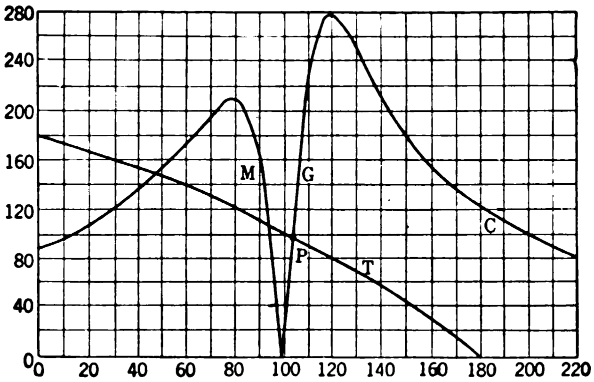

Fig. 1—Small Hydraulic Induction Generator Plant ***Constant*** *Terminal Voltage.*

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.

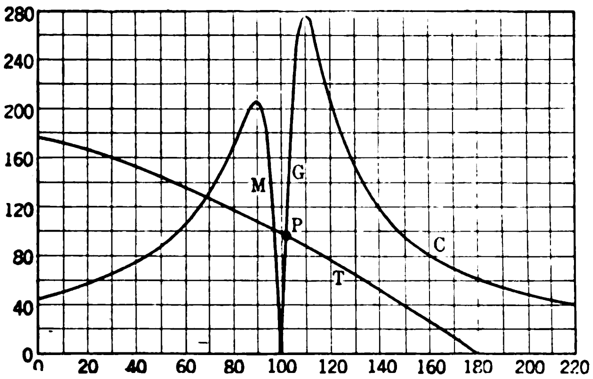

Fig. 2.—Small Hydroelectric Induction Generator Plant—Constant Voltage in Synchronous Station.

Assuming however an induction machine with much less slip, with only half the rotor resistance of Figs. 1 and 2. At constant

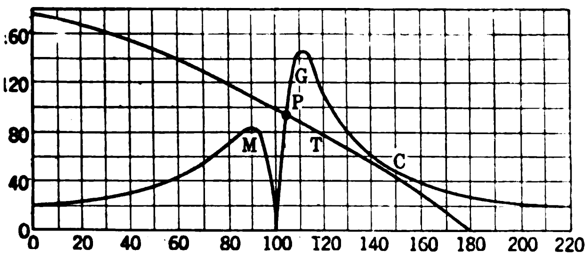

Fig. 3.—Large Hydroelectric Induction Generator Plant—Constant Terminal Voltage.

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 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,

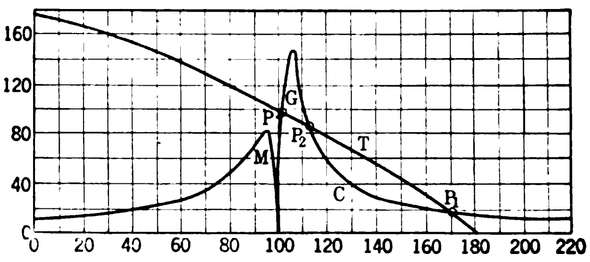

Fig. 4—Large Hydroelectric Induction Generator Plant—Constant Voltage in Synchronous Main Station.

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.

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

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-

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.

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

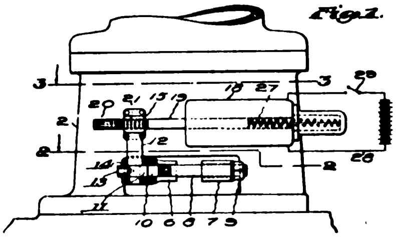


Fig. 1.

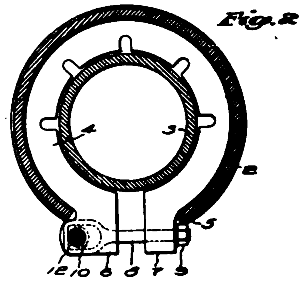
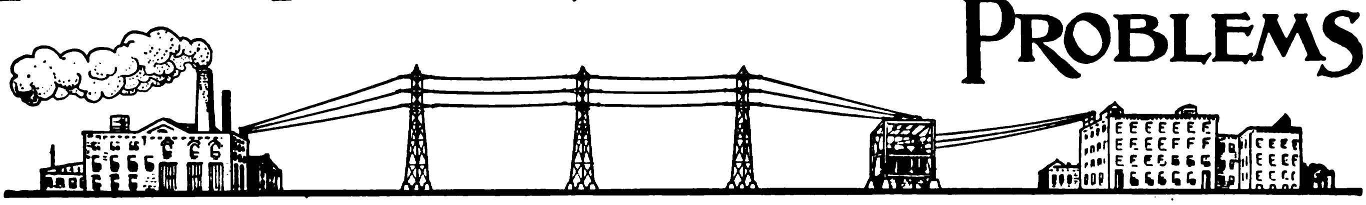


Fig. 2

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).

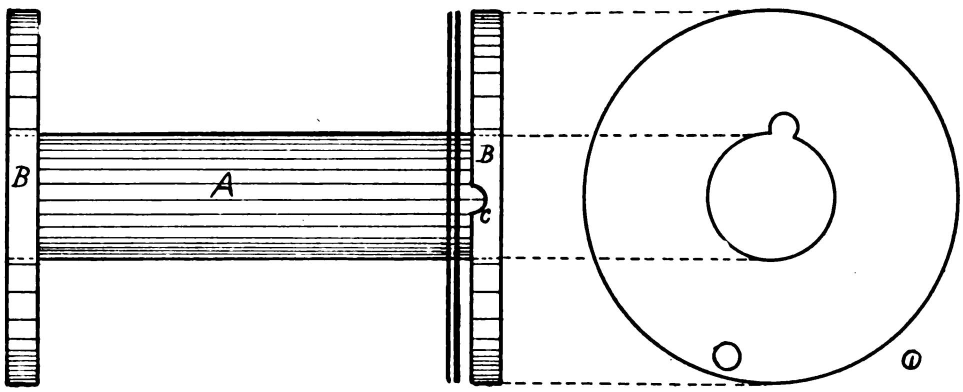


Fig. 1

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:

(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) $T^\circ = \dfrac{T \times W}{S}$

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

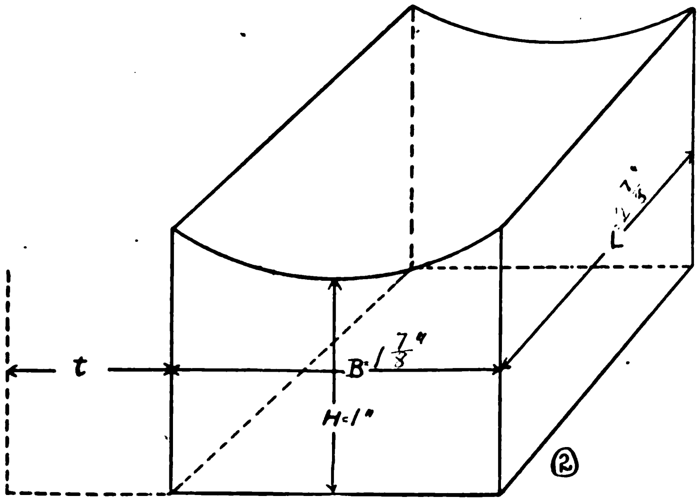


Fig. 2

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.

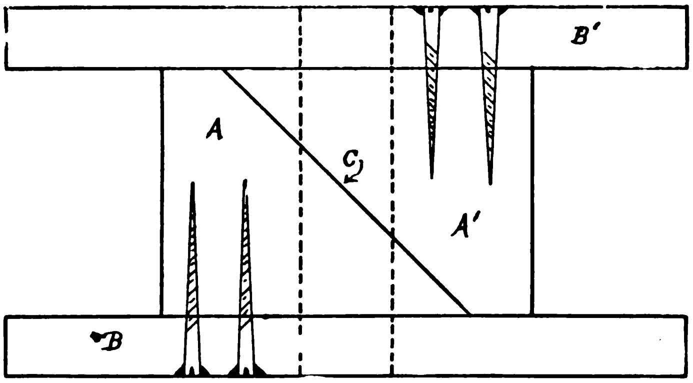


Fig. 3

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)

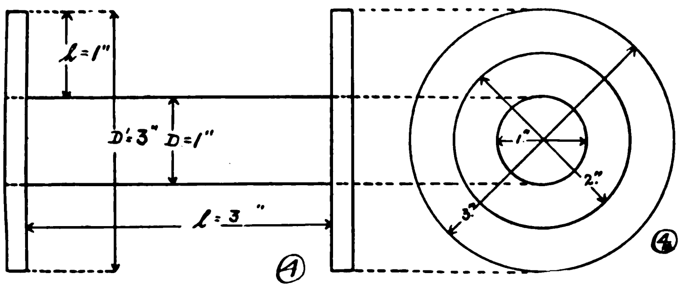


Fig. 4

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:

$$m = \frac{(2\,D + 2\,h) \times \pi}{2}^{2} = \frac{2 \times 1 + 2 \times 1) \times 3.1416}{1}^{2}$$

$= 6.2832$ 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° + 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: $B = 1\frac{7}{8}$ in.; $H = 1$ in.; $L = 2\frac{7}{8}$ 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 $\frac{1}{8}$ 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.

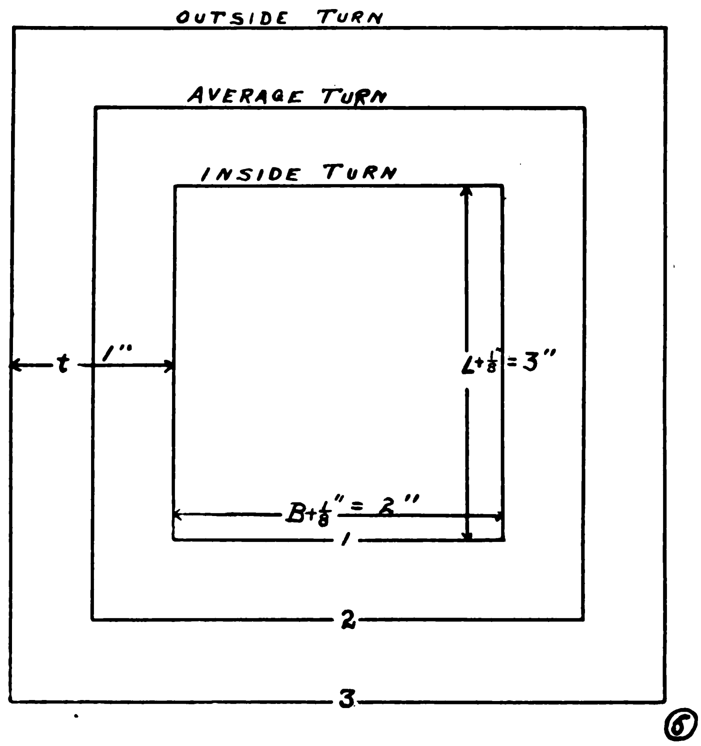


Fig. 5

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 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° + 70° = 145° 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 × 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 × 18.3 × 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

> **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.**

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.

✦ ✦ ✦

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.

✦ ✦ ✦

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.

✦ ✦ ✦

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.

✦ ✦ ✦

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.

✦ ✦ ✦

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.

✦ ✦ ✦

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.

✦ ✦ ✦

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.

✦ ✦ ✦

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.

✦ ✦ ✦

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.

✦ ✦ ✦

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.

◆ ◆ ◆

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.

◆ ◆ ◆

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.

◆ ◆ ◆

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.

◆ ◆ ◆

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.

NUTS FOR THE KNOWING ONES

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.

◆ ◆ ◆

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, 3-¾ in.
Width of slots, ⅜ in.
Diameter or armature, 6½ in.
Field core, 1½ in. X 3½ in.

C. E. COLLIER,
Eddyville, Ky.

Electrical ODDS AND ENDS

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.

◆ ◆ ◆

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.

◆ ◆ ◆

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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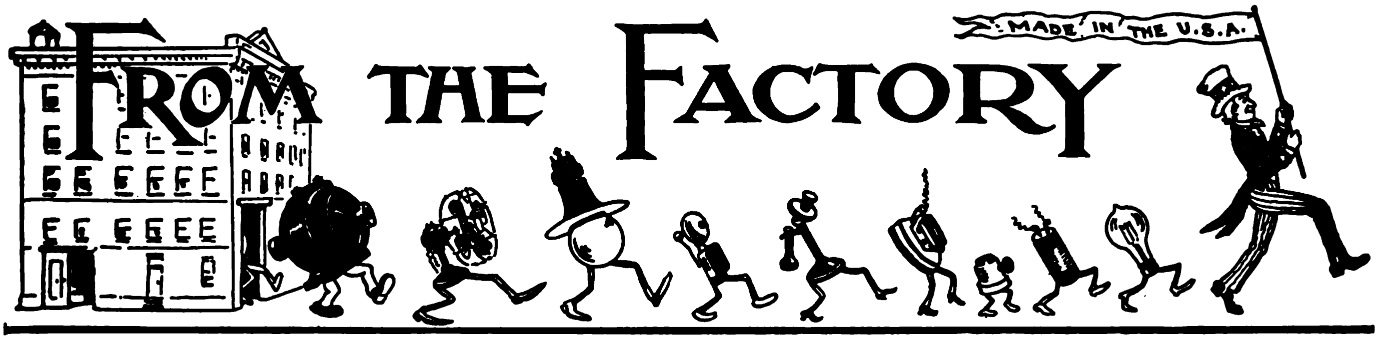
FOREIGN TRADE AFTER THE WAR

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

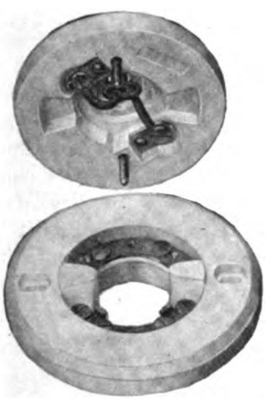


Fig. 1

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 Cömmttee 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

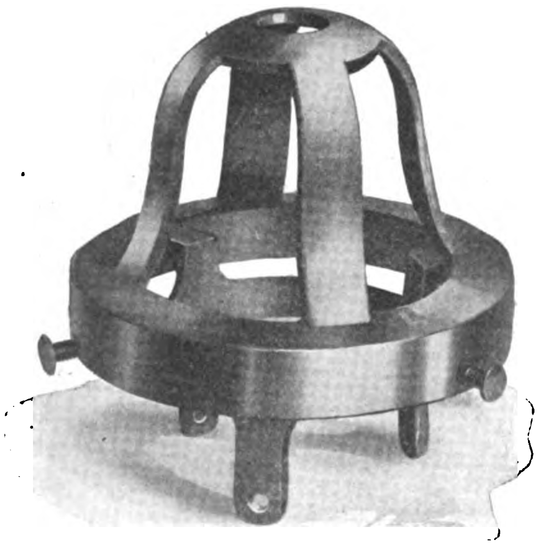
A portable lamp is being manufactured by the Anderson Electric Specialty Company, 118 South Clinton Street, Chicago, Ill. This lamp consists of an Adapt-a-Lite extension unit, 10 ft. of cord and socket, an adjustable shade and a bracket base.

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



Kwikfit holder, Fensterer & Ruhe, 37 Murray Street, New York.

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.

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.

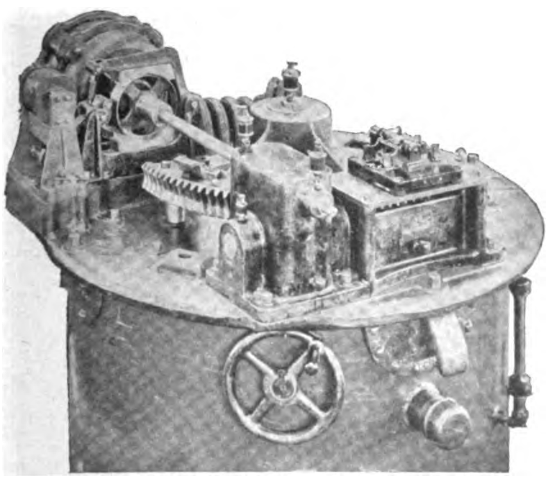
The contacts will close 5 amperes at 250 volts or less.

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.

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.

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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.

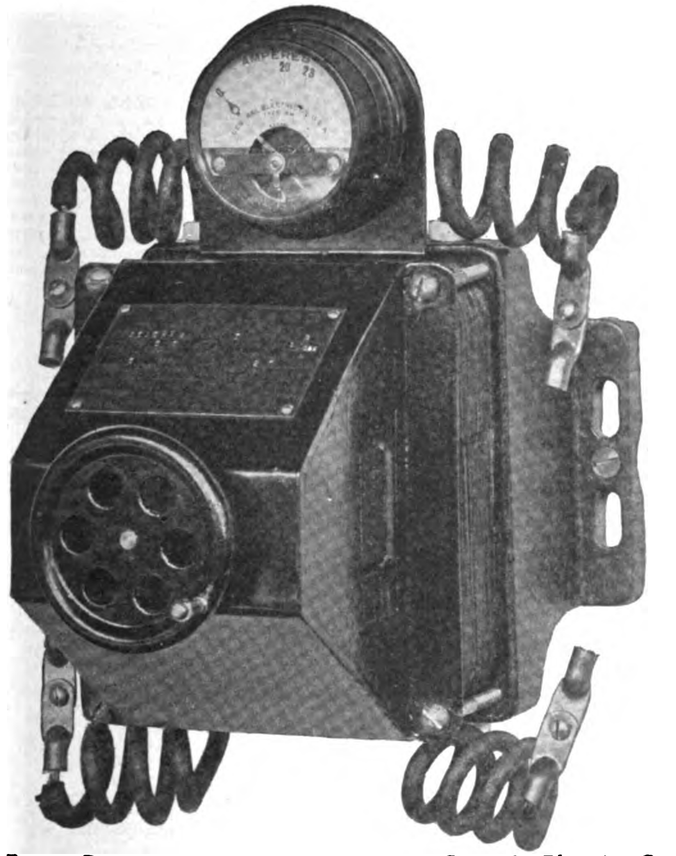
SEAL FOR CONDUIT

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

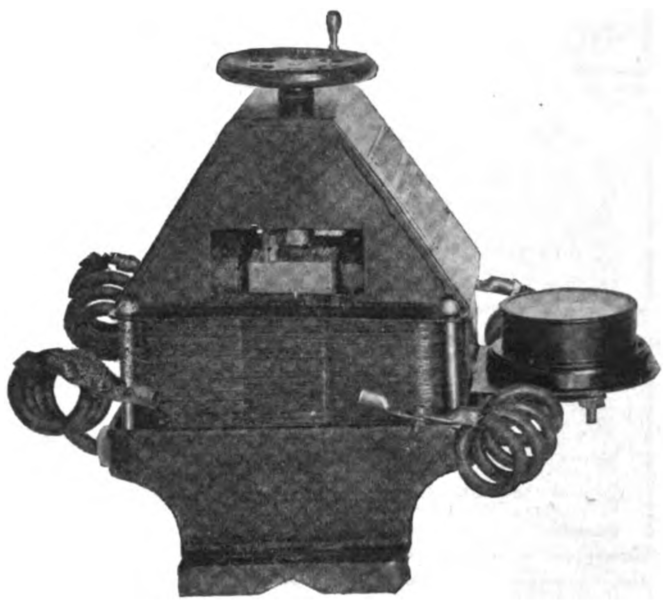


Form B reactance type compensarc. General Electric Co., Schenectady, N. Y.

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.

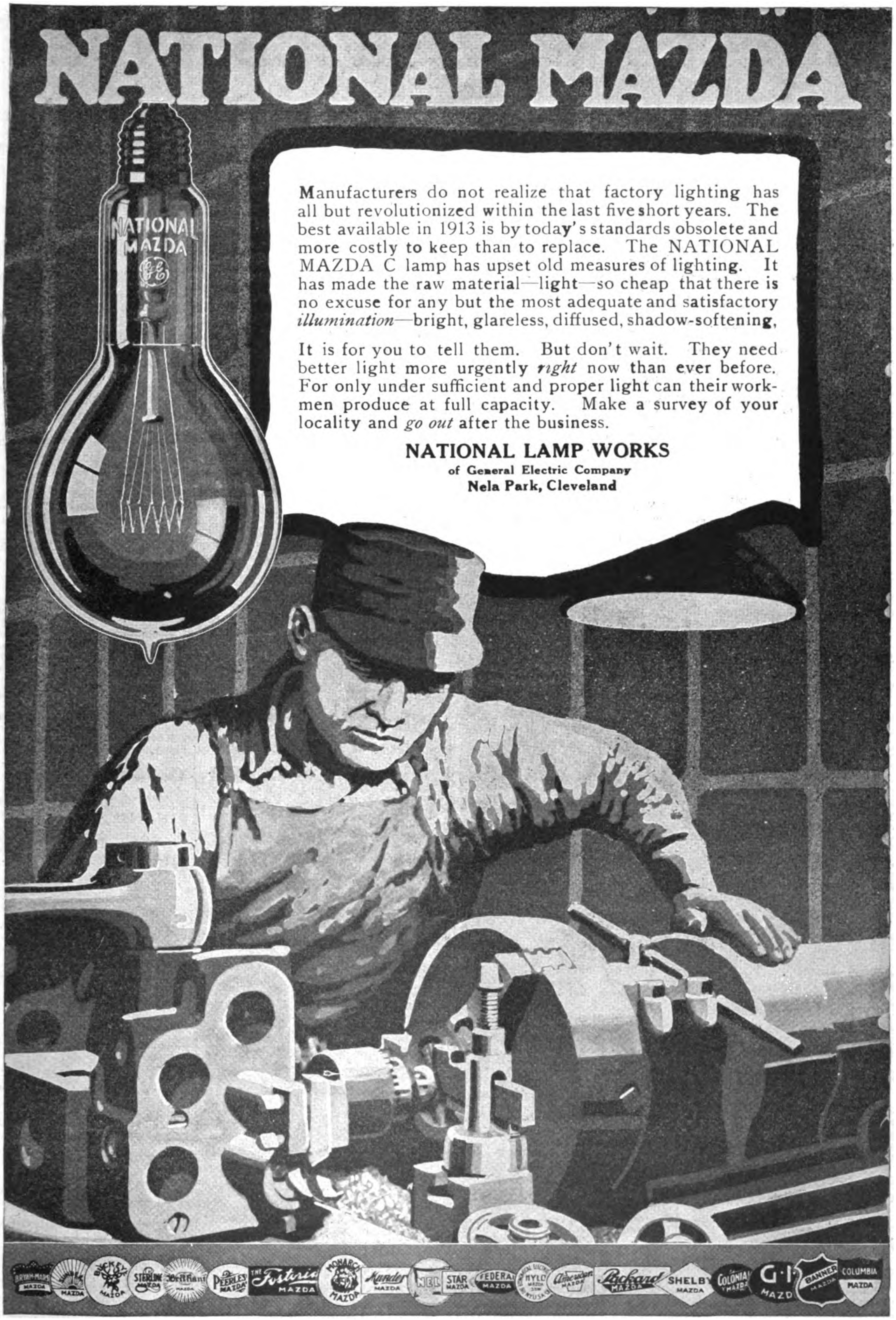
STOPPING THE LEAKS

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.

DIRECTORY OF CONSULTING ENGINEERS ARCHITECTS and CONTRACTORS


NATIONAL MAZDA
NATIONAL MAZDA
Manufacturers do not realize that factory lighting has all but revolutionized within the last five short years. The best available in 1913 is by today's standards obsolete and more costly to keep than to replace. The NATIONAL MAZDA C lamp has upset old measures of lighting. It has made the raw material—light—so cheap that there is no excuse for any but the most adequate and satisfactory *illumination*—bright, glareless, diffused, shadow-softening.
It is for you to tell them. But don't wait. They need better light more urgently *right* now than ever before. For only under sufficient and proper light can their workmen produce at full capacity. Make a survey of your locality and *go out* after the business.
NATIONAL LAMP WORKS
of General Electric Company
Nela Park, Cleveland

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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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Sanderson & Porter, N. Y. City.
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FIBRES
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LAMPS, Flaming Arc
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Western Electric Co. New York City
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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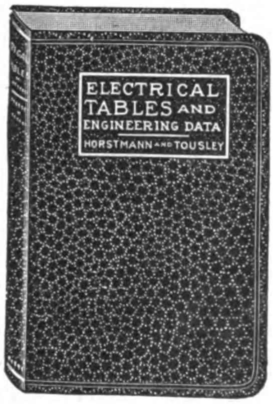
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Palmer Electric & Mfg. Co., Boston, Mass.

SWITCHES, Safety
Palmer Electric & Mfg. Co., Boston, Mass.

SWITCHES, Service
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Western Electric Co., New York City

WASHERS, Iron, Steel and Mica
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Leffel & Co., James, Springfield, O

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General Electric Co., Schenectady N. Y.
Lowell Ins. Wire Co., Lowell, Mass
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Okonite Co., The, New York City
Roebling's Sons Co., John A., Trenton N. J.
Phillips Insulated Wire Co., Pawtucket, R. I.
Rome Wire Co., Rome, N. Y.
Southern Electric Co., Baltimore, Md
Simplex Wire & Cable Co., Boston
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co., New York City

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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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ELEMENTS OF ILLUMINATING ENGINEERING—End of the Series. This Article Shows How to Make Practical Use of the Matter Discussed in the Preceding Installments.

METHOD OF MAKING NITRIC ACID—Another timely story on Extracting Nitrogen From the Air for Munition and Fertilizer Purposes.

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Electrical Engineering

Incorporating Electrical Age and Southern Electrician

ISSUED MONTHLY BY FRANK A. LENT

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GEO. A. WARDLAW, Editor

Volume 52 | OCTOBER 1918 | Number 4

In This Issue:

Other Items of Interest:

MEMBER ABE

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BUYERS' CLASSIFIED INDEX, PAGE 52

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Who whines or growls about the little sacrifice he is asked to make?

Who gets panicstricken and thinks that it would be better to compromise with the Hun and listens to the serpent whisperings of German propaganda?

If such an American exists let him realize what Germany has done to Russia, which gave in and negotiated a cowardly peace.

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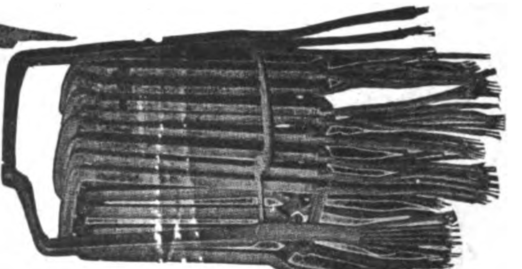

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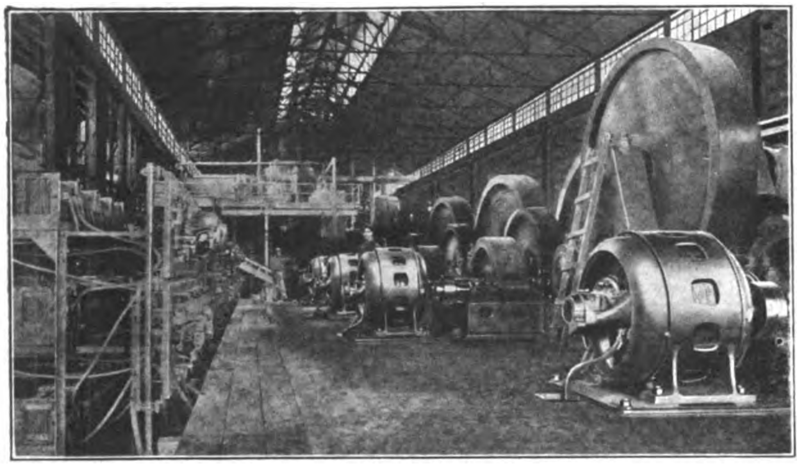

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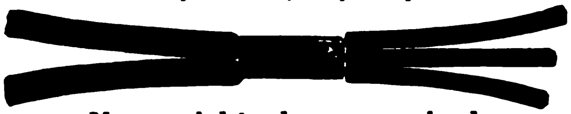

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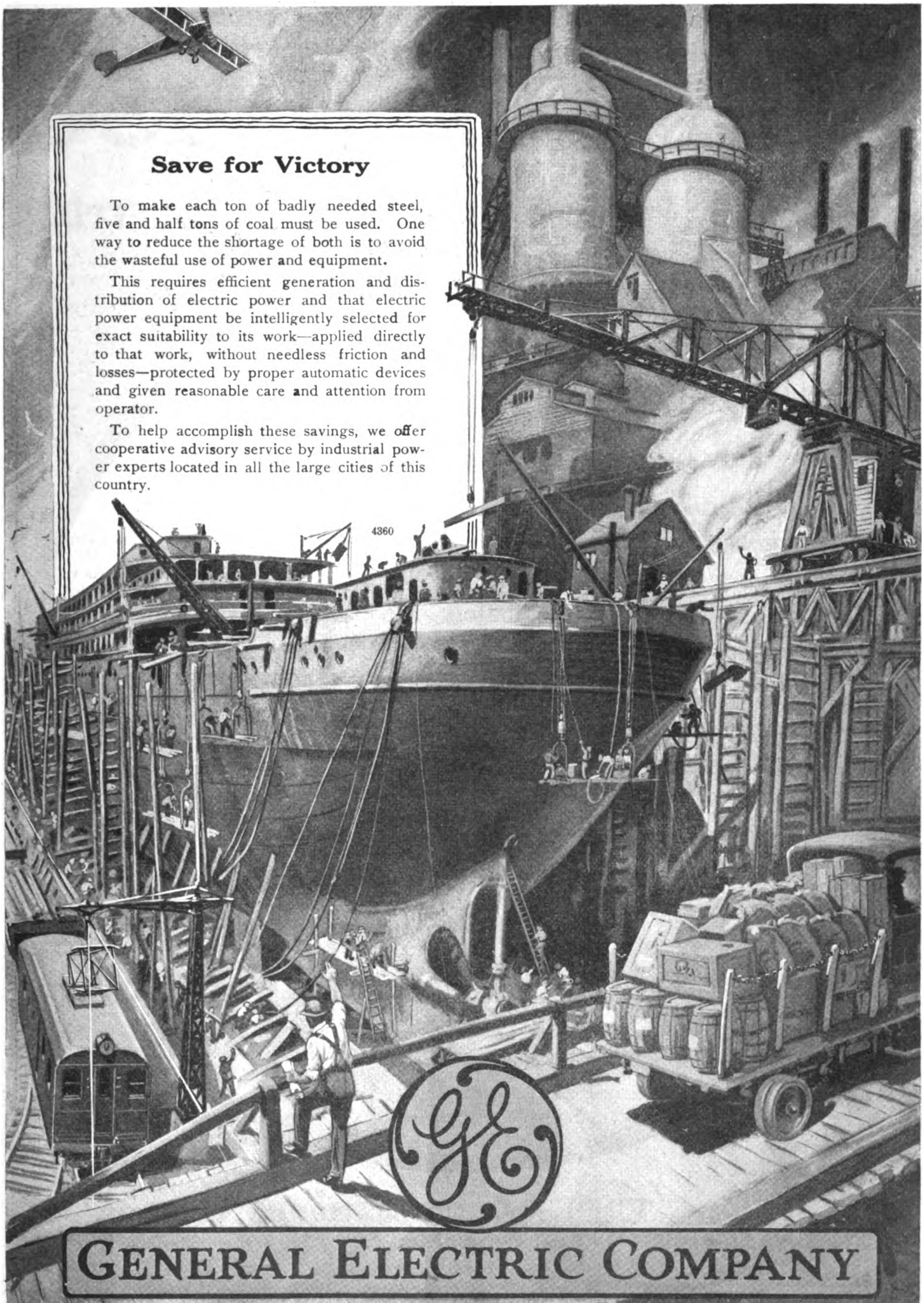
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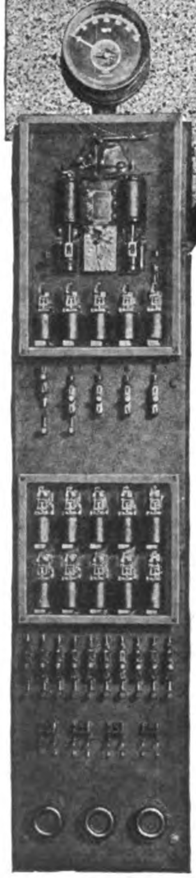

Fig. 1—Type AN-12 Generator Voltage Regulator for Controlling Three Exciters, Each Connected Directly to a Generator with Generators in Parallel Eastern Michigan Power Co's. 18,750 K.V.A. Junction Development.

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The Voltage Regulators are arranged in suitable cases for bracket, panel or pedestal mounting. The use of master relays permits the construction of regulators with as many as 60 rheostat-shunting relays. Any size regulator can be designed to be mounted on one or more 16-in. panels.

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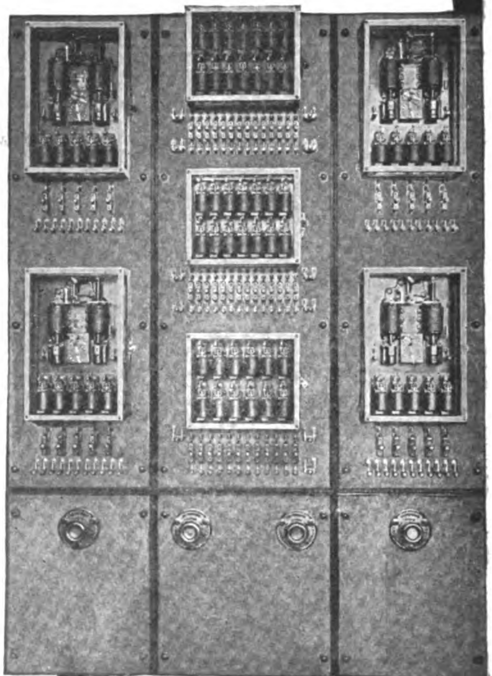

Fig. 3—Special 10-Relay Regulator for Laurentide Power Co.

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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 **OCTOBER, 1918** **No. 4**

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.

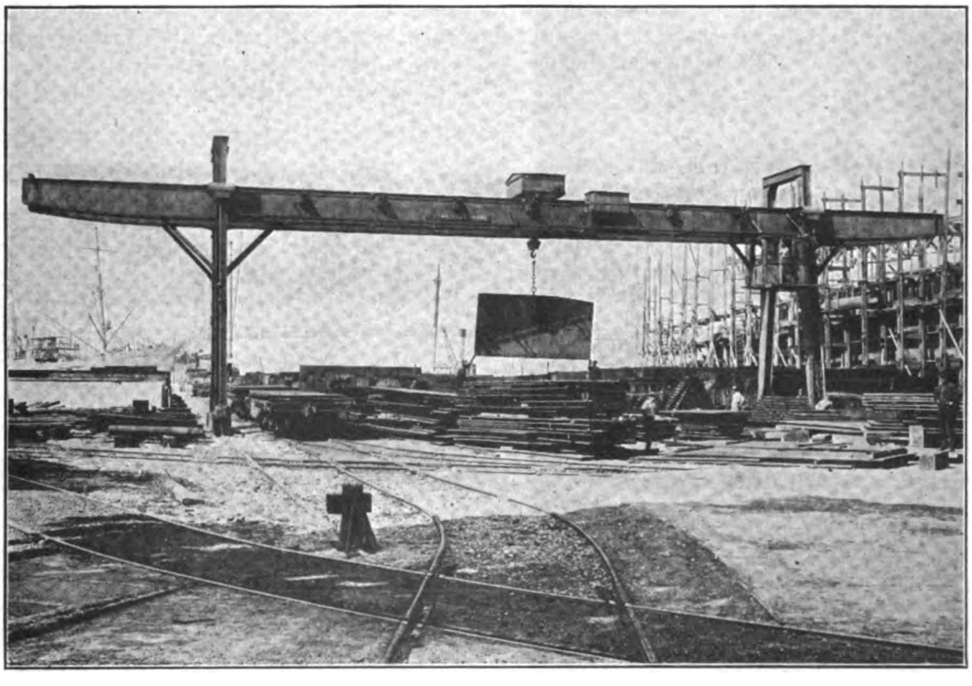

Fig. 1. 40-Ton Electric Traveling Crane

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

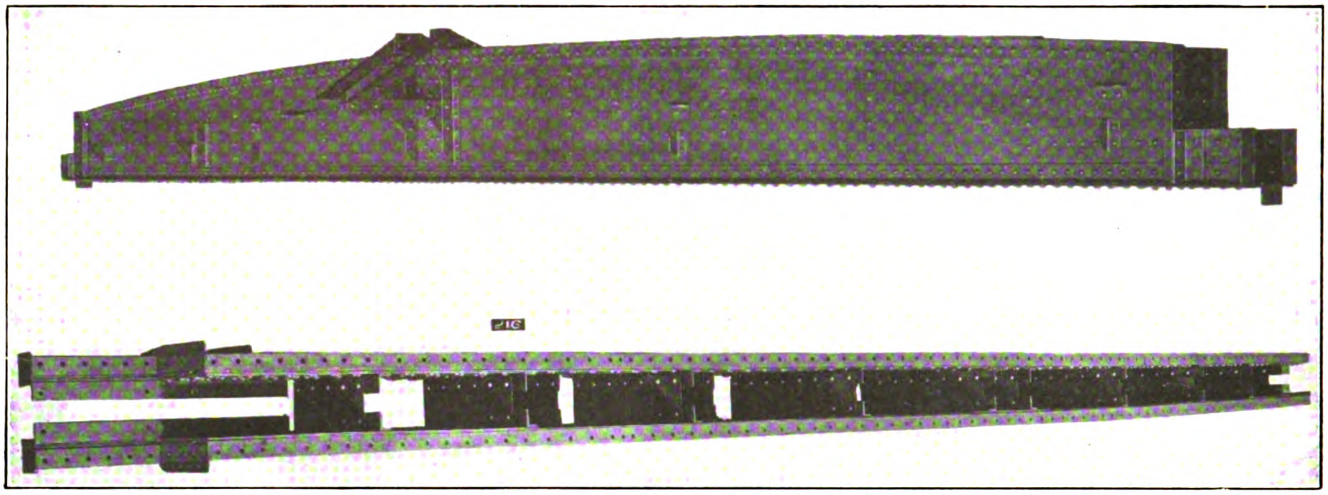

Fig. 2. Box-Section Type of Girder

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

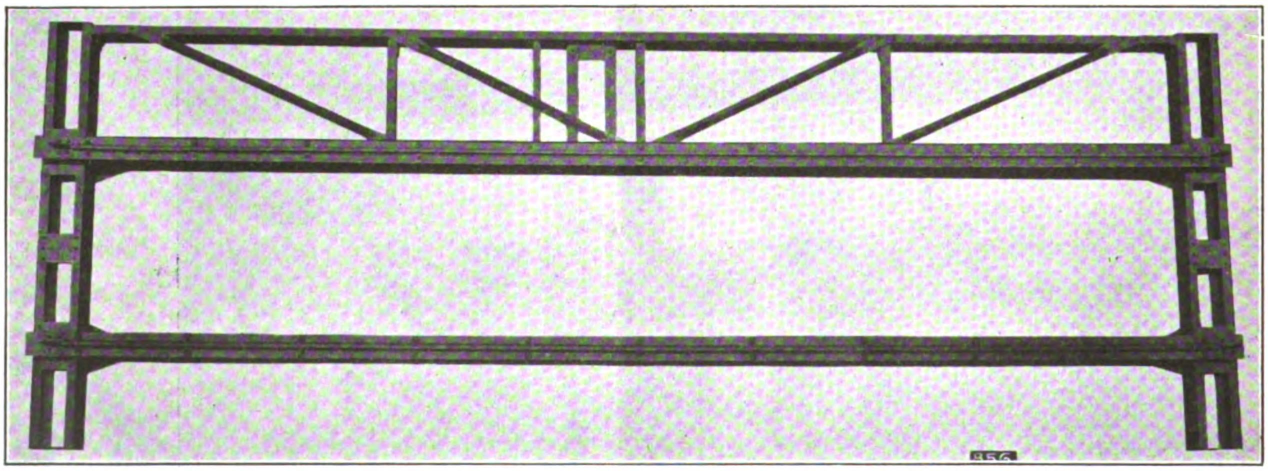

Fig. 3. Auxiliary-Braced Girder

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

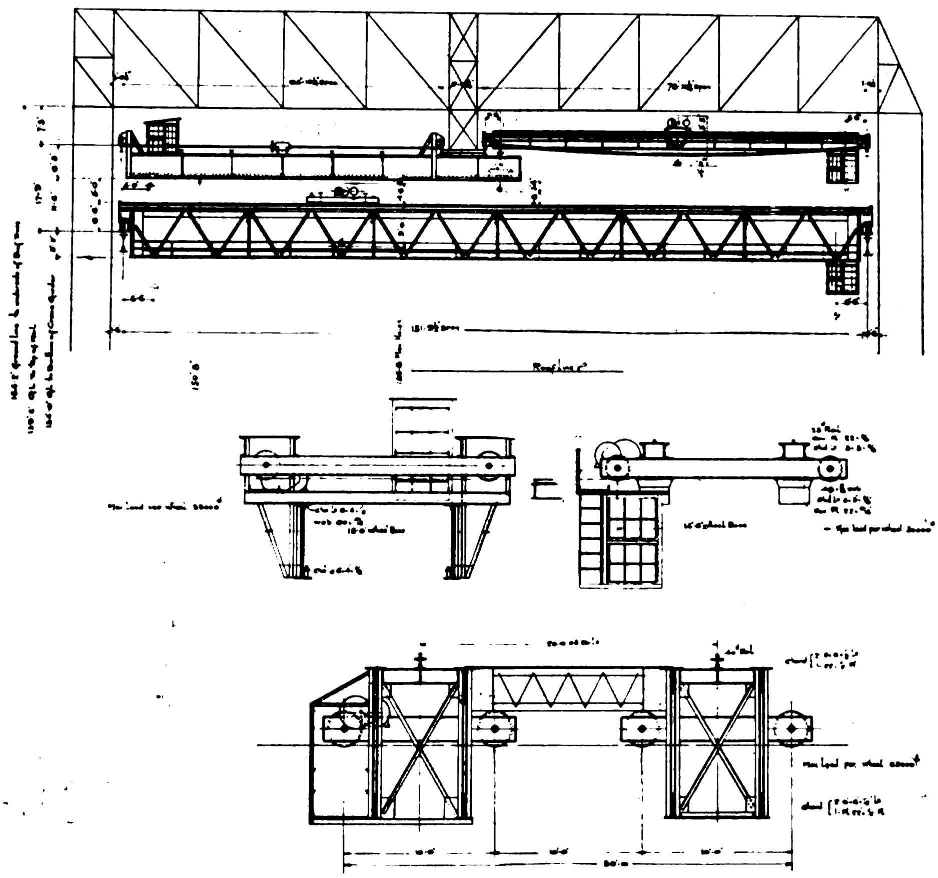

Fig. 4. Lattice Type Girder
Fig. 5. Sketch Drawing of 40-Ton, 152-Ft. Crane

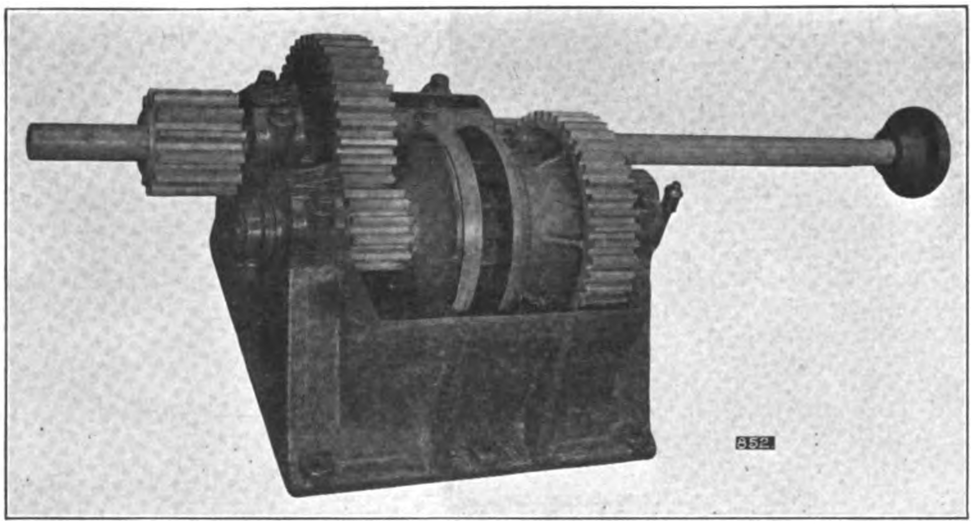

Fig. 6. Double Disc Mechanical Brake

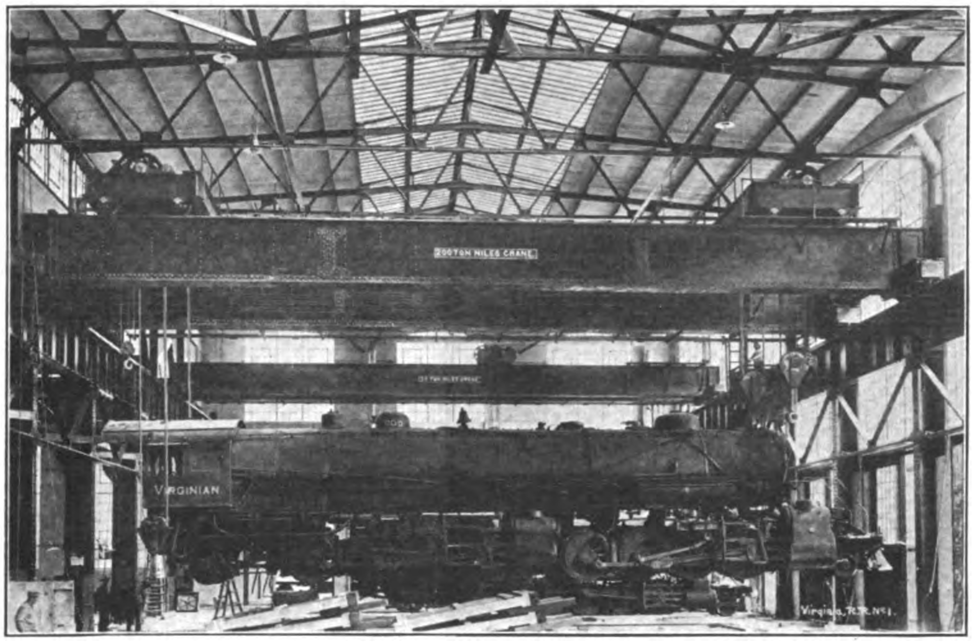

Fig. 7. Showing Cranes Operated by Alternating Current Motors

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.

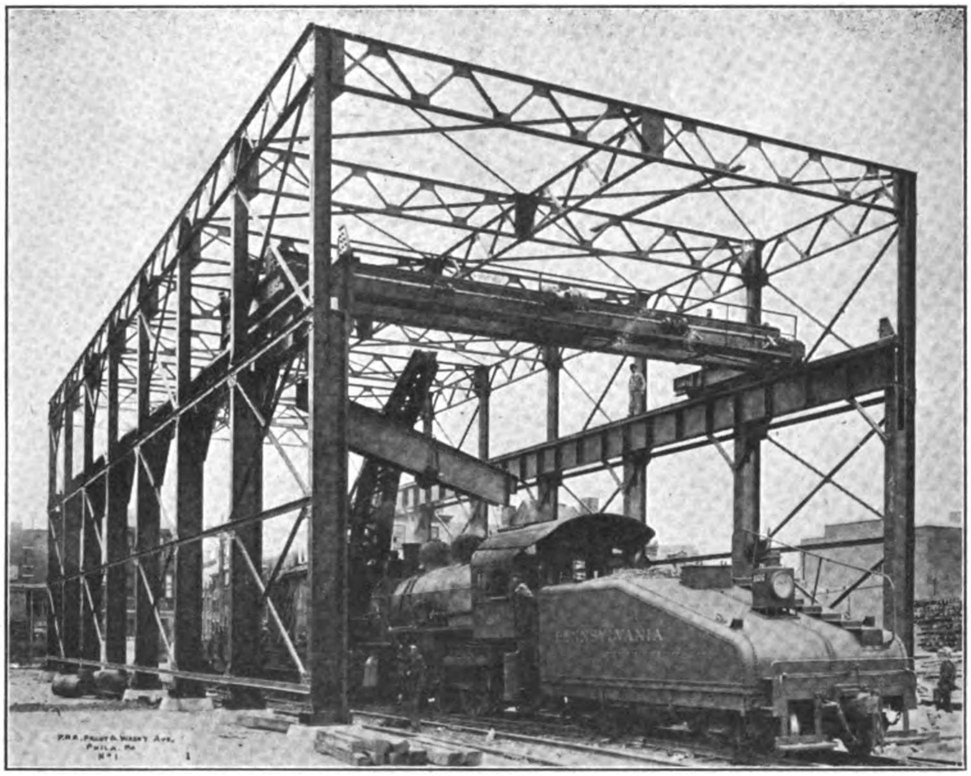

Fig. 9. 200-Ton Crane and Load

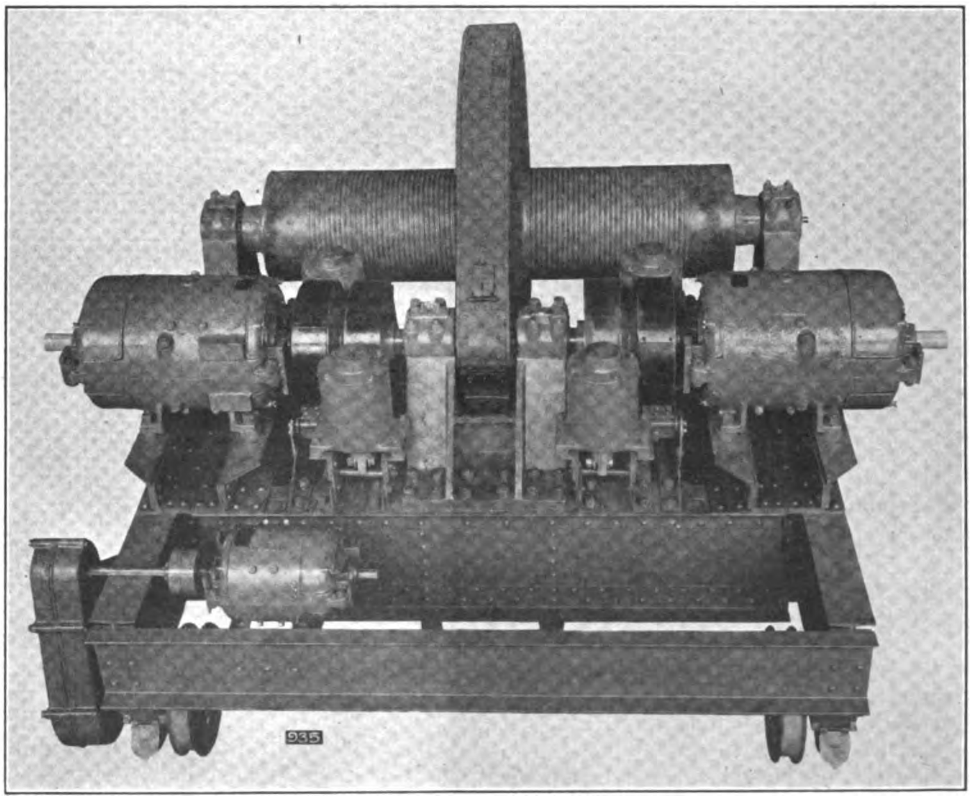

Fig. 10. Trolley for Gun-Dipping Crane

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.

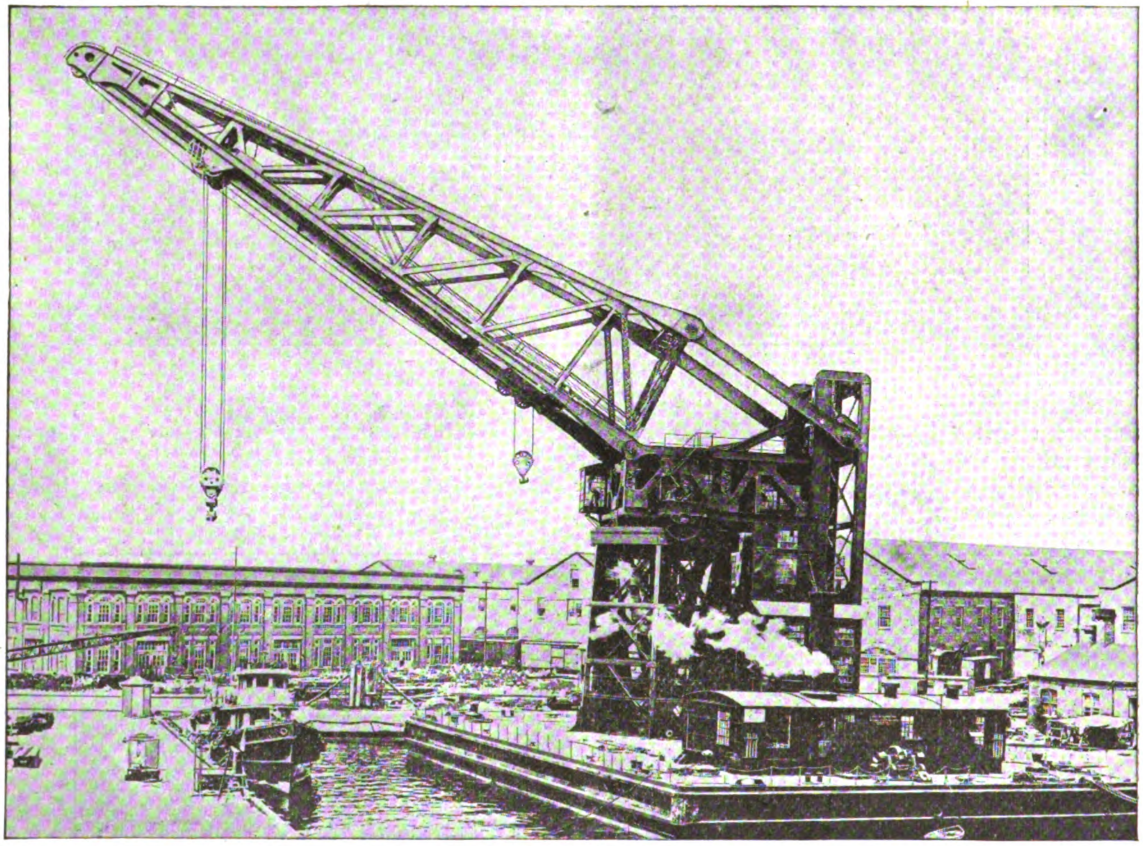

Fig. 8. Gantry Crane

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.

❖ ❖ ❖

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

Example of a well-lighted store

Length

Ceiling height

29 feet

105 feet

15 feet

Color of ceiling—very light cream

Color of walls—greenish grey, medium

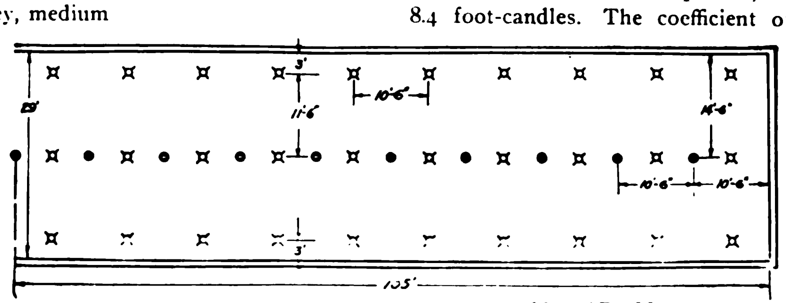

Fig. 1. Floor plan of a large, general office (Problem 1.

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:

$$\text{Ratio, } \frac{\text{Room width}}{\text{Ceiling height}} = \frac{29}{15} = 1.93 \text{ (Use 2)}$$

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,

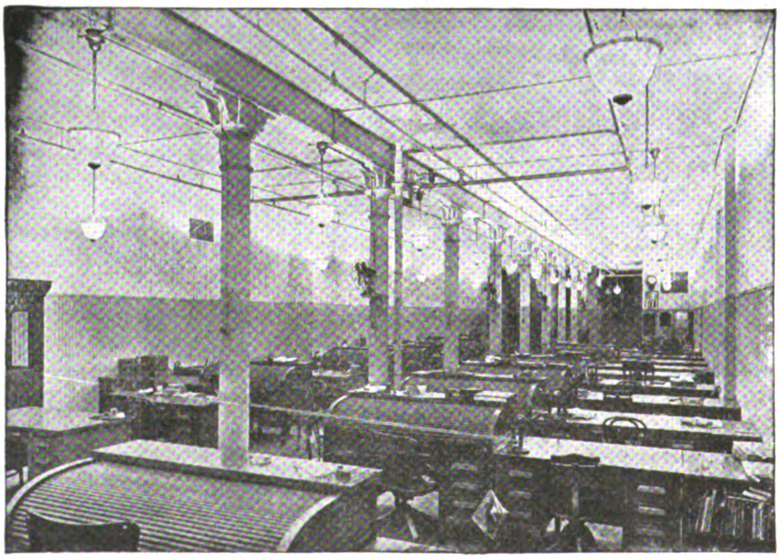

Fig. 2. Solution to office lighting problem (Problem 1.)

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-

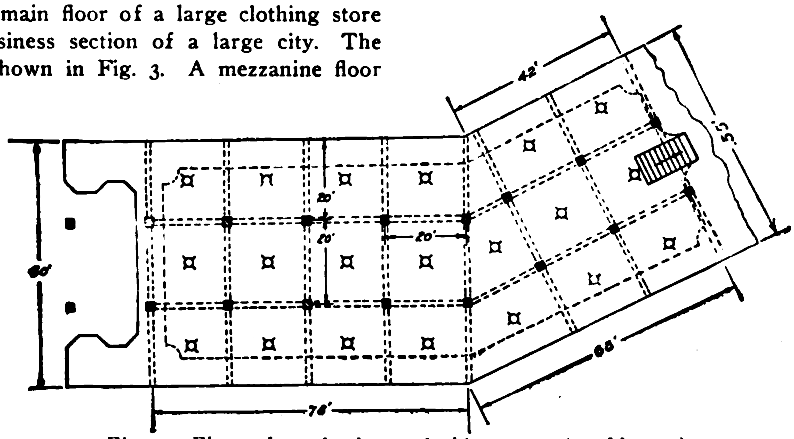

Fig. 3. Floor plan of a large clothing store (problem 2.)

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

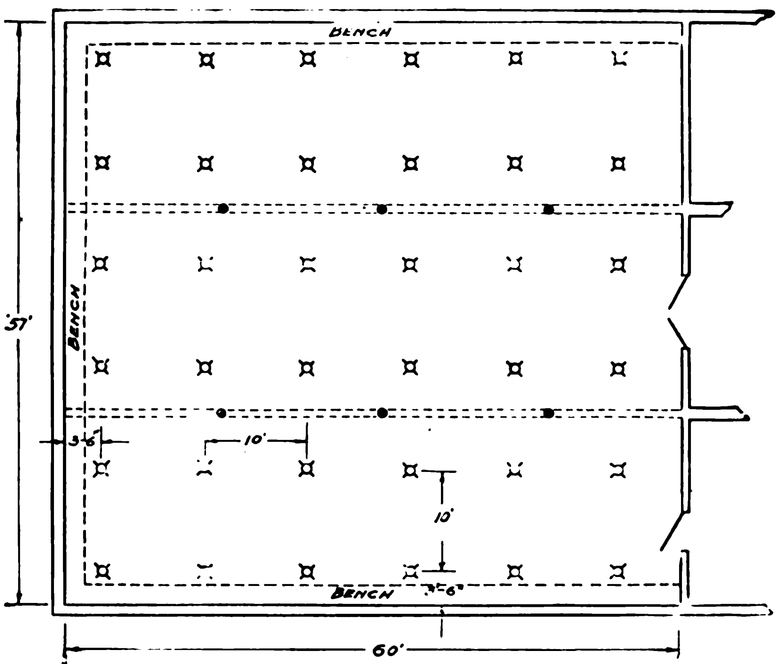

Fig. 5. Floor plan of a furniture factory (problem 3.)

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.)

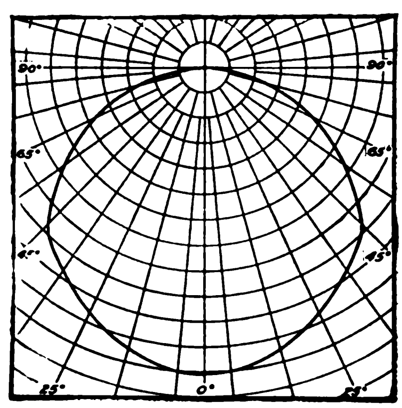

Fig. 8. Distribution curve of metal-cap diffusing unit. (problem 3)

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-

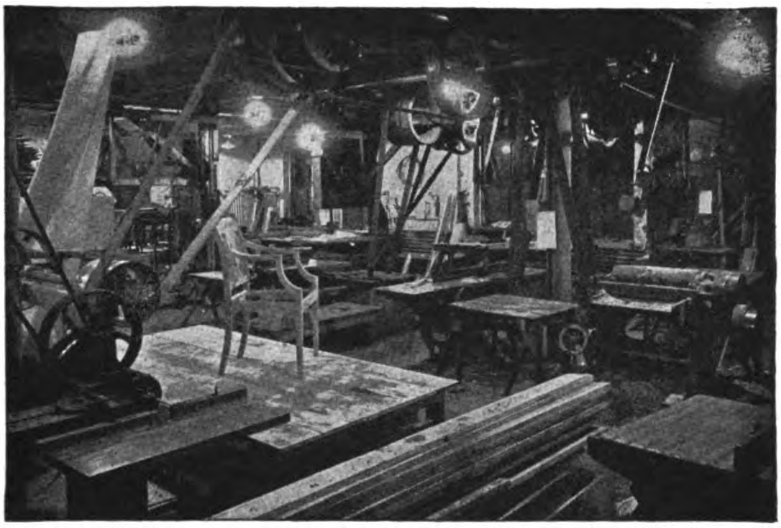

Fig. 7. Illumination of woodworking plant (problem 3)

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

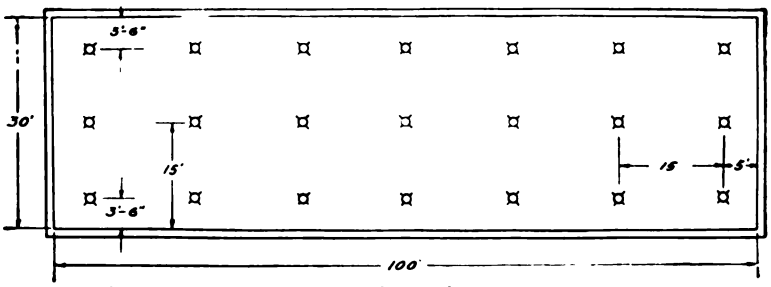

Fig. 9. Floor plan of metal-working plant (problem 4)

to insure that the average intensity will not ball 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

$$\frac{6.5 \times 60 \times 57}{0.69} = 32{,}200 \text{ lumens.}$$

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 Sam 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. 2. To make cyanamid. 3. To make nitic acid.	1. To make nitric acid.
Operations	1. Burning limestone. 2. Grinding lime. 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.	1. Blowing air through electric arc flame to produce nitrous gases. 2. Absorption of gases in towers to produce acid.
	Indirect Method	**Direct Method**
Raw Materials	1. Lime 2. Coke 3. Carbon electrodes in carbide furnaces. 4. Carbon resistors in cyanamid retorts. 5. Pure nitrogen. 6. Superheated steam. 7. Air. 8. Water.	1. Air. 2. Metal electrodes 3. Water.
Electric Energy for	1. Carbide furnaces. 2. Grinding carbide. 3. Cyanamid retorts. 4. Grinding cyanamid. 5. Heating catalyst. naces. 6. Motors for power, etc., including several cranes.	1. Arc flame furnaces.
Skilled Labor for	1. Carbide fur- 2. Cyanamid retorts. 3. Packing cyanamid. 4. Grinding machinery. 5. Making pure nitrogen. 6. Making ammonia. 7. Catalytic process. 8. Absorption plant.	1. Arc flame furnace. 2. 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

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 helpfui 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 any 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 horsepower.

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.

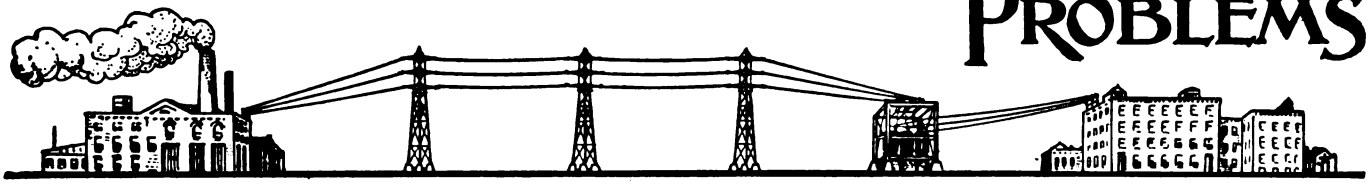
The coal is taken from the botton of the steel storage bins by short screw conveyors driven by variable speed motors and delivered into down pipes communicating with the burners. The passage of the coal through the down pipes is facilitated by air and in the Santmyer burner preliminary mixing is accomplished 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.

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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.

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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.

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.

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.

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.

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 installation of three oven furnaces, each requiring 80 kw. to operate over long-hour periods.

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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 eleceric 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.

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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.

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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.

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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, Dkla., 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 to 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 at 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.

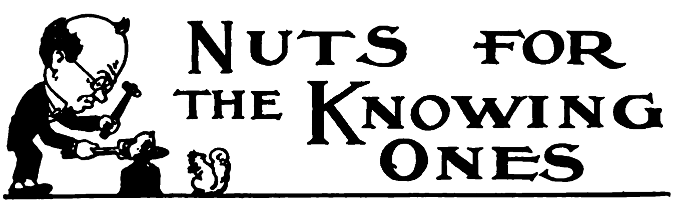
At the convention of the Illinois State Association of Electrical Contractors and Dealers at Peoria, on September 19-20, the following papers were read:

"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.



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.

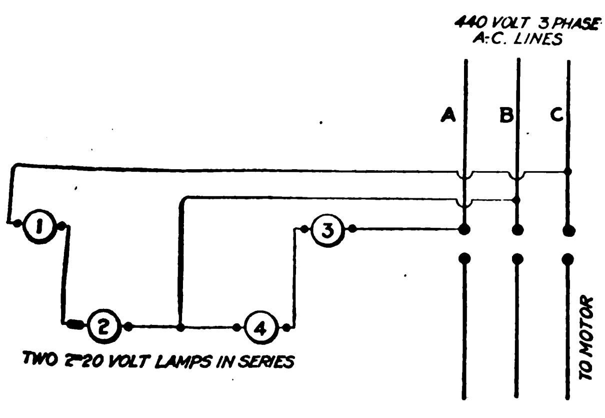

Diagram of connection for a phase testing set

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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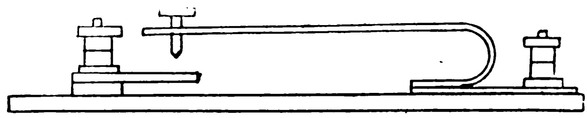
I propose to have electric fire alarms installed in a factory under my control. Can you guide me in the selection of a good system, says a writer in *Electricity*, London.

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 servicees 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.

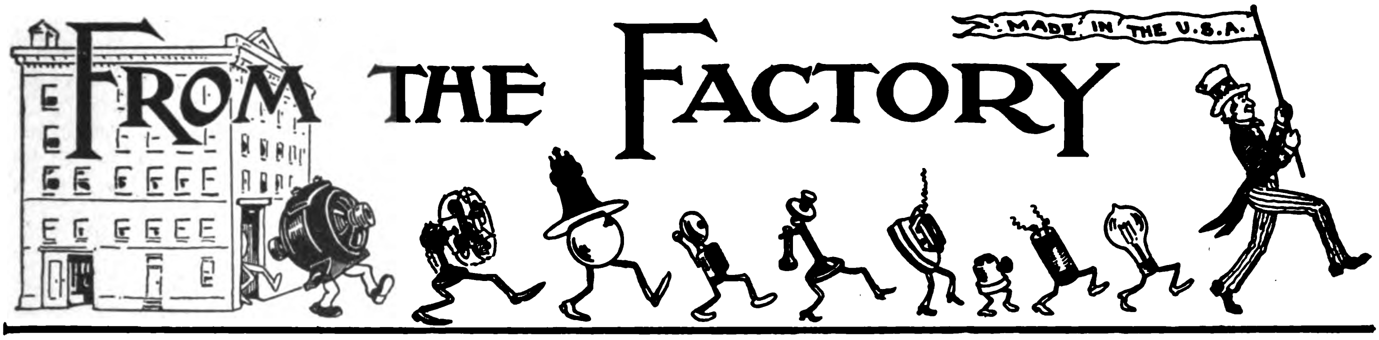
At present the Essington works occupies a comparatively small part of the 500-acre tract, which provides for ultimate expansion, and contemplates an increase of three to four times its present capacity.

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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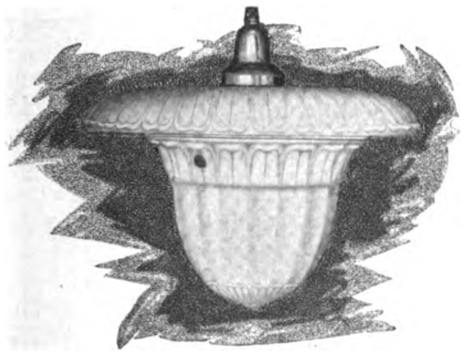
TWO-PIECE LIGHTING UNIT

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

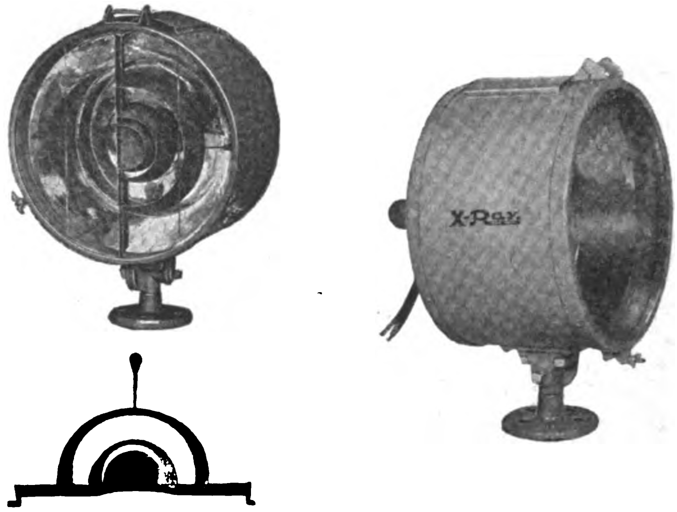
A new corrugated reflector No. 845 has just been produced for the number 60 projector by the National X-Ray Reflector Co., of Chicago, Ill.

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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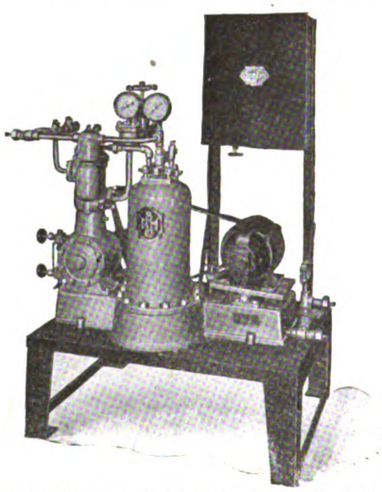
SANITARY REFRIGERATING MACHINE

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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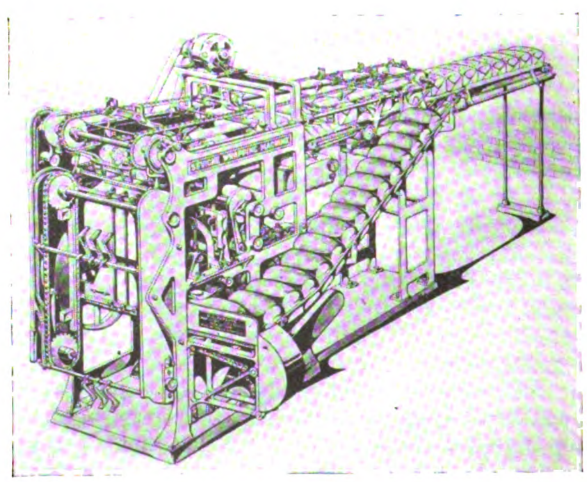
MOTOR OPERATED BREAD WRAPPING MACHINE

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.

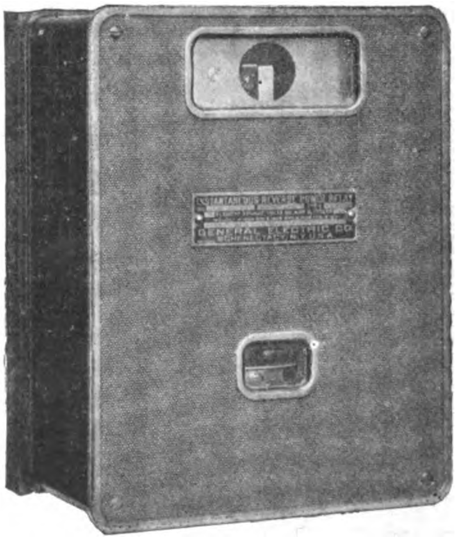
Safety devices may be connected in the control circuit, so that the opening of any switch will bring the car to rest. Those most commonly used are the emergency switches, to be used by the operator in case of accident or failure of the car switch; machine-limit and hatchway-limit switches, which operate 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

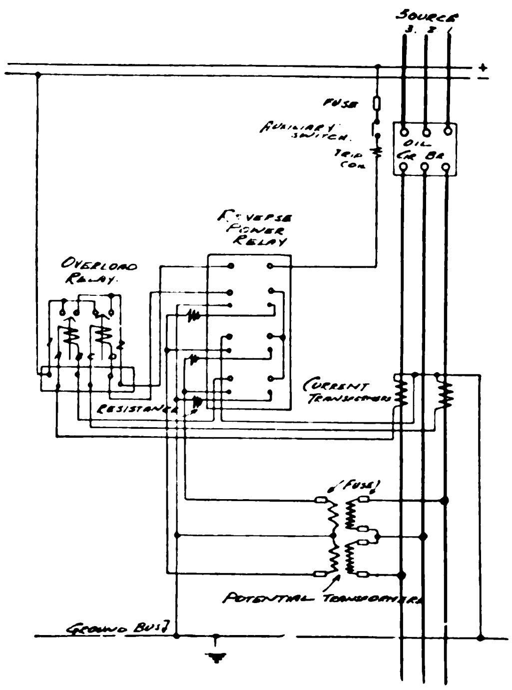


Polpphase induction reverse power relay

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.)

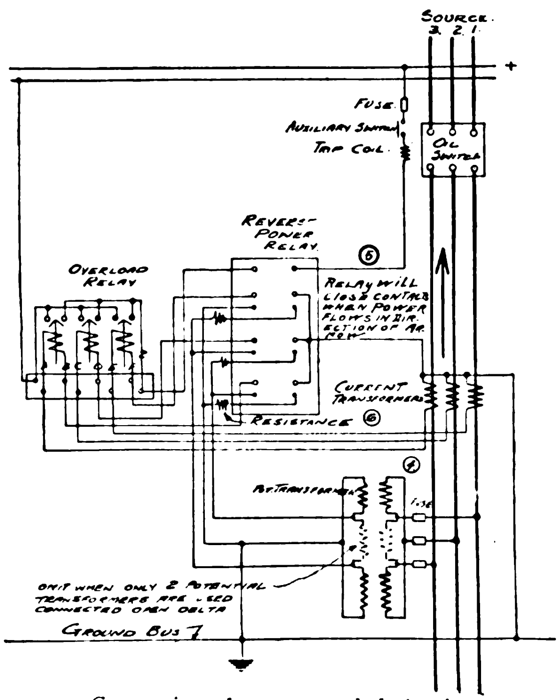
The relay is constructed along the lines of a polyphase watthour meter, but with three instead of two driving elements. Each of the elements has a current and a potential coil.

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.

✤ ✤ ✤

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

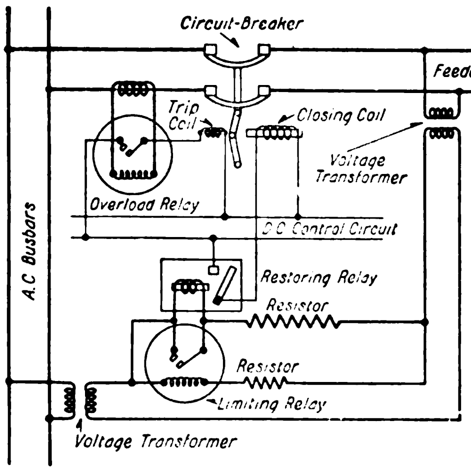


Fig. 1.—Schematic Diagram of Connections of Service-Restoring Relay System

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-

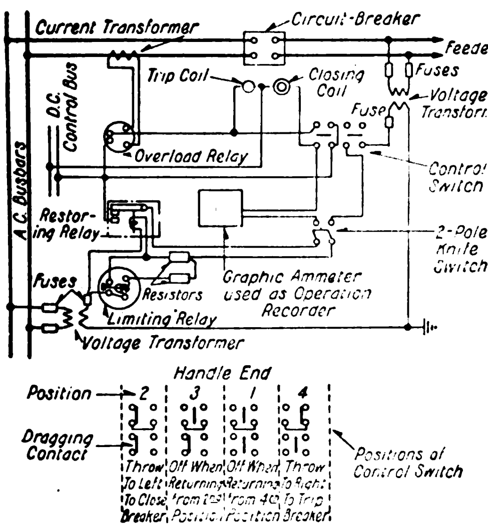


Fig. 2—Complete Diagram of Connections of Service-Restoring Relay System

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

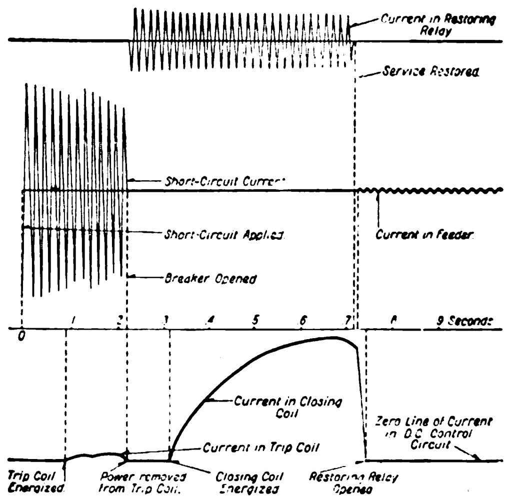


Fig. 3—Oscillograph Records Showing Operation of Service-Restoring Relay System on a Transient Short Circuit

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.

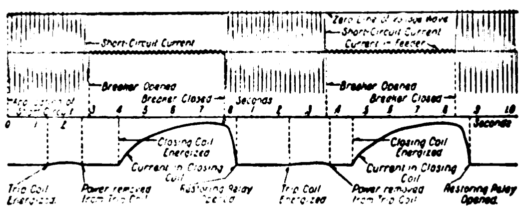


Fig. 4—Oscillograph Records Showing Operation of Service-Restoring Relay System on a Permanent Short-Circuit

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.

DIRECTORY OF CONSULTING ENGINEERS ARCHITECTS and CONTRACTORS

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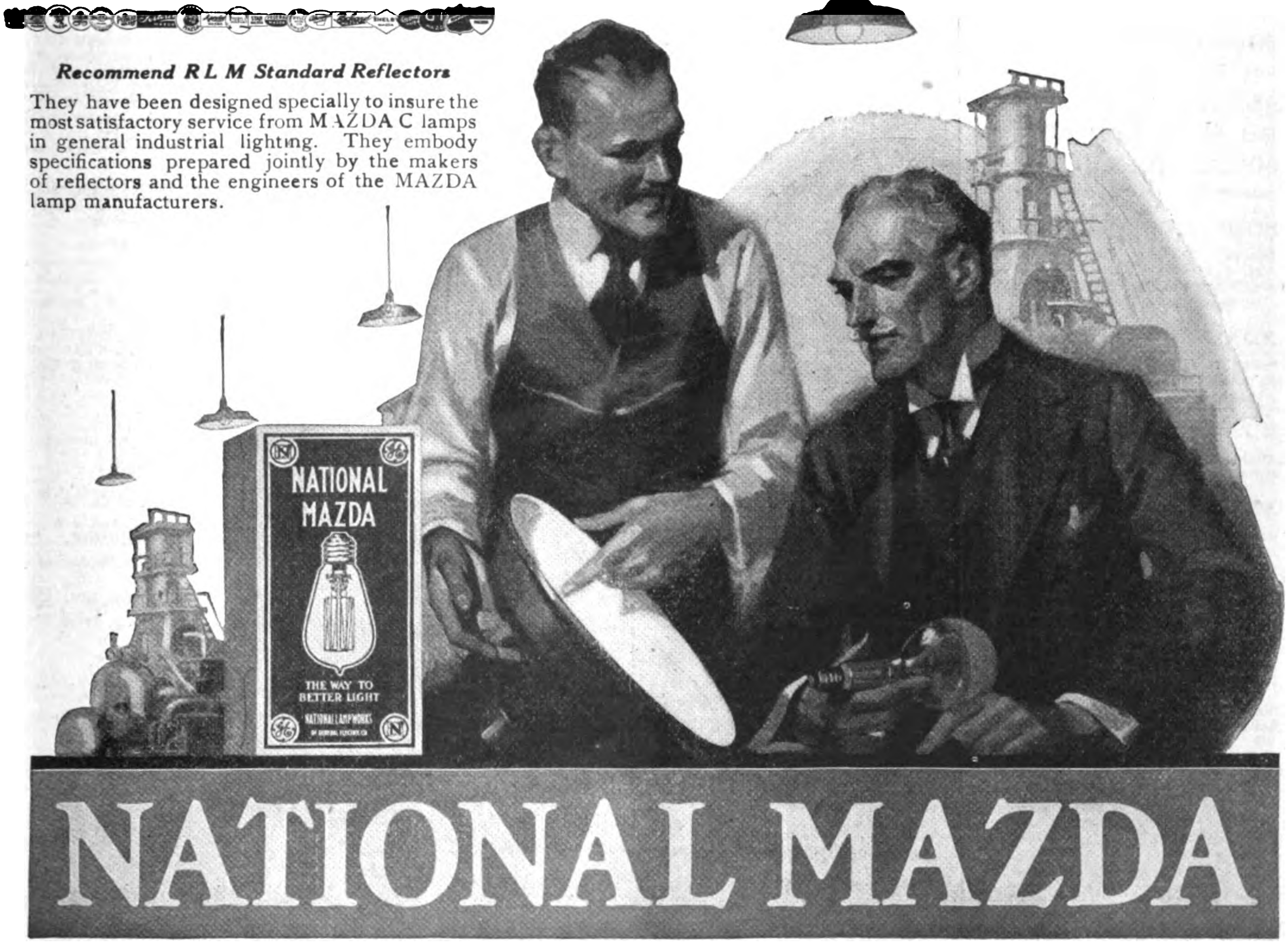
NATIONAL LAMP WORKS of General Electric Company, Nela Park, Cleveland, Ohio.

Any of these labels is a guarantee of National Quality.



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Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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Brady Elec. & Mfg. Co., New Britain, Conn.

POLES, Brackets, Pins, Etc.
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Southern Exchange Co., The, N. Y. C.
Western Electric Co., New York City

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Okonite Co., The, New York City
Standard Underground Cable Co., Pittsburgh, Pa.

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Roebling's Sons Co., John A., Trenton, N. J

RECEPTACLES
" See Sockets

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RESISTANCE UNITS
Dixon Crucible Co., Jos., Jersey City
General Electric Co., Schenectady N. Y.

RESISTANCE WIRE
" See Wires

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Western Electric Co., New York City

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Weston Elec. Inst. Co., Newark, N. J.
Wisconsin Elec. Co., Milwaukee, Wis

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National Metal Molding Co., Pittsburgh, Pa.

SOCKETS, Turndown
General Electric Co., Schenectady N. Y.

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Pittsburgh Elec. Specialties Co., Pittsburgh, Pa.
Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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Electric Bond & Share Co., N. Y. City

STOVES, Electric
" See Heating Apparatus, Electrical

STRAINERS, Perforated
Erdle Perforating Co., Rochester, N. Y.

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Westinghouse Elec & Mfg. Co., East Pittsburgh, Pa.

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" See Telephone Equipment

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Palmer Electric & Mfg. Co., Boston, Mass.

SWITCHES, Knife
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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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General Electric Co., Schenectady, N. Y.

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General Electric Co., Schenectady, N. Y.
Palmer Electric & Mfg. Co., Boston, Mass.

SWITCHES, Safety
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SWITCHES, Service
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Thordarson Elec. Mfg. Co., Chicago
Western Electric Co., New York Cit
Westinghouse Elec. & Mfg. Co., Eas Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J

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Westinghouse Elec. & Mfg. Co., Eas Pittsburgh, Pa.

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General Electric Co., Schenectady N. Y.
Leffel & Co., James, Springfield, O.
Western Electric Co., New York Cit
Westinghouse Elec. & Mfg. Co., Eas Pittsburgh, Pa.

VENTILATORS
Erdle Perforating Co., Rochester, N

WASHERS, Iron, Steel ar Mica
Erdle Perforating Co., Rochester, N

WATER Wheels and Turbin
Allis-Chalmers Mfg. Co., Milwauk Wis.
Leffel & Co., James, Springfield, O

WATTMETERS
" See Instruments, Electrical

WIRES AND CABLES
American Platinum Works, Newark
American Steel & Wire Co., N. Y. C
Detroit Insulated Wire Co., Detroit
General Electric Co., Schenectady N. Y.
Moore, Alfred F. Philadelphia, Pa.
Okonite Co., The, New York City
Roebling's Sons Co., John A., Trenton N. J.
Phillips Insulated Wire Co., Pawtucket, R. I.
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Southern Electric Co., Baltimore, Md
Simplex Wire & Cable Co., Boston
Standard Underground Cable Co., Pittsburgh, Pa.
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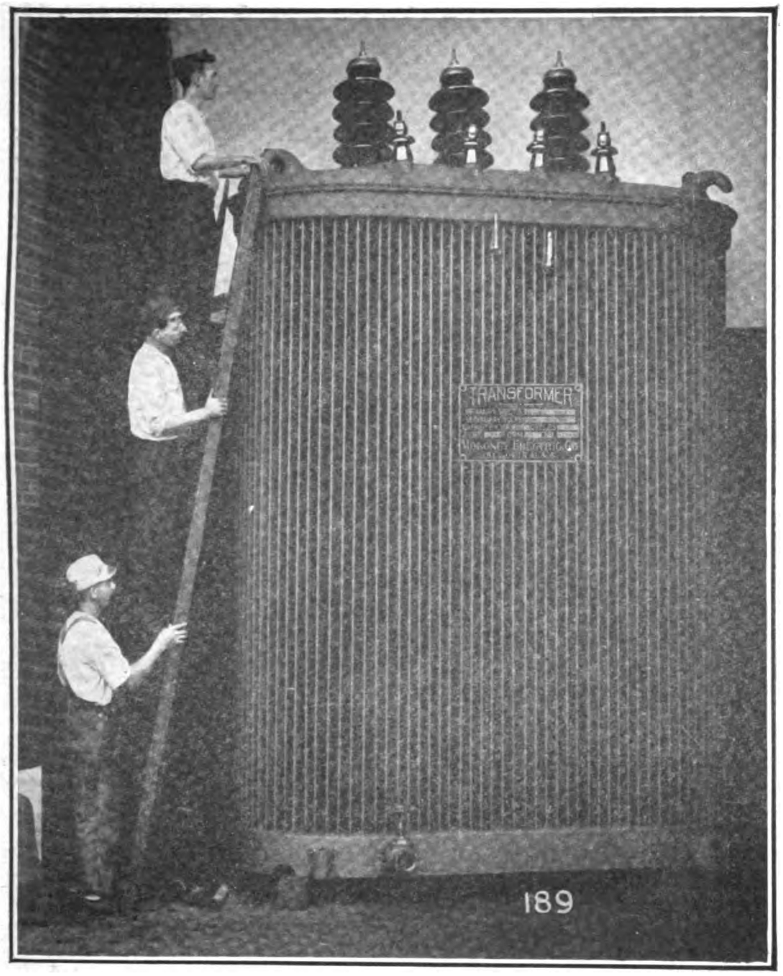
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Tech. Div.

Vol. 52 NOVEMBER, 1918 No. 5

ELECTRICAL ENGINEERING

A Monthly Journal for All Interested in the Practical Application of Electricity

Published at 258 Broadway, New York

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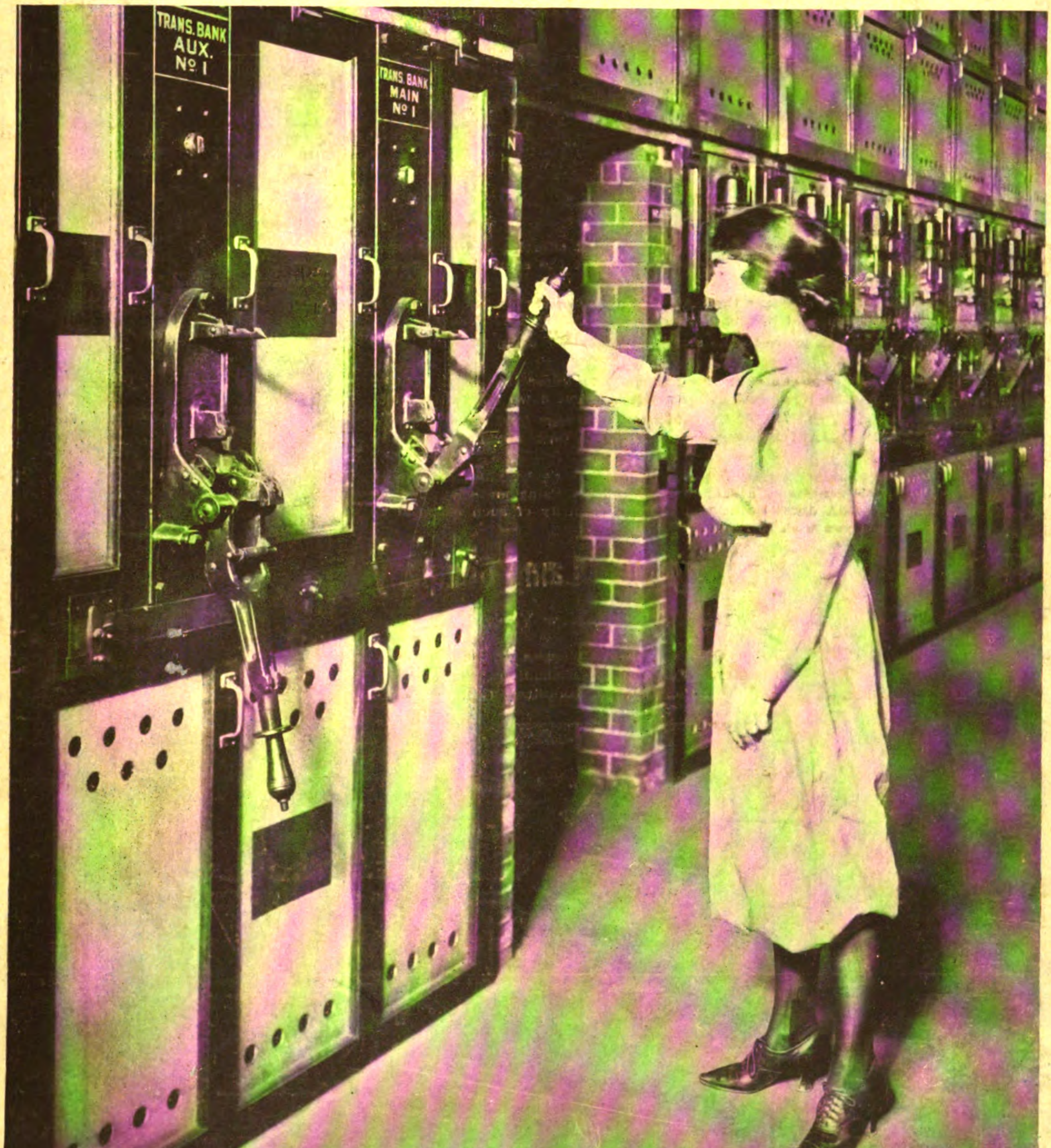


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OCTOBER-NOVEMBER

Electrical Engineering

VOLUME LII — NOVEMBER, 1918 — No. 5

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SUBSCRIPTION PRICE—United States and Possessions, Mexico and Cuba, $2.00 a year. Canada, $2.50 a year. Foreign countries in Postal Union, $3.00.

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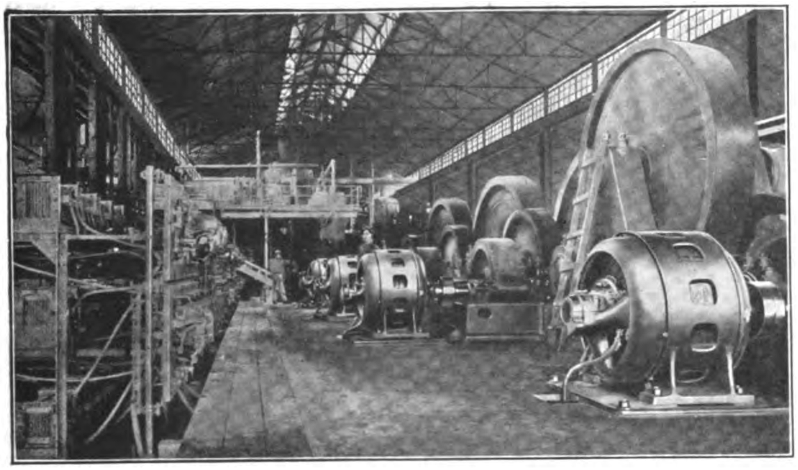

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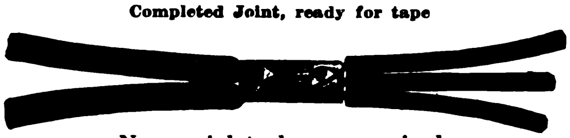

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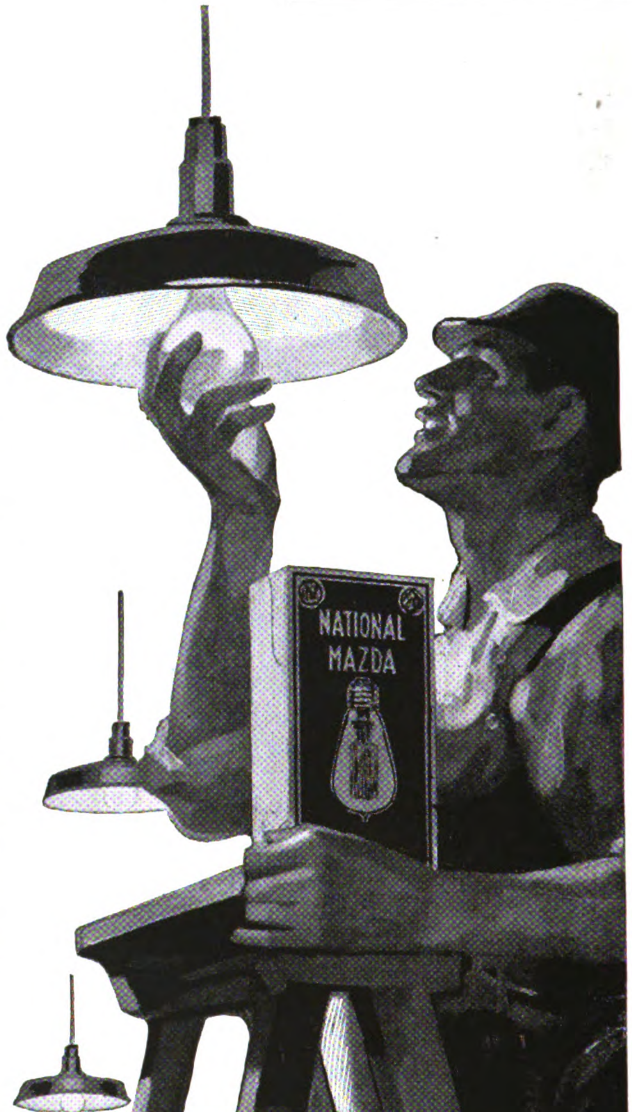
NATIONAL
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NATIONAL MAZDA

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.

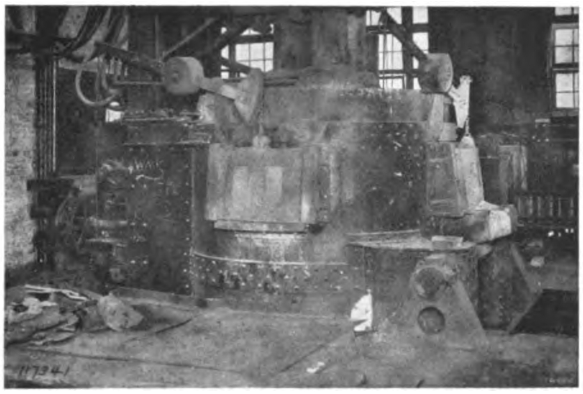
With this issue of the magazine there has been a distinct change in form, not only as to mere externals, but also in plan and purpose. That the improved typographical appearance and arrangement will meet with the hearty approval of its many faithful and devoted readers, we are convinced. Perhaps a glance 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.

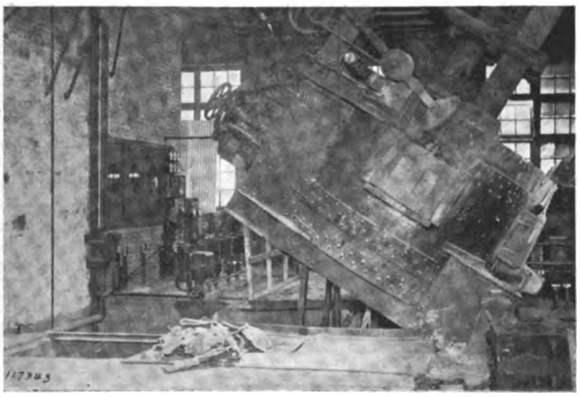
The high momentary overloads are characteristic of electric furnace work and make it very different from ordinary power service. They must be taken into account in designing the electrical equipment for the furnace, and some of the apparatus must be especially designed to withstand them, as shown in the following description of the Driver-Harris installation.

FILLING MOULDS FROM ELECTRIC FURNACE

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.

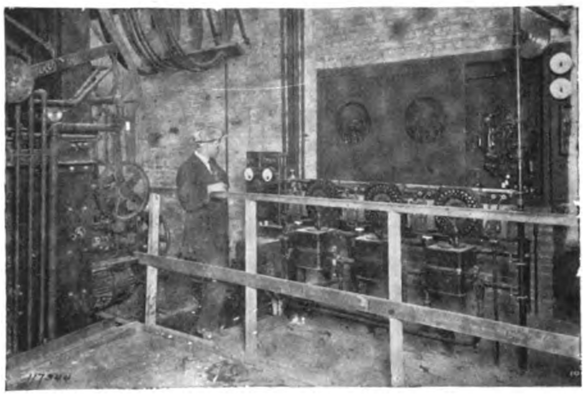
One of the most interesting features of the equipment is the Thury regulator, which automatically maintains an approximately constant current at the furnace electrodes. Without this device the current consumption would vary eratically even if an operator were constantly endeavoring to correct the variations.



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 furnace and geared to the tilting mechanism. It is controlled by 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

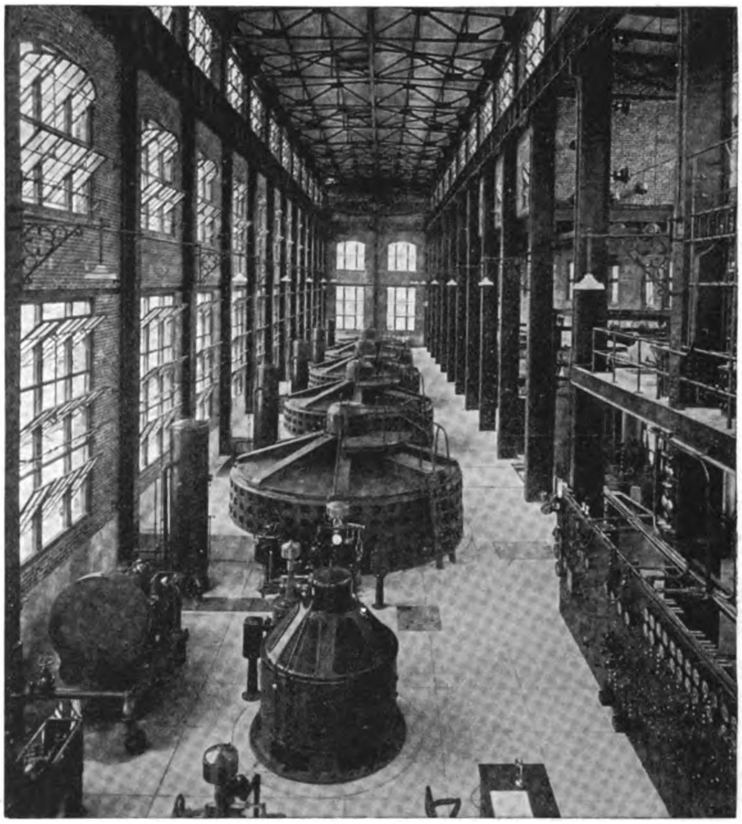
The Egis Shipbuilding Yard, on the northeast coast of England, is an all electrical one, the light and power being exclusively supplied by current. This yard was begun in November last and is now virtually completed well within the year. Throughout its every department electric power on the three-phase 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 shutdowns 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

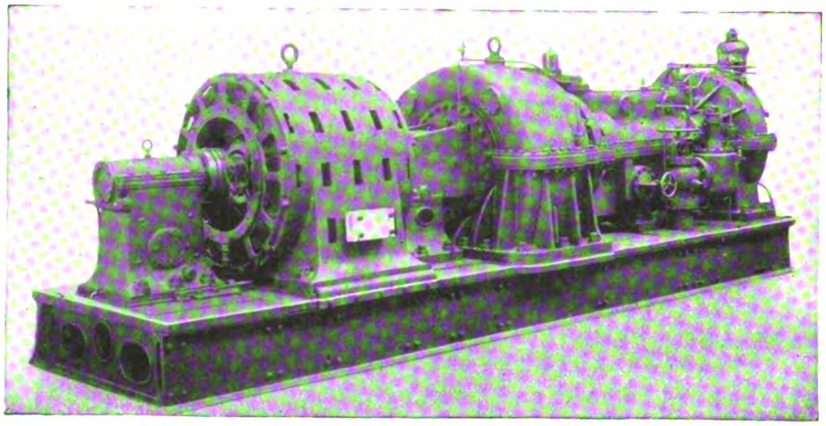
As a war move the Denver Gas & Electric Light Company will furnish toluol to the Government at the actual cost of production. In order to obtain this product the Government is erecting a plant for its extraction from the gas. All gas produced by the Denver company will pass through the toluol plant, 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.

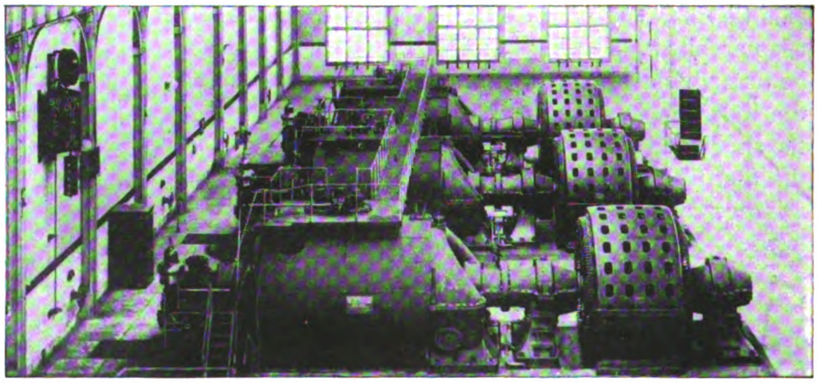
The steam turbine is generally regarded as of European origin, the reduction to useful practice having been carried out by Messrs. Parsons and DeLaval, and it is not generally known that steam turbines were commercially built in Syracuse, New York, as early as 1833. Several of these were sold and employed 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.



Straight Parsons Single-Cylinder Steam Turbine
Installed for the Hartford Electric Light Company in 1900 and designed to operate at 1200 revolutions per minute

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

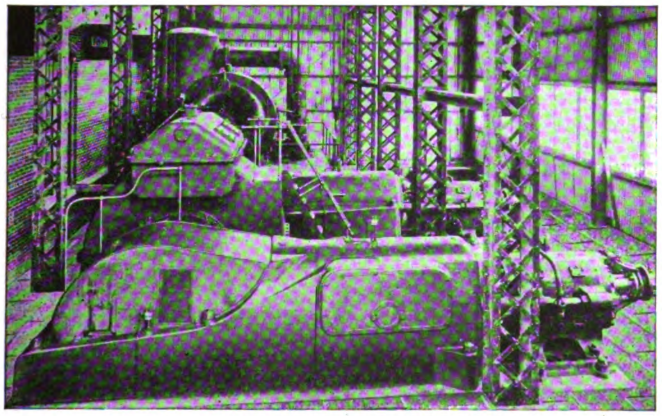


Straight Parsons Steam Turbines
Regarded when built in 1905 as of unprecedented capacity and still in serviceable operation

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.

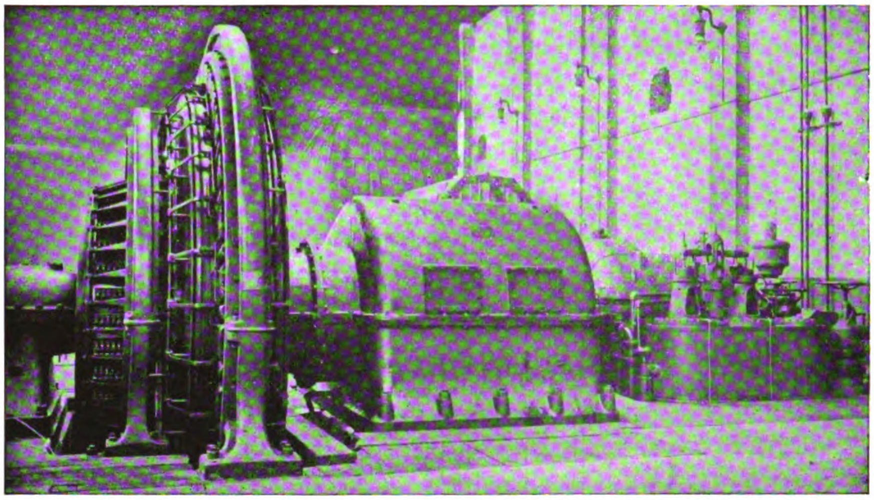
During the period from 1884 to 1889 about 300 turbines were built, ranging up to 75 kilowatts. In 1894 a number of 350 to 500- kilowatt non-condensing turbines were built for driving 50-cycle generators at 3000 r.p.m. These were furnished to the various electric lighting companies in London and displaced 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

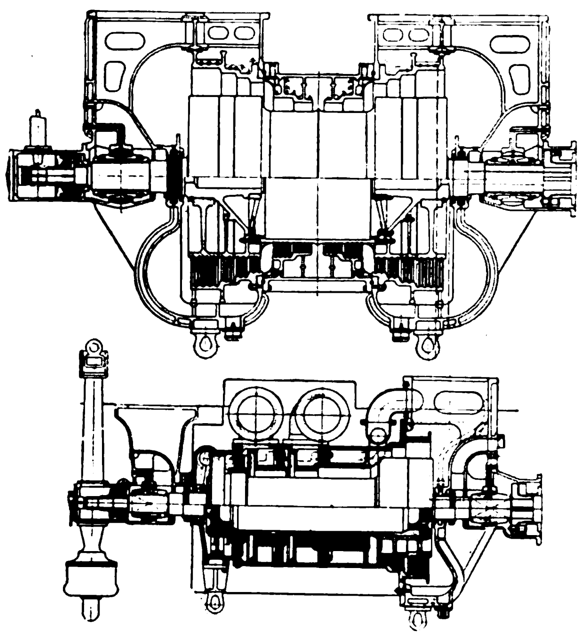
During the year 1899, the powerhouse of the Westinghouse Air Brake Company, Wilmerding, Pa., was equipped with three 400-kilowatt turbines which was the first serious turbine installation carried out in this country. The performance of these machines with 150 pounds steam pressure, 100 degrees F. superheat, 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—

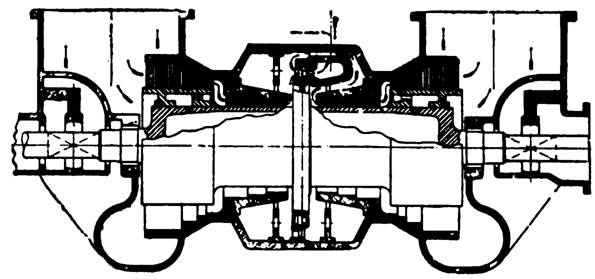
Kw. Load	Steam Press. Lbs. Gage	Superheat Degrees F.	Vacuum In. Hg.	Lbs. Per Kw. Hg.	Eff. Ratio
9,806	177.6	96.0	27.31	15.21	67.4

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



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

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—

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. Jameison, 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 furnishing 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.

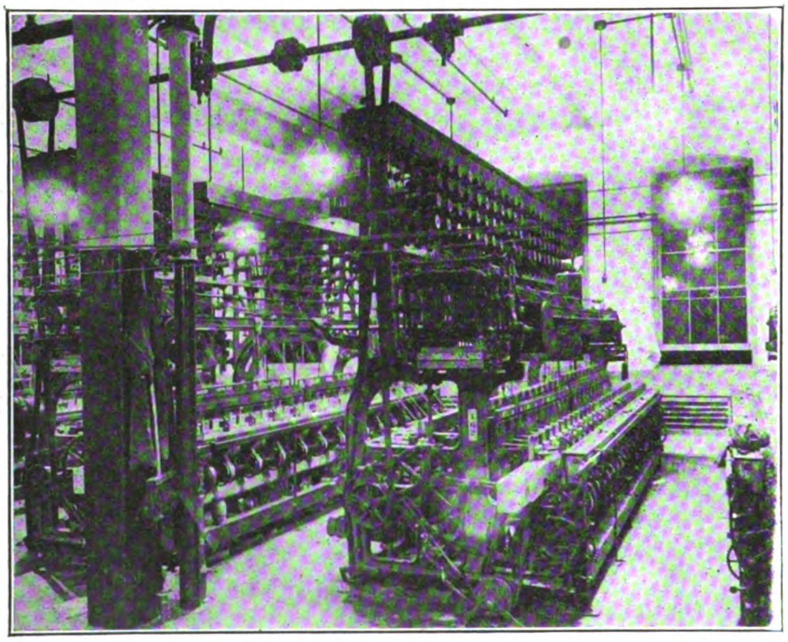
A man can't be a fair, square, successful builder and neglect to take overhead expense into account when making up his estimate.

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.

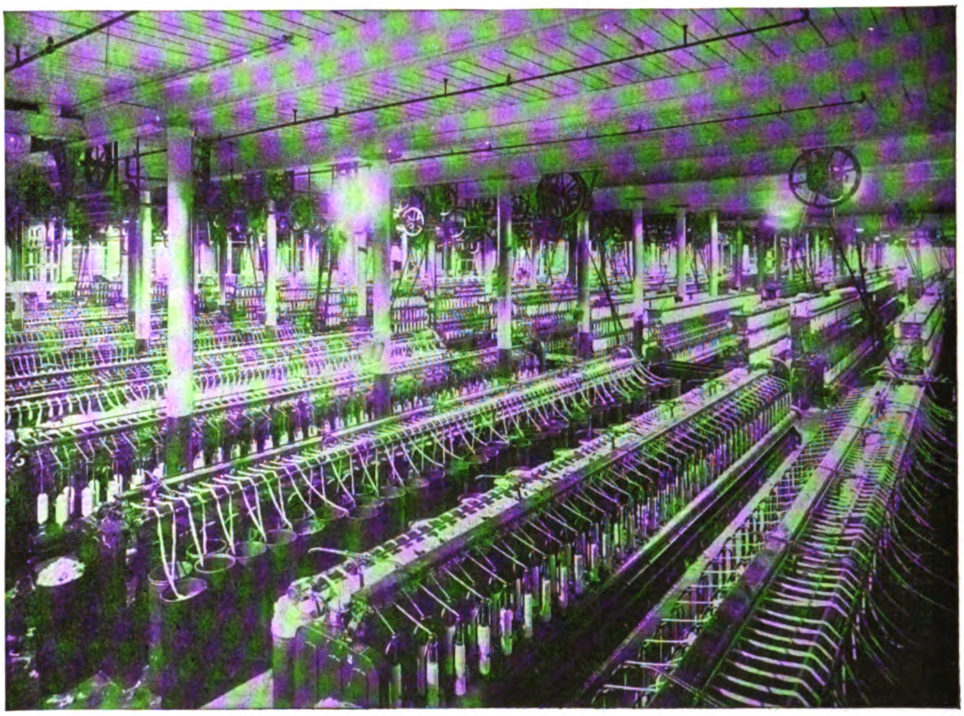
Where enclosed arc lamps were employed, they were hung as high as possible and spaced rather widely. This lamp was none too efficient, and economic considerations prevented lamps being placed as close together as desirable for producing the most effective results. The travel of the arc precluded the 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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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

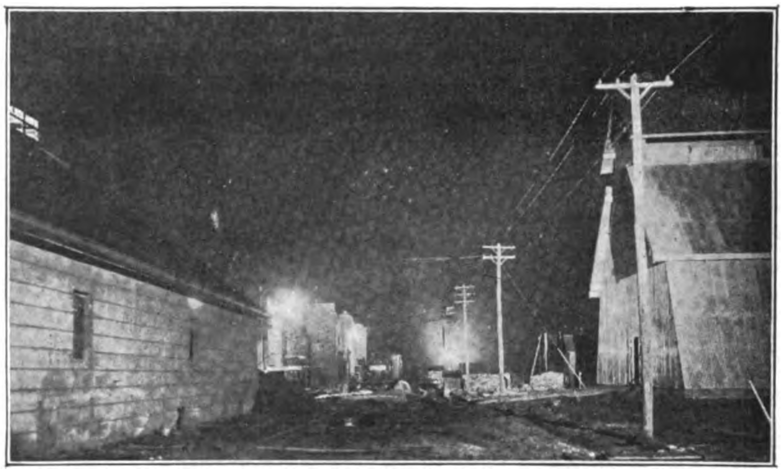
The City Companies of London connected with the various building trades are carrying out a comprehensive educational programme. These City Companies are the survival of the old mediaeval guilds, and in many cases have considerable invested funds. There are various practical courses at the Trades Training 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.

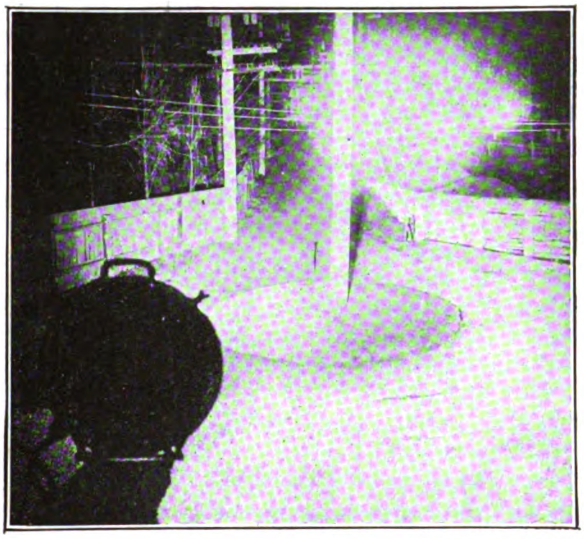
Since it is always possible that enemies may enter as workmen, dark spaces and shadows within a plant, which may serve for concealment, should be eliminated. While it is desirable to illuminate in such a way that the watchmen may be inconspicuous, this feature is ordinarily subordinate to the question 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,

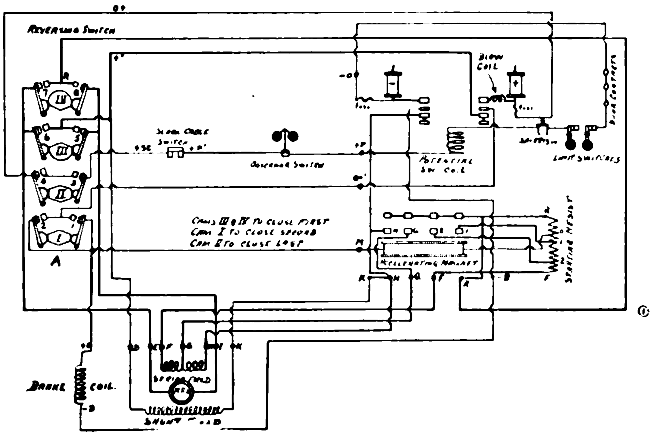


Figure No. 1

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

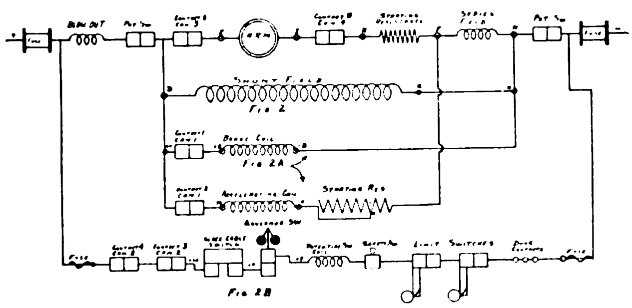


Figure No. 2.

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

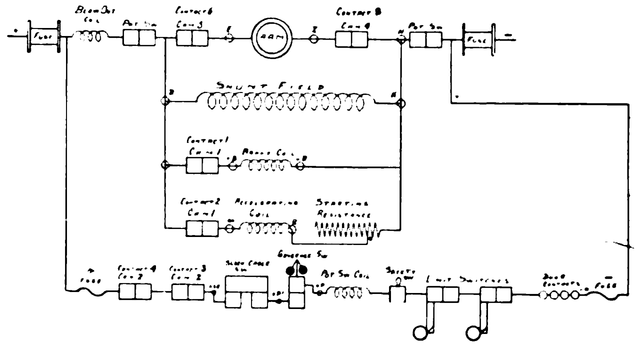


Figure No. 3

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 1 on cam 1; to terminal + B, through the brake coil to terminal — B and back to the

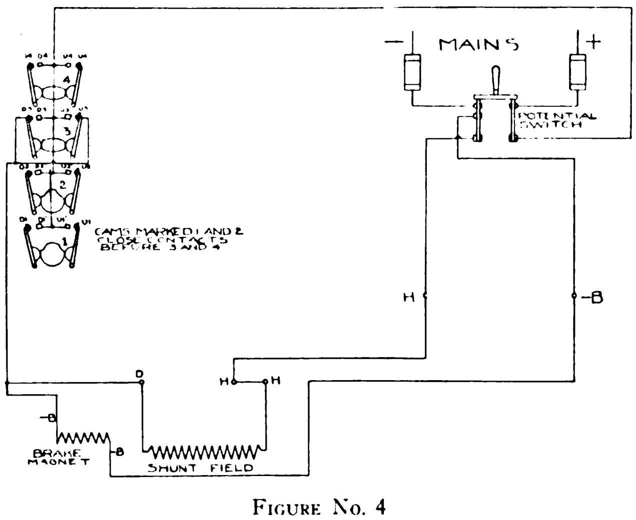


Figure No. 4

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

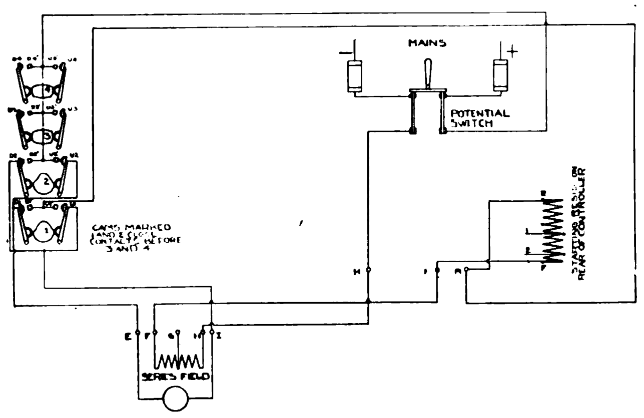


FIGURE No. 5

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

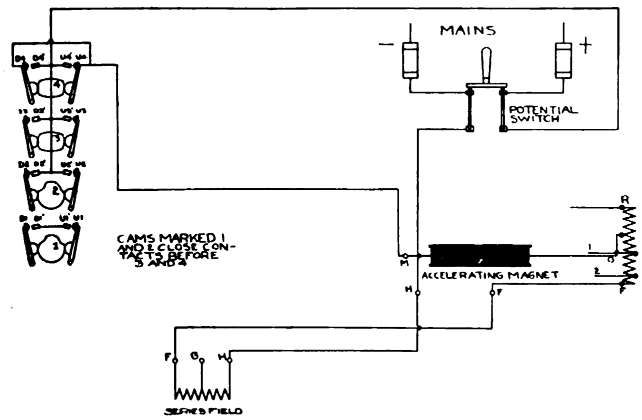


FIGURE No. 6

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

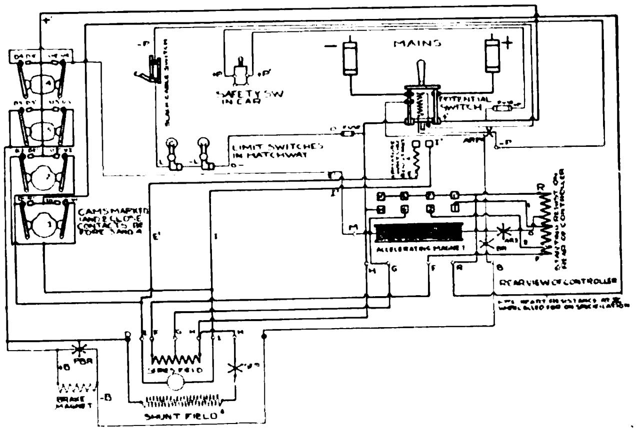


FIGURE No. 7

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:

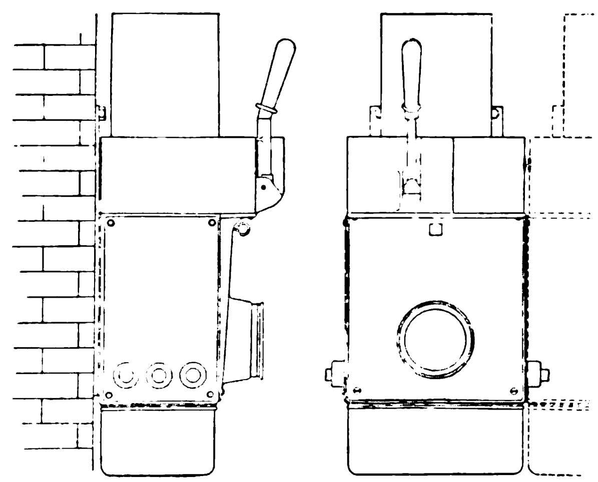
Electrical Manufacturers' Agents, Charles Crofoot, Chairman	$ 457,800
Contractor-Dealers, Louis Kalischer, Chairman	1,409,550
Electrical Machinery Manufacturers' Branch Offices, E. D. Kilburn, Chairman	10,133,550
Electrical Societies, T. C. Martin, Chairman	212,300
Electrical Supply Jobbers, George L. 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.

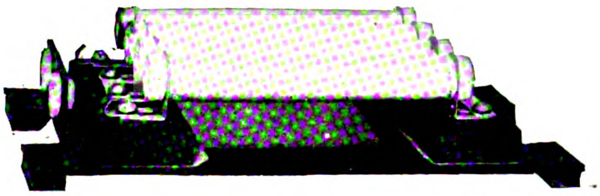
Congressman Caldwell said that it would cost at least 100 billions before our proposed army of 5,000,000 was placed in France and maintained there until the Prussian menace was ended. "We want six billion now and we're going to get it," he declared. "The cost of liberty is high but whatever the cost, 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

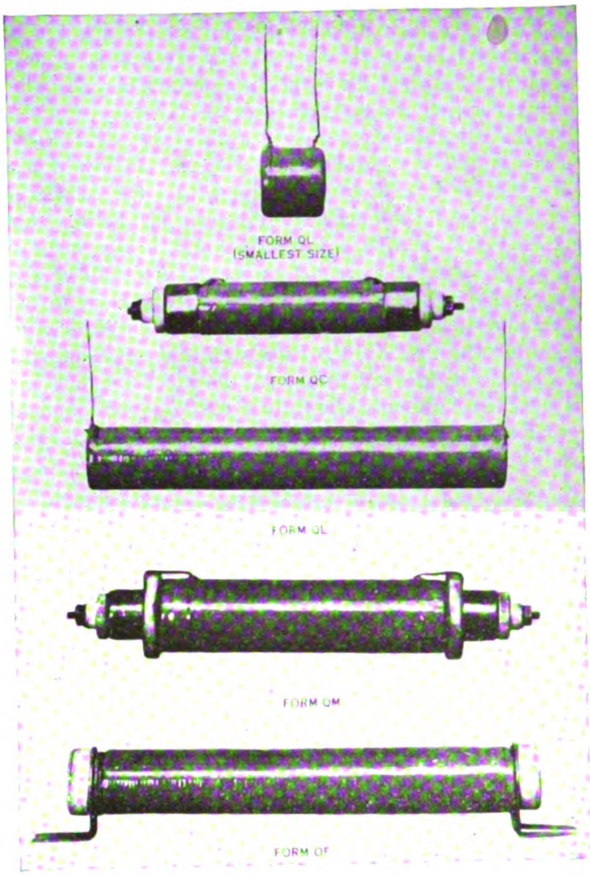


Headlight Dimming Resistor with Cover Removed

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.

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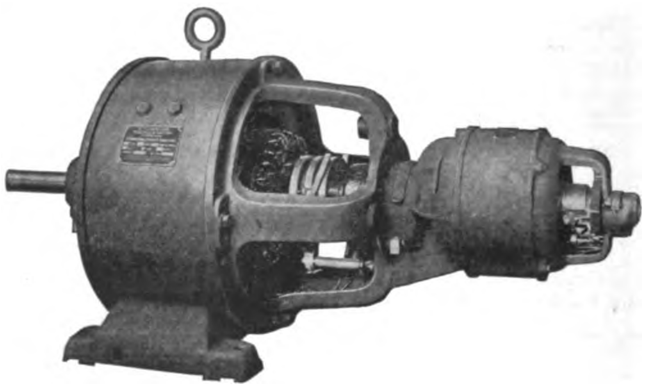

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New Catalogues

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.

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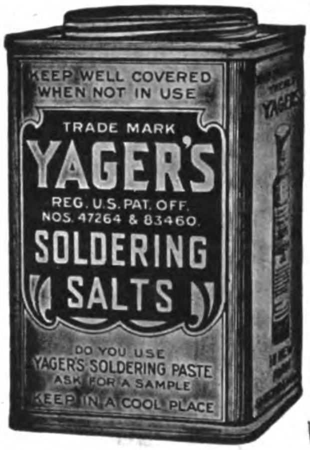

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Of "Electrical Engineering," published monthly at New York, N. Y., for October 1, 1918.

State of New York, }
County of New York, } ss.

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.

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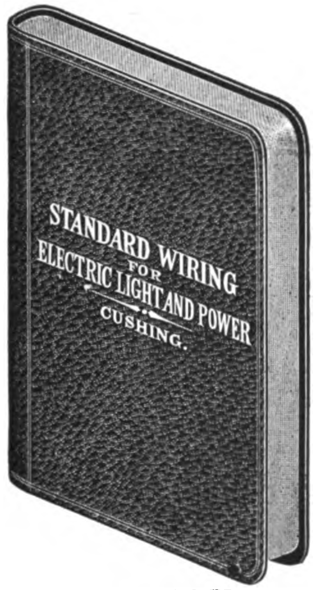

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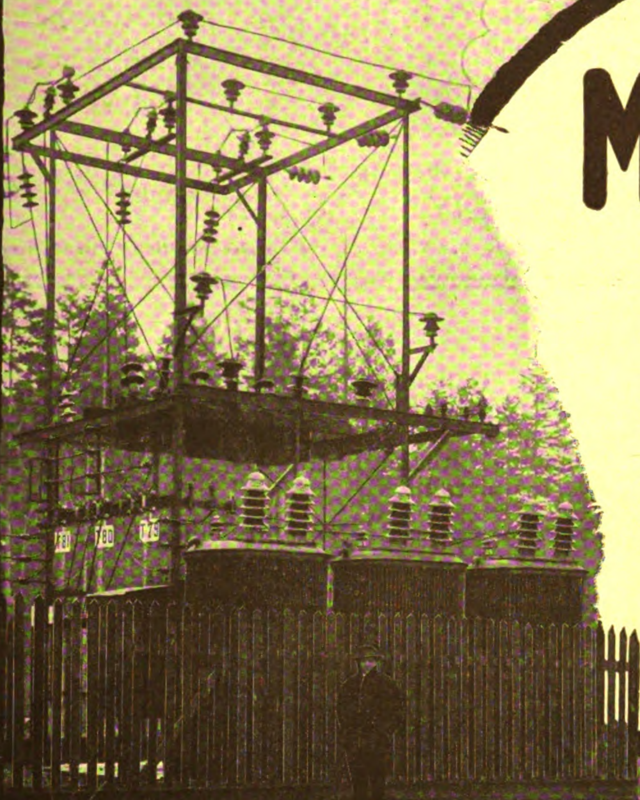

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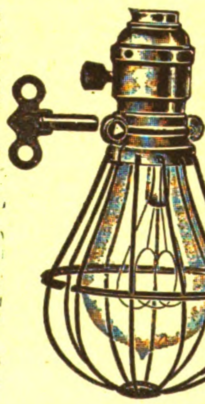

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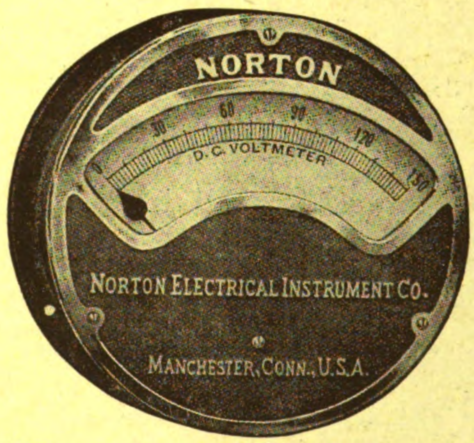

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Vol. 52 DECEMBER, 1918 No. 6

ELECTRICAL ENGINEERING

A Monthly Journal for All Interested in the Practical Application of Electricity

Published at 258 Broadway, New York

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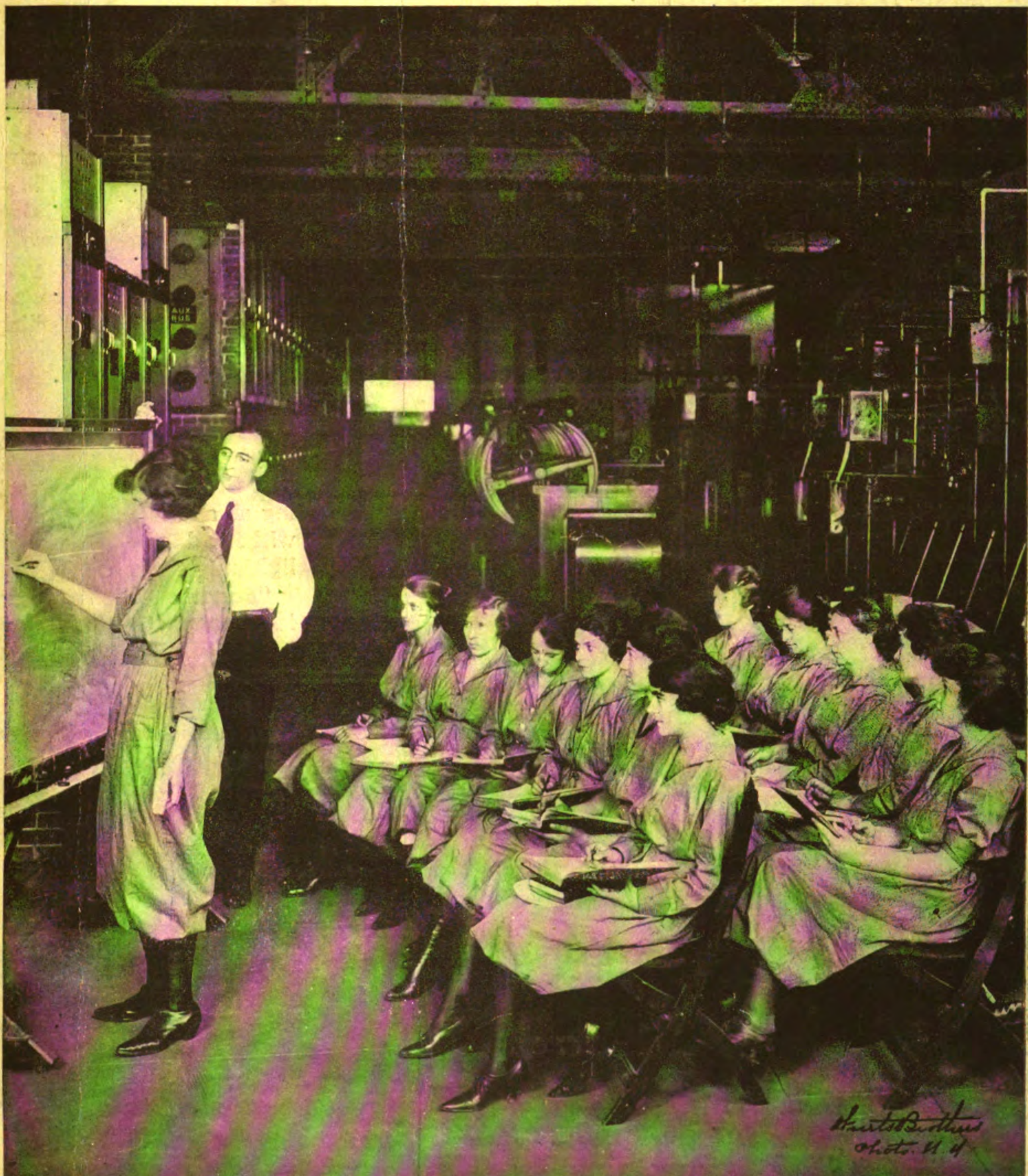

Electrical Engineering

VOLUME LII | DECEMBER, 1918 | No. 6

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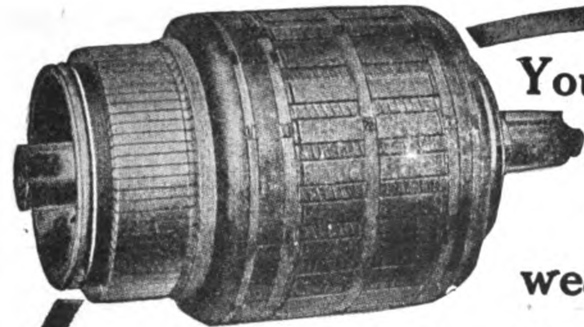

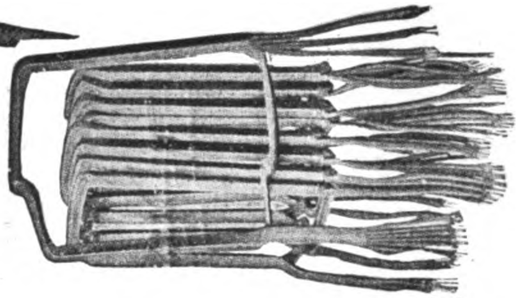

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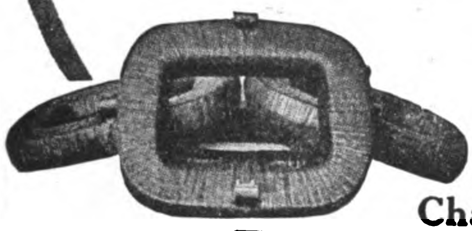

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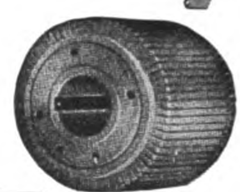

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ELECTRICAL ENGINEERING

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 breakdown 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

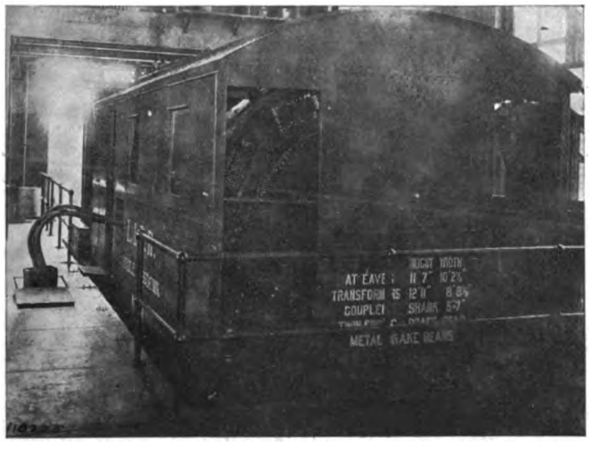
Consul A. A. Williamson, of Darien, Manchuria, reports that the existing wireless office located at Shatotzu having been found inadequate to meet the increasing requirements, an extension has been planned on a considerable scale. The site for the new dispatch station has been fixed at the old west fort 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.

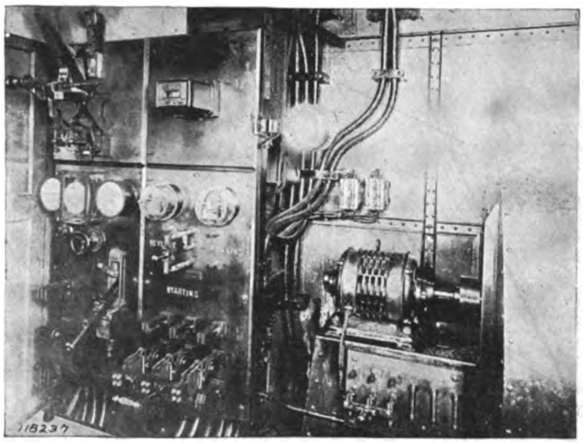
The over-all dimensions of the car was restricted and this caused many manufacturing difficulties. Its length was limited to 38 feet, due to the fact that the permanent substations are equipped inside with railroad sidings on which the portable substation is located when operating in multiple with the 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.



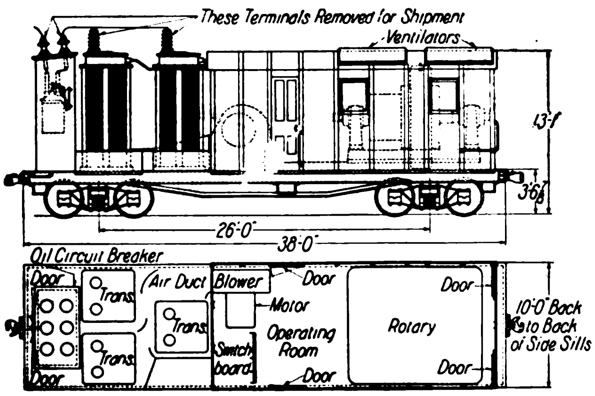
SUBSTATION, SHOWING SWITCHBOARD AND BLOWER MOTOR

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 3/8 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 construction.



General Layout of Portable Substation

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.

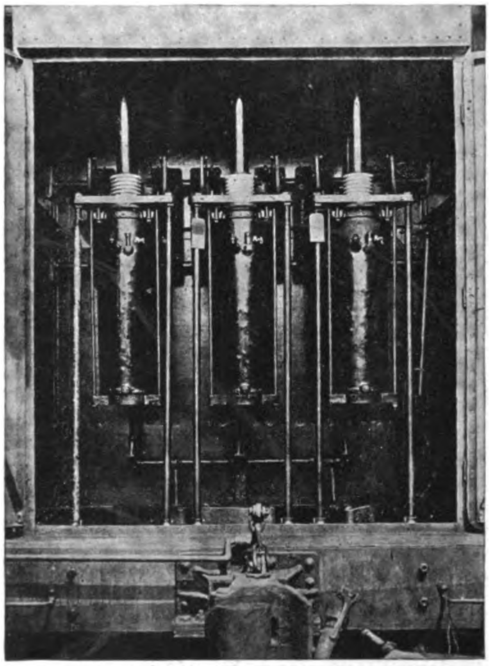
The army and the nation needed food and electricity produced it. Fertilizers produced by electrochemical means made the earth productive, electric drive threshed much of the wheat, prepared the meat, operated the packing plants, ground the flour, entered everywhere into the production of food to make 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.

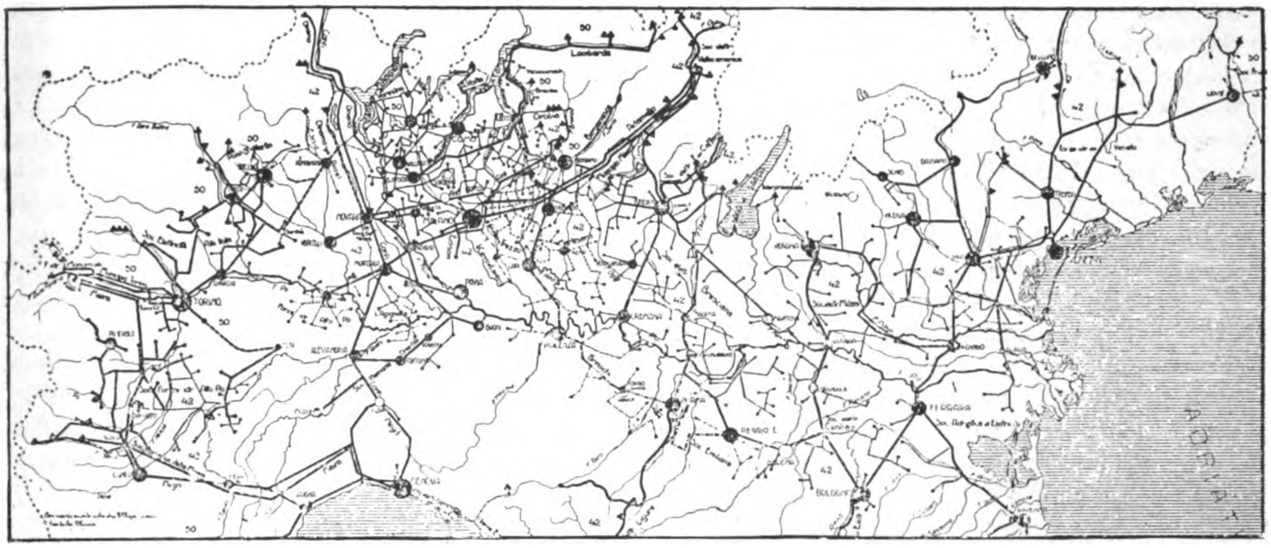
Development of Hydroelectric Power

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.

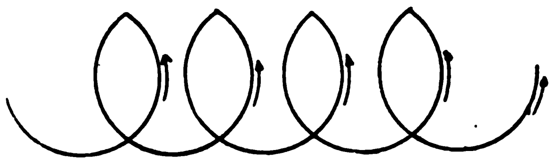
But the development of the distribution of power by three-phase currents has gradually revealed a source of trouble, the cause of which may be summed up in the necessity for the use of the power factor in all calculations where alternating currents are employed. It will be remembered that the simple 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 electromagnetic 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 electrostatic 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

FIG. 1.



current, the delay being so small that very sensitive instruments would be required to show its presence.

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 overhead 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

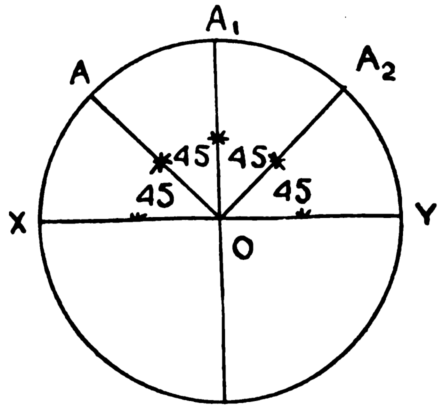


FIG. 2.

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 :.

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:

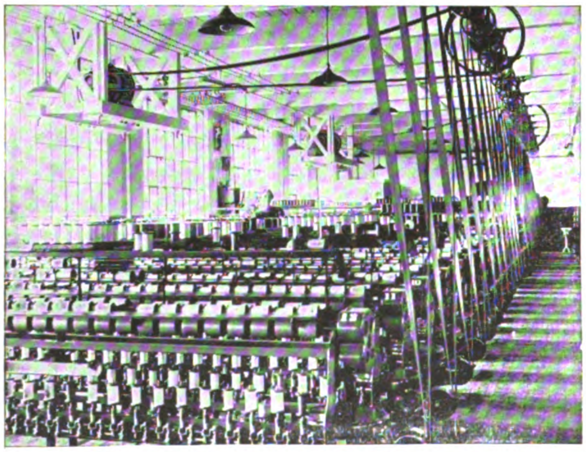
1.—Low Cost of Power. Most central stations have equipped their plants with apparatus especially adapted to take on mill loads and have, therefore, adopted as part of their business campaign among mills a schedule of power rates which are lower than the cost of power produced at the ordinary mill power 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.

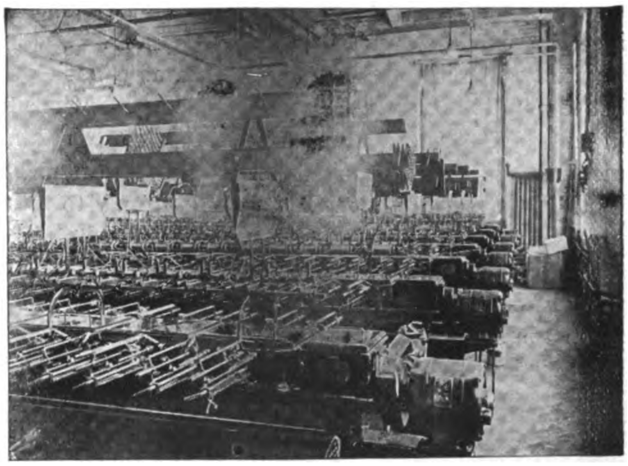
In a throwing mill having group drive, the motor equipment was as follows: Two 50-h.p., four 35-h.p., one 25-h.p. and one 15-h.p., all with 1,170 r.p.m., and two 5-h.p., 1,735-r.p.m. These operated 1,612 spindles. The power consumption was as follows:

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



INDIVIDUAL ELECTRIC DRIVE
A modern silk mill equipped with individual Westinghouse motor drive applied to silk winders

may be illustrated by the following example, which is one of a number of test cases:

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 dieerent 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 man-power 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, Emeå Alv, and Luleå 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

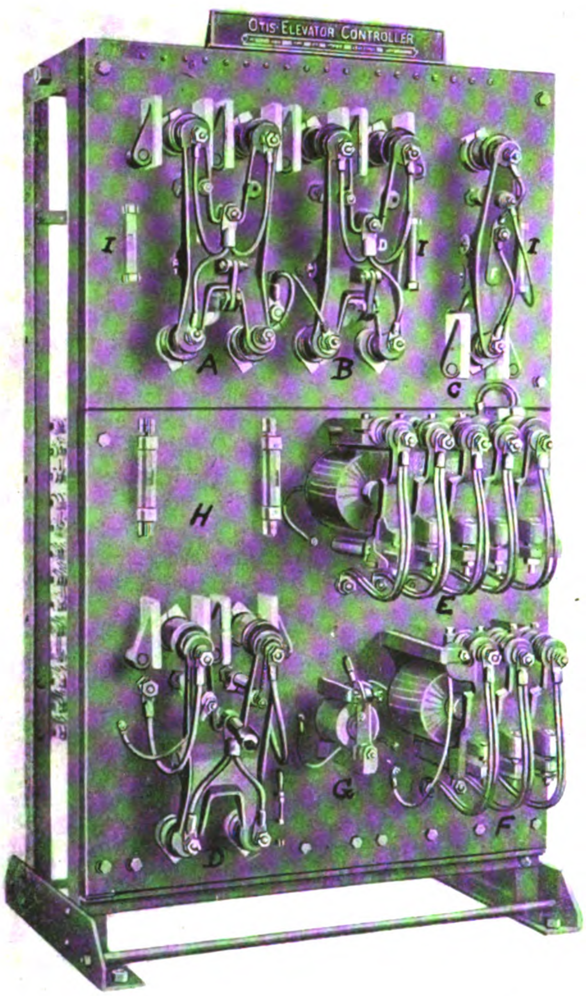


Fig. 1.—Otis Elevator Control

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

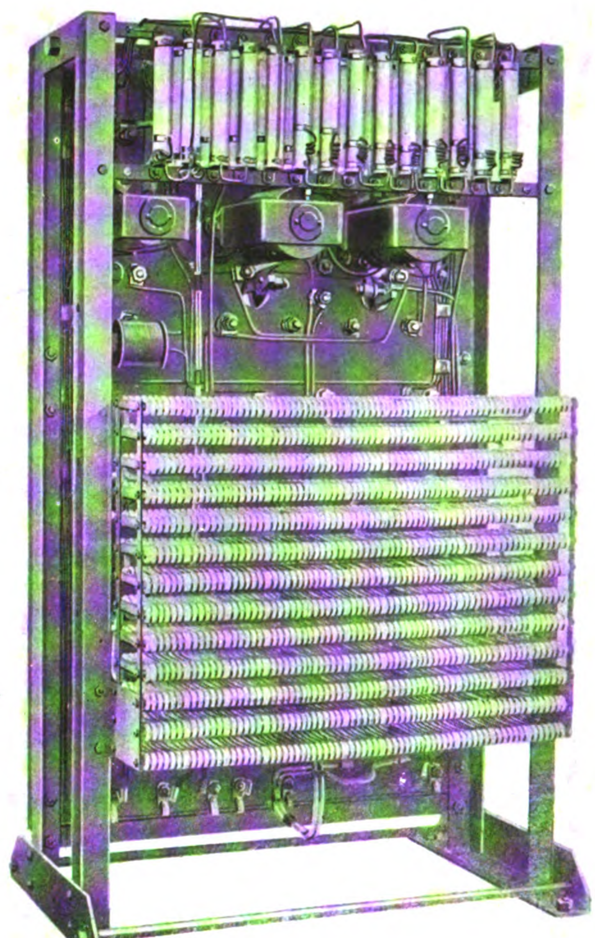


Fig. 1.—Rear View of Elevator Control

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 re-

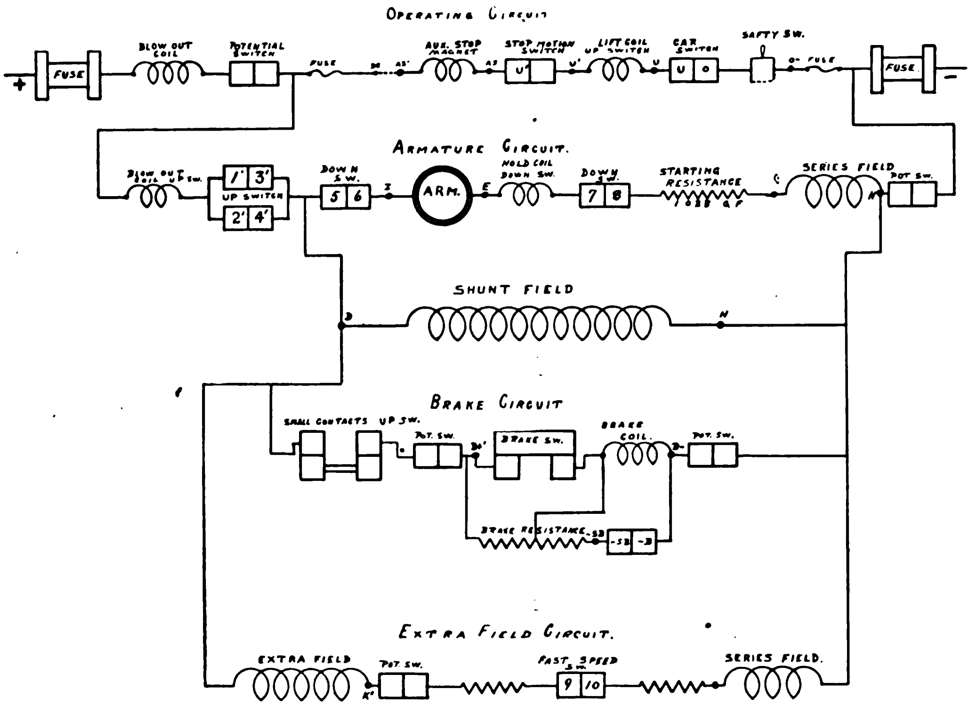


Figure 3

lease 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.

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

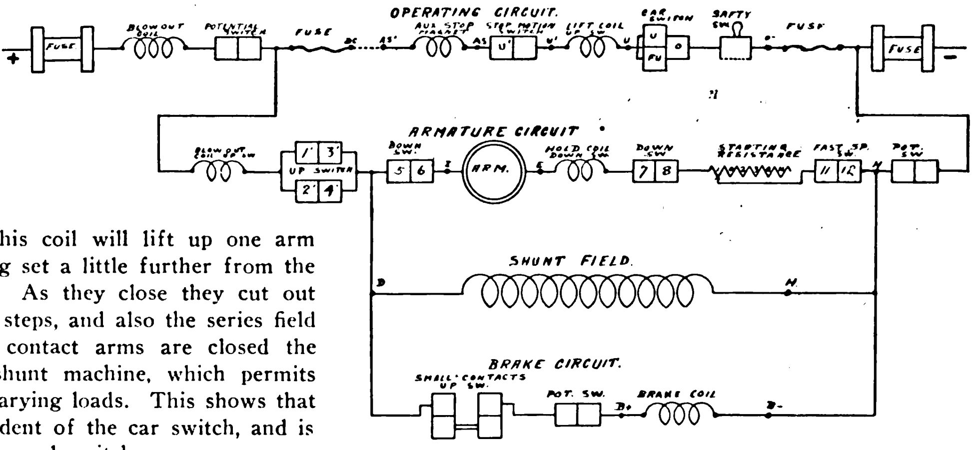


Figure 4

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.

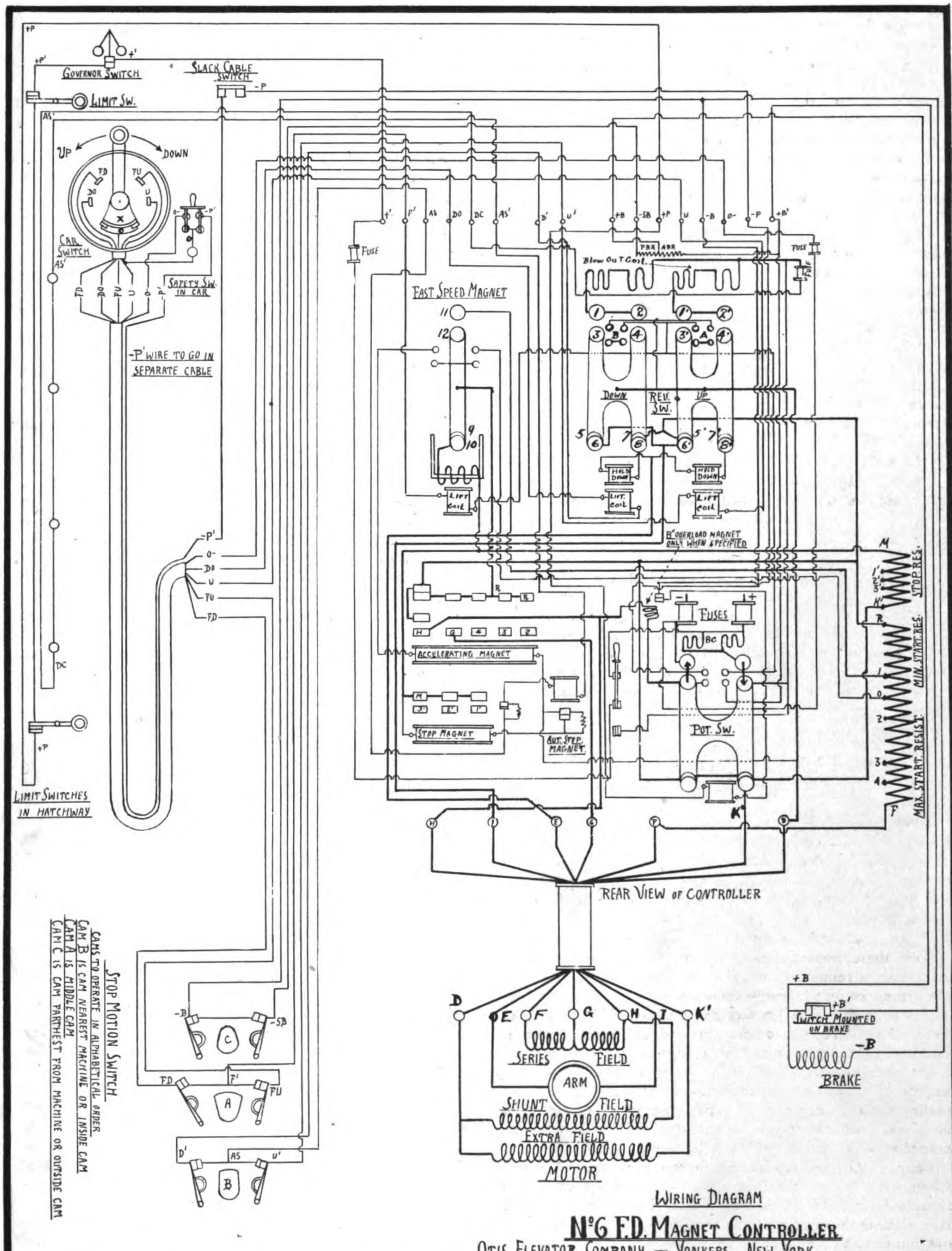
White Way Installation Completed

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



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.

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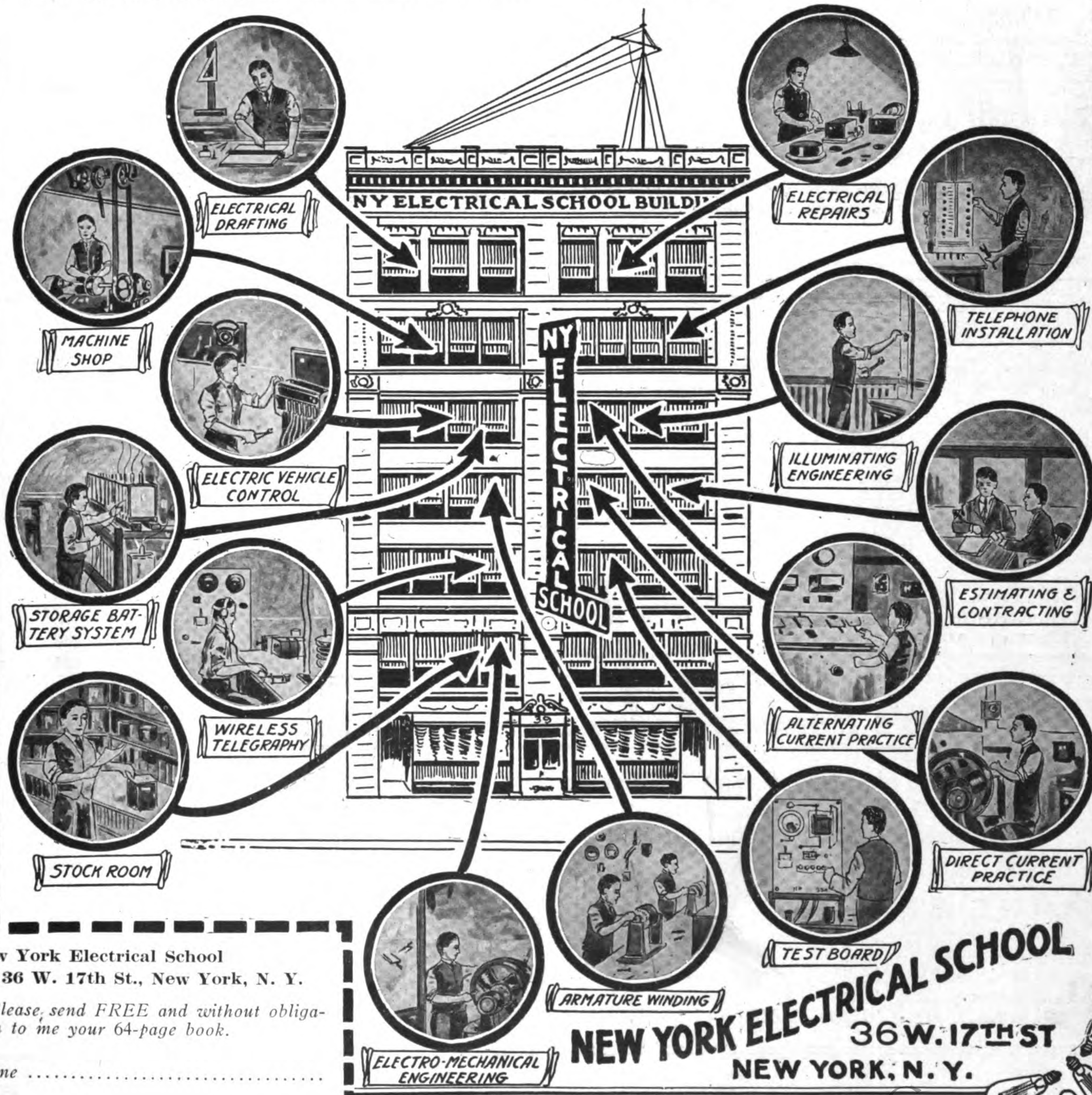

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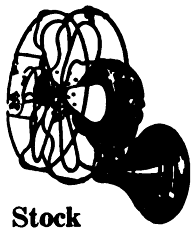

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National Metal Molding Co., Pittsburgh.

Brushes (Motors and Generators)
Dixon Crucible Co., Joseph, Jersey City.
General Electric Co., Schenectady, N. Y.

Brushings—
National Metal Molding Co., Pittsburgh, Pa.

Cabinets—
Columbia Metal Box Co., N. Y. City.

Cable (Insulated)—
Okonite Co., The, New York City.
Standard Underground Cable Co., Pittsburgh, Pa.

Cable (Steel Taped)—
Standard Underground Cable Co., Pittsburgh, Pa.

Cable (Submarine and Lead Covered)—
General Electric Co., Schenectady, N. Y.
Moore, Alfred E., Philadelphia, Pa.
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Rome Wire Co., Rome, N. Y.
Standard Underground Cable Co., Pittsburgh, Pa.

Cable (Steel Armored)—
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton, N. J.
Standard Underground Cable Co., Pittsburgh, Pa.

Cable (Underground)—
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton, N. J.
Standard Underground Cable Co., Pittsburgh, Pa.

Cable (Junction Boxes)—
Standard Underground Cable Co., Pittsburgh, Pa.

Carbons (Brushes)—
Dixon Crucible Co., Jos., Jersey City.
General Electric Co., Schenectady, N. Y.

Circuit Breakers—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Cleats—
National Metal Molding Co., Pittsburgh, Pa.

Coils (Armature and Field)—
Chattanooga Armature Works, Chattanooga, Tenn.

Coils (Choke)—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Commutators—
Chattanooga Armature Works, Chattanooga, Tenn.

Coil Taping Machines—
Chattanooga Armature Works, Chattanooga, Tenn.

Compounds (Boiler)—
Dixon Crucible Co., Joseph, Jersey City.

Condensers—
Allis-Chalmers Mfg. Co., Milwaukee.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Conductors (Armored)—
National Metal Molding Co., Pittsburgh.
Roebling's Sons Co., John A., Trenton.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

Conduit Fittings—
Columbia Metal Box Co., N. Y. City.
National Metal Molding Co., Pittsburgh.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

Conduit (Flexible)—
American Circular Loom Co., New York City.
National Metal Molding Co., Pittsburgh.

Conduit (Interior)—
American Circular Loom Co., New York City.
National Metal Molding Co., Pittsburgh.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

Conduit (Rigid)—
American Circular Loom Co., New York City.
National Metal Molding Co., Pittsburgh.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

Connectors (Frankel Solderless)—
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Construction Material—
Southern Electric Co., Baltimore, Md.

Controllers—
Allis-Chalmers Mfg. Co., Milwaukee.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Cords—
Moore, Alfred F., Philadelphia, Pa.
Samson Cordage Works, Boston, Mass.
Standard Underground Cable Co., Pittsburgh, Pa.

Cord (Arc Lamp)—
Samson Cordage Works, Boston, Mass.

Cord (Flexible)—
General Electric Co., Schenectady, N. Y.
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton.
Samson Cordage Works, Boston, Mass.
Southern Electric Co., Baltimore, Md.
Standard Underground Cable Co., Pittsburgh, Pa.

Cord (Telephone)—
Moore, Alfred F., Philadelphia, Pa.
Standard Underground Cable Co., Pittsburgh, Pa.

Cord (Trolley)—
Samson Cordage Works, Boston, Mass.

Cross-Arms—
Western Electric Co., New York City.

Cut-Outs—
General Electric Co., Schenectady, N. Y.
Palmer Electric Mfg. Co., Boston.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Dynamos and Motors (Second-Hand)—
Chattanooga Armature Works, Chattanooga, Tenn.

Electrical Repairing—
Chattanooga Armature Works, Chattanooga, Tenn.

Electric Fixtures—
Southern Electric Co., Baltimore, Md.

Engines (Gas and Gasoline)—
Allis-Chalmers Mfg. Co., Milwaukee.
General Electric Co., Schenectady, N. Y.
Westinghouse Machine Co., East Pittsburgh, Pa.

Engines (Steam)—
Allis-Chalmers Mfg. Co., Milwaukee.
Westinghouse Machine Co., East Pittsburgh, Pa.

Engineers (Consulting)—
Arnold Co., The, Chicago, Ill.
Byllesby, H. M., & Co., Chicago, Ill.
Cooper, Hugh L., & Co., N. Y. City.
Stone & Webster, Boston, Mass.
White & Co., J. G., New York City.

Fans (Exhaust)—
Robbins & Myers Co., Springfield, Ohio.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Fan Motors—
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, Ohio.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Fibres—
Continental Fibre Co., Newark, Del.

Financial—
Electric Bond & Share Co., N. Y. City.

Fixtures (Light)—
Southern Electric Co., Baltimore, Md.

Friction Tape and Cloths—
Okonite Co., The, New York City.

Fuses (Electric)—
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City.

Gas Engines—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Generators and Motors—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, Ohio.
Southern Electric Co., Baltimore, Md.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Globes, Shades, Etc.—
General Electric Co., Schenectady, N. Y.

Graphite—
Dixon Crucible Co., Jos., Jersey City.

Hand Lamps (Electric)—
Southern Electric Co., Baltimore, Md.

Hangers (Cable)—
Standard Underground Cable Co., Pittsburgh, Pa.

Heating Apparatus, Etc.—
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Hoists (Electric and Steam)—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Hydraulic Machinery—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Indicators—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

Instruments (Electrical)—
General Electric Co., Schenectady, N. Y.
Norton Electrical Inst. Co., Manchester, Conn.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Inst. Co., Newark.

Insulators—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Insulating Material—
Continental Fibre Co., Newark, Del.
General Electric Co., Schenectady, N. Y.
Moore, Alfred F., Philadelphia, Pa.
Okonite Co., The, New York City.
Standard Underground Cable Co., Pittsburgh, Pa.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Irons (Electrical)—
General Electric Co., Schenectady, N. Y.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Lamp Cord—
Moore, Alfred F., Philadelphia, Pa.
Samson Cordage Works, Boston, Mass.
Standard Underground Cable Co., Pittsburgh, Pa.

Lamp Guards—
McGill Mfg. Co., Valparaiso, Ind.

Lamps (Carbon Arc)—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Lamps (Flaming Arc)—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa

Buyers' Classified Index—Continued

Lamps (Incandescent)—
General Electric Co., Schenectady, N. Y.
National Lamp Works, Nela Park, Cleveland, Ohio.
Southern Electric Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Westinghouse Lamp Co., N. Y. City.

Lamps (Miniature)—
General Electric Co., Schenectady, N. Y.
Southern Electric Co., Baltimore, Md.

Lanterns (Electric)—
Southern Electric Co., Baltimore, Md.

Lightning Arresters—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Line Material—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburg, Pa.

Lubricants—
Dixon Crucible Co., Jos., Jersey City.

Machinery Guards (Perforated)—
Erdle Perforating Co., Rochester, N. Y.

Magnet Wire—
American Steel & Wire Co., N. Y. City
Moore, Alfred F., Philadelphia, Pa.
Roebling's Sons Co., John A., Trenton, N. J.
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co., New York City.

Mechanical Stokers—
Westinghouse Machine Co., East Pittsburgh, Pa.

Metal (Perforated)—
Erdle Perforating Co., Rochester, N. Y.

Metal Punching—
Erdle Perforating Co., Rochester, N. Y.

Metals—
American Platinum Works, Newark.

Meters—
General Electric Co., Schenectady, N. Y.
Norton Elec. Inst. Co., Manchester, Conn.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

Mining Machinery—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.

Molding (Metal)—
National Metal Molding Co., Pittsburgh, Pa.

Ozonizers—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Paints (Insulating)—
General Electric Co., Schenectady, N. Y.
McGill Mfg. Co., Valparaiso, Ind.
Standard Underground Cable Pittsburgh, Pa.

Panelboards—
Columbia Metal Box Co., N. Y. City.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Perforated Metals—
Erdlee Perforating Co., Rochester, N. Y.

Platinum—
American Platinum Works, Newark.
Baker & Co., Newark, N. J.

Plugs (Flush and Receptacles)—
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. ....

Poles, Brackets, Pins, Etc.—
Western Electric Co., New York City.

Pot-Heads—
Okonite Co., The, New York City.
Standard Underground Cable Co., Pittsburgh, Pa.

Producers (Gas)—
Westinghouse Machine Co., East Pittsburgh, Pa.

Pumps—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Rail Bonds—
American Steel & Wire Co., N. Y. City.
General Electric Co., Schenectady, N. Y.
Roebling's Sons Co., John A., Trenton, N. J.

Rectifiers—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Reflectors—
Erdle Perforating Co., Rochester, N. Y.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Resistance Rods—
Dixon Crucible Co., Jos., Jersey City.

Resistance Units—
Dixon Crucible Co., Jos., Jersey City.
General Electric Co., Schenectady, N. Y.

Rheostats—
Erdle Perforating Co., Rochester, N. Y.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Rosettes—
National Metal Molding Co., Pittsburgh, Pa.

Screens and Sieves (Perforated)—
Erdle Perforating Co., Rochester, N. Y.

Searchlights—
General Electric Co., Schenectady, N. Y.
Western Electric Co., New York City.

Second-Hand Machinery—
Acme Machinery & Motor Co.
Commercial Elec. & Mach. Co.
Klein, N., & Co.
Reliable Electric Motor Co.
Schwartz & Land.
Standard Elec. & Repair Co.
Wicks Machinery Co.
Wath Electric Co.

Sewing Machine Motors—
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

Sockets and Receptacles—
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.

Soldering Irons—
General Electric Co., Schenectady, N. Y.
Pittsburgh Elec. Specialties Co., Pittsburgh, Pa.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, N. Y.

Soldering Material—
Alex. R. Benson Co., Hudson, N. Y.

Solderless Connectors (Frankel)—
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Solenoids—
General Electric Co., Schenectady, N. Y.

Stage Lighting Apparatus—
General Electric Co., Schenectady, N. Y.

Staples (Insulating)—
American Steel & Wire Co., N. Y. City.

Starters and Controllers (Motor)
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Stocks and Bonds—
City.
Electric Bond & Share Co., N. Y.

Strainers (Perforated)—
Erdle Perforating Co., Rochester, N. Y.

Substations (Outdoor)—
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Supplies (Electrical)—
General Electric Co., Schenectady, N. Y.
National Metal Molding Co., Pittsburgh, Pa.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Supplies (Telephone)—
Southern Electric Co., Baltimore, Md.

Surfacing (Steel and Tin)—
Erdle Perforating Co., Rochester, N. Y.

Switchboards (Light and Power)—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Switches—
General Elec Co.
National Metal Molding Co., Pittsburgh, Pa.
Southern Elec. Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Tape—
Okonite Co., The., New York City.
Standard Underground Cable Co., Pittsburgh, Pa.

Telephone Equipment—
Western Electric Co., New York City.

Terminals (Cable)—
Standard Underground Cable Co., Pittsburgh, Pa.

Testing (Electrical)—
Electrical Testing Laboratories, New York City.

Theater Dimmers—
General Electric Co., Schenectady, N. Y.

Tools (Linemen's)—
Western Electric Co., New York City.

Transformers—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Enterprise Electric Co., Warren, Ohio.
General Electric Co., Schenectady, N. Y.
Moloney Electric Co., St. Louis, Mo.
Pittsburgh Transformer Co., Pittsburgh.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Elec. Inst. Co., Newark, N. J.

Transformers (Bell Ringing)—
Southern Electric Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Turbines (Steam)—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Leffel & Co., James, Springfield, Ohio.
Western Electric Co., New York City.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Ventilators—
Erdle Perforating Co., Rochester, N. Y.

Washers (Iron, Steel and Mica)—
Erdle Perforating Co., Rochester, N. Y.

Water Wheels and Turbines—
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Leffel & Co., James, Springfield, Ohio.

Wires and Cables—
American Platinum Works, Newark.
American Steel & Wire Co., New York City.
Detroit Insulated Wire Co., Detroit.
General Electric Co., Schenectady, N. Y.
Moore, Alfred F., Philadelphia, Pa.
Okonite Co., The, New York City.
Roebling's Sons Co., John A., Trenton, N. J.
Phillips Insulated Wire Co., Pawtucket, R. I.
Rome Wire Co., Rome, N. Y.
Southern Electric Co., Baltimore, Md.
Standard Underground Cable Co., Pittsburgh, Pa.
Western Electric Co., New York City.