POPULAR ELECTRICITY
IN PLAIN ENGLISH

VOL. I AUGUST 1908 No. 4

THE COST OF ELECTRICITY.

"Why should I pay 10 cents per unit for electricity for lighting my home when Mr. Brown pays but half that amount for electricity to run his motor?" This question has perplexed many persons for many years. Every since the abandonment of the early "flat rate" system of charging a certain amount each month for each lamp used and the substitution of the meter system of charging, the problem of rates has been a thorn in the side of both the user of electricity and the company which supplies it.

At first it does seem unreasonable that a householder should be compelled to pay more for each unit of electric energy used than does the storekeeper, or the manufacturer who runs his shops by motors, but when the subject is understood the justice of the different rates is acknowledged. Contrary to popular belief, the difference in rates is not based altogether upon the quantity of current the customer uses but upon the number of hours he uses it. A man may get a very low rate if he runs a few lamps or a small motor 24 hours each day, while another customer using many lamps or large motors only an hour or two a day may pay a higher rate and generally does so. The reason for this is easily explained if we take a parallel case in some other industry.

For example, suppose a man has a large number of packages to deliver each day and goes to a livery stable to hire a horse, wagon and driver. If it can be arranged so that the work is spread out over the full eight hour working day, the cost will be only a few dollars. But suppose this man insists that all the packages be delivered within one hour each day. That would require eight horses, wagons and drivers, all working only a single hour, and the cost, quite properly, would be higher. Now, suppose a hundred men required packages to be delivered, each man insisting that his job be done within one hour and all wanting the deliveries made at the same hour. The liveryman would have to have 800 horses, wagons and men for this special work, and unless he could get other work for them to do during the balance of the day he would have to charge a very high price indeed for this service, because he would have to be paid, not alone for the work, but for a large amount of waste time when horses and men are idle.

This example applies exactly to the electric lighting business. The company makes a large investment in machinery, wires and all the thousand and one appurtenances necessary to supply electric current. Only comparatively few of the company's customers use electricity throughout the day. By far the greater number want it only a few hours, from dusk until bedtime. The result is that the machinery and apparatus necessary to serve the householder who burns a few lights in the evening is idle at least 20 out of every 24 hours. Not only this, but at the very time he is burning his lights every other householder is also burning light. The demand all comes at once and continues only for a few hours.

It can be readily understood that the company must charge such a customer for the time the machinery is idle. The machinery represents a permanent investment. For every 20 incandescent lamps this investment is about $125, so that the customer pays not alone the actual cost of making the electricity he burns, but also pays interest on this investment. In addition to this there is the maintenance of the pole lines and wires, the cost of meter reading, bookkeeping, clerical work and other unproductive labor, a portion of which each customer must in justice bear *pro rata*. All these charges are much higher in proportion when the lighting company's customer uses electricity only a few hours daily than when he uses it all day, or both day and night.

Some people think that the average of all the company's customers should equalize this charge and lower the rates for electricity in the home, but such a contention, while logical, does not work out in practice. Electricity must be manufactured the instant it is wanted. Snap the button on a lamp in your home and that very instant a huge machine in the lighting company's power house must meet the demand and produce 50 more watts of energy. If electricity could be stored in a huge tank, like gas, it would make comparatively little difference when the demand is made; but having to make the current the instant the customer wants it, puts the electric company in a very bad position.

It is a fact, developed by an inquiry recently made by a Public Service Commission, that about one-half the residence customers served by lighting companies represent an actual loss. The amount of money they pay does not really cover the cost of supplying them. It may pay many times for the actual cost of manufacturing the current, but it does not take care of the vast amount of clerical work and meter reading, the bookkeeping and billing, the expensive and constant repairs and renewals to all the delicate apparatus needed to generate and distribute the small amount of current used.

"Who pays for these losing customers?" you ask. The customers who use electricity for longer hours—the merchant who burns his sign far into the night, the manufacturer whose motors hum busily all day long. Such a customer pays for the losses on residence service, and this in spite of the fact that such a customer may be paying but half as much for his electricity as does the residence customer who cries, "lower rates."

SIMPLE EXPLANATION OF HIGH FREQUENCY CURRENT.

Within recent years some very astonishing things have been done with high frequency electric current. It is extensively used by medical practitioners, for wireless telegraphy, etc., and seems to act in a manner widely different from the ordinary electric current now more or less familiar to all. The following explanation of high frequency current will be found perfectly simple and will enable the average person to understand the seemingly magical things done, which are often seen at electrical shows and like exhibitions.

When the current flows in one direction in a conductor and then reverses and flows in the opposite direction it is said to be an alternating current. The number of times per second that the current makes a complete change of the direction and comes back to its original direction of flow is called its frequency. The frequency of commercial alternating currents is seldom over a hundred per second, and generally less. A high frequency current is one in which the frequency is numbered in the thousands or millions per second, although there is no strict dividing line where high frequency begins and low frequency leaves off.

Machines that produce high frequency currents directly are called high frequency alternators. Very few of them have ever been made, other methods having been devised for changing ordinary low frequency currents into those of high frequency.

The general method used is as follows: What is known as a step-up transformer is used to raise the voltage of ordinary low frequency current to a pressure of several thousand volts. This current is used to charge a condenser which consists of either the common Leyden jar or its equivalent in plates of glass, ebonite or mica coated with tinfoil.

When such a condenser is discharged through a suitable coil, high frequency current is produced. A Tesla coil for this purpose consists of a primary winding of a few turns of heavy wire and a secondary of finer wire of many more turns spaced apart to prevent short circuits between adjacent turns. Coils of this kind are often immersed in oil for insulation. There is no iron core of any kind in a Telsa coil. When the condensers are discharged through the primary of a Tesla coil in series with spark gap, which is simply a break in the circuit over which a spark jumps, a current of enormous voltage and frequency is produced in the secondary. With this current can be produced many interesting and peculiar phenomena. Fig. 1 shows at the left the transformer for raising the pressure or voltage of the ordinary current to several times its original value. Next is the glass plate condenser, and at the extreme right is the Tesla high frequency coil.

When one terminal of the Tesla coil is instead of producing death there is no sensation whatever and the current can be handled with impunity.

In the electrocuting of criminals a voltage of about 2,000 is used and only one-fourth ampere of current is sufficient to cause the death of any man. If an ordinary 16 c. p. lamp is held in the hand by one terminal and the other connected to only one terminal of the Tesla coil the lamp lights up brilliantly, consuming fully one-half an ampere or double the current used for electrocution, besides being painless. If any one doubts that the current passes through the body another method of holding the lamp will convince him. If the terminals of the lamp are connected to two persons and

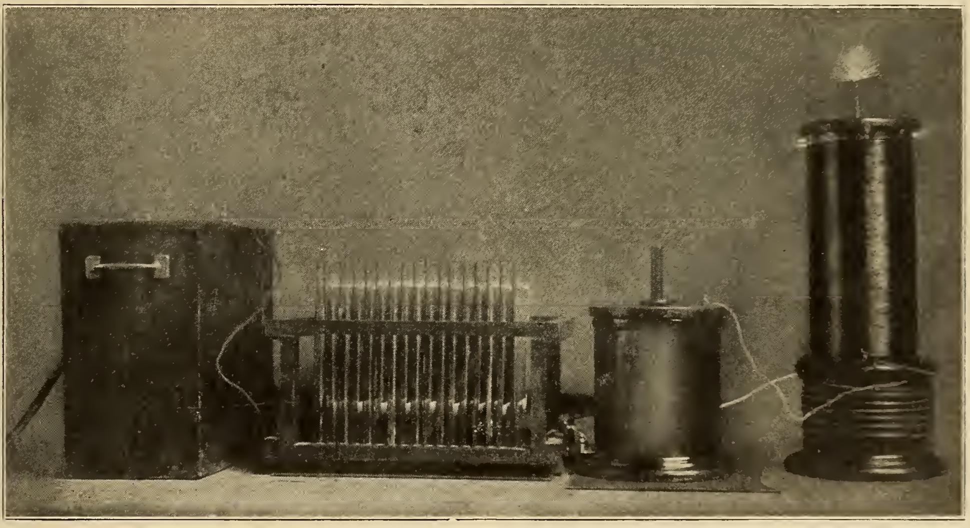


FIG. 1. APPARATUS FOR GENERATING HIGH FREQUENCY CURRENTS.

grounded, long specter like streams of sparks dart into space in all directions from the other terminal. If the capacity is increased these streams resolve themselves in flames making a striking display as shown in Fig. 2.

Nikola Tesla, while in Colorado carrying on a series of experiments, produced discharges 23 ft. in length, passing a current of 800 amperes at the tremendous pressure of 10,000,000 volts, producing a roar that could be heard for miles. At ordinary frequencies it is well known that current at a pressure of 1,000 volts and over will cause instant death. If, however, the frequency is very high, the terminal of the coil is connected to either one of them the lamp burns at full candle power. Even fine iron wire can be melted in two in the same way.

When the coil is in operation and is approached by a metal rod held in the hand the spark of the coil, which may be of over a foot long, will jump to the rod and entirely disappear if the terminal is touched, showing that all the current passed through the body.

With the pressure of this coil over 100,000 volts, if one person touches the terminal of the coil and another person comes near, sparks jump to the second person when several inches away. If a vacuum tube is held in the hand in the vicinity of the coil it will glow with a soft white light, but if the coil is touched the effect is greatly enhanced, so that it is possible to read by it. Geissler tubes are affected the same way.

This current would rather jump a considerable distance through air than go through even a few turns of heavy wire on account of the choking effect. This effect can be shown in a remarkable manner by connecting an ordinary 16 candlepower lamp in series with a piece of heavy wire bent in a circle. This lamp, although short circuited, can be

FIG. 2. DISCHARGE OF A TESLA COIL.

lighted to full candlepower by touching it to the coil, showing that the current would rather go through the lamp of high resistance than through the heavy wire whose resistance is negligible.

When a Tesla coil of considerable power is in operation sparks can be drawn from metal objects in the vicinity, although many feet away.

Wireless telegraphy is a practical application of high frequency currents.

In wireless telephony frequencies of from 100,000 to a million are used.

In electrotherapeutics the high frequency current is valuable.

Generally the source used to generate the high pressure necessary to charge the condensers is an X-ray coil, when used in electrotherapeutics.

It is held by many, Tesla among the number, that high frequency currents will work a revolution in the application of electric force, and that the electric power of the future will be produced in high frequency generating plants, will be sent out through space without transmission wires and will be collected at will at any point desired.

WIG-WAGGING BEFORE THE TELEGRAPH

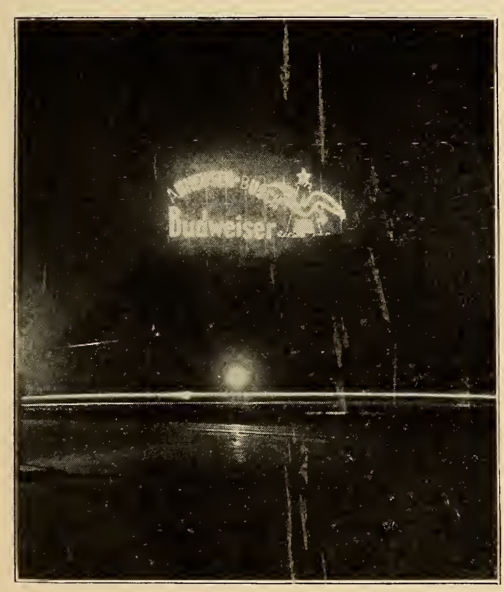
During the demolition of the Custom House in Wall street, New York, several old flags were found underneath the flooring of the upper story. The supposition was that they had been used for the announcement of the arrival of certain ships. It was ascertained that these long hidden flags had been used for a number of years before the electric telegraph line was built between Jersey City and Philadelphia in wig-wagging stock market quotations and numbers drawn in lotteries between New York and Philadelphia. From the roof of the old Custom House, then the Merchants' Exchange, a flagman signalled to a man on Bergen Hill, N. J., who in turn signalled to a man six miles away, and so on, to Third and Market streets, Philadelphia. This flag signal service communicated a ten word message in about two hours on days free from fog or snow storms. At times the service was supplemented by a lantern method of communication.

When the Morse telegraph line came into use between Phildelphia and Jersey City, for a time the messages between New York City and Jersey City were wig-wagged between the telegraph offices. Thereafter a line was built along the Jersey line of the Hudson River 50 miles northward, to reach a narrow part of the river, where a wire was stretched over and thence continued to New York City, making a circuit of over 100 miles, because it was not believed that a submarine cable was practicable, although S. F. B. Morse, Alfred Vail and a great grandson of Benjamin Franklin had made successful experiments with a submerged line of electric telegraph between the New Jersey shore and Governor's Island some time before the line was built between Washington and Baltimore.

A REMARKABLE ELECTRIC SIGN.

At the very top of one of San Francisco's tallest hills is the largest electric sign on the Pacific coast, and it is also the second largest sign in the world. The sign is easily read from any part of the city and far out in the Bay, being visible day or night for a distance of six miles.

The letters are made of 22 gauge galvanized iron and protected with four



A REMARKABLE ELECTRIC SIGN.

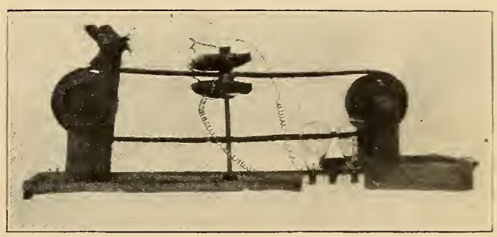
coats of white enamel, giving a powerful reflecting surface to the light given off by the 1,500 four c.p. lamps which cover the letters.

The "A" and "B" in Anheuser Busch, also the "A" of the emblem are illuminated by 50 natural ruby glass incandescents. The emblem measures from tip to tip 72 feet, the whole sign being over 80 feet high. The letters are securely bolted to 10 cedar poles 18 inches by 95 feet, sunk 14 feet into solid rock and braced from the front and back by 20 No. 6 galvanized iron guy wires attached to 12 by 12 by 8 foot "dead men" sunk 12 feet in the rock. The lights are controlled from a metal cabinet box located at one end which contains all the switches and cut-outs.

Considering the difficulties overcome in the placing of this sign, especially the danger to the workmen swinging into position the great letters, measuring 16 feet in height, in gales of wind which blow over this point at a velocity of from 45 to 70 miles per hour, it is safe to say that this is the greatest piece of electrical engineering done anywhere for the sake of advertising.

A FREAK DYNAMO.

The illustration shows what foolish ideas some "would-be" inventors have stored away in their heads. This machine was recently unearthed in a small shop. It consists of an endless leather belt, with two rows of copper rivets (disconnected), which is made to run



A FREAK DYNAMO.

over two wooden pulleys. An upright piece of round iron supports the fields, which are insulated from the iron by means of paper washers. Small No. 18 wire is wrapped around the two pole pieces as shown, and current from the electric light service passing through several lamps affords the exciting current. The leather riveted belt is made to pass through this magnetic field and current is supposed to be collected from the two carbon sticks near one of the pulleys. A motor is used to drive the machine and it is needless to say that current is not generated.

The inventor says that the idea came to him during one of his dreams and, unfortunately, believes there is something out of the ordinary to be accomplished with his freak machine.

ELEMENTARY ELECTRICITY.

BY EDWIN J. HOUSTON, PH. D. (PRINCETON).

CHAPTER IV.—EFFECTS OF ELECTRIC DISCHARGES.

As already stated, the essential parts of simple electric circuits are the electric sources, for producing the electricity, the electroreceptive devices for obtaining some of the many effects electricity is capable of producing, the electric circuits for connecting the electroreceptive devices with the sources and the switching devices for opening or closing the circuits at convenient points.

Since the object of every electric installation or plant is to produce electricity, and so lead it through various electroreceptive devices that different electric effects may be obtained, it will be readily seen that a discussion of these effects is a matter of prime importance.

Having now briefly explained the peculiarities of electric circuits, we are in a position intelligently to discuss some of the effects of electric discharges.

While it is not exactly known what an electric discharge or current is, yet it is possible, by means of one or another of these effects, not only to know when electricity is passing through any circuit, but also to determine the amount of electricity that is passing in any given time. If the passage of the discharge produces a certain effect, the fact of this passage is at once determined by the production of this effect. Moreover, the amount of electricity that passes can be determined by the amount of the effect. Various devices are employed for measuring the amount of current. Some of these are known as ampere-meters or ammeters, because they measure the amount of current that passes in amperes. Others are called wattmeters, because they measure the amount of electric power transmitted in a given time in units of electric power called watts. An example of an electric measuring device is shown in Fig. 30. which represents the Thomson recording wattmeter. the operation of which will be explained in another article.

It is not our intention now to more than briefly refer to the character of the effects produced by the passage of electric discharges.

The more important effects produced by the passage of an electric discharge through any circuit are:

(1) Magnetic effects. The passage of an electric discharge is invariably attended by the production of magnetism in the medium surrounding the circuit. The magnetic effects produced by electric discharges are exceedingly common. Indeed, magnetism invariably attends the discharge of electricity through a circuit. No matter what may be the kind or condition of the materials of forming the circuit, or what may be the

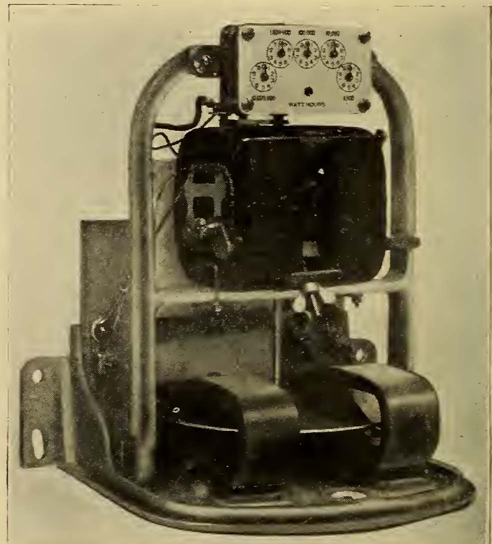


FIG. 30. RECORDING WATTMETER.

character of the discharge, its passage is invariably attended by magnetism. As is well known, magnetism gives rise to a variety of effects, among the commonest of which are the attraction or repulsion magnets exert on one another. Under proper conditions, these attractions and repulsions may produce a continuous rotation, as in the electric motor, as shown in Fig. 31, by the electric desk fan motor.

(2) Thermal or heating effects. The passage of an electric discharge through any circuit is invariably attended by an increase in temperature of the substance

or substances forming the circuit. The amount of this increase in temperature depends not only on the amount of electricity that passes; that is, the rate at which it is passing, but also on the char-

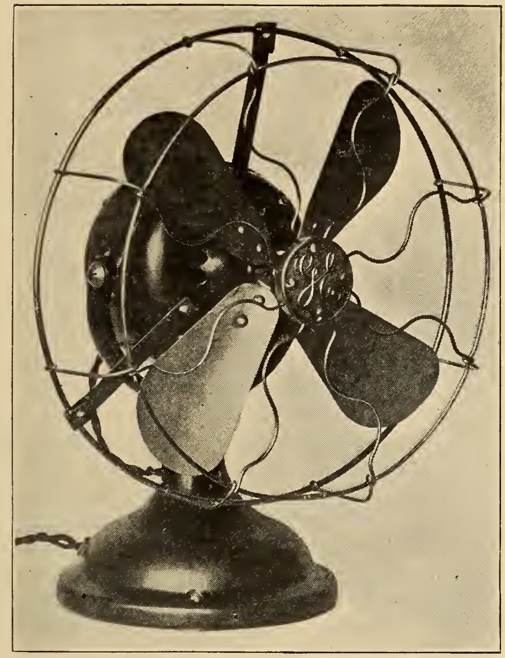


FIG. 31. THE ELECTRIC FAN MOVES BY ELECTRIC REPULSION.

acter and dimensions of the circuit in which the heat is produced. A variety of heating effects may be produced by the passage of an electric current, such, for example, as are seen in the electric flatiron represented in Fig. 32.

(3) Luminous effects. As soon as the temperature of portions of the circuit passes beyond a certain limit, the passage of an electric discharge through any circuit is invariably attended by the production of light.

A variety of luminous effects are produced by the passage of an electric current. Among the commonest of these are the arc and incandescent electric lights, which are well known to every one. Fig. 33 is an example of a new type of incandescent lamp not so well known—the tungsten lamp. This lamp is made luminous by the passage of current through filaments of tungsten, as in the ordinary carbon filament lamp.

It is interesting to note that the three effects already enumerated as being produced by the passage of an electric discharge; i. e., the magnetic, the thermal, and the luminous, agree with one another in that they all take place in the same medium—the universal ether.

Without entering into an explanation as to what is meant by the universal ether, it will suffice to say that it is an exceedingly tenuous medium that occupies not only all the spaces between the grosser particles of matter, not only the spaces between the mere minute portions, the molecules and atoms, but also the space through which the sun, earth and other bodies of the solar system move, and, as far as is known, extends throughout the stellar space that fills the entire universe.

The passage of an electric discharge through any circuit sets up wave motions in the universal ether. These motions may consist either of the streamings or vortices that produce magnetism; or, of the rapid to-and-fro motions that produce

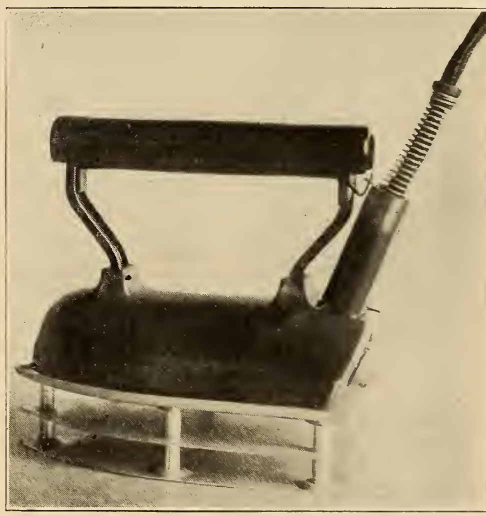


FIG. 32. THE ELECTRIC FLATIRON — AN EXAMPLE OF THE HEATING EFFECT OF ELECTRICITY.

heat and light, light differing from heat solely in the fact that its to-and-fro motions are far more rapid.

But there are still other effects produced by the passage of an electric discharge. Let us, therefore, pass to their consideration.

(4) Chemical effects. The passage of an electric discharge through a circuit sometimes results in the decomposi-

tion of the molecules; that is, in the atoms in the molecules being separated from one another. After their separation the atoms may remain uncombined with other atoms, or they may re-unite to form new molecules. Effects of this character are called chemical effects. The peculiar odor observed during the operation of an electric machine is due to a chemical change produced on the molecules of the oxygen of the atmosphere through which the discharge passes.

(5) Mechanical effects. The passage of an electric discharge through a circuit is not only attended by the rapid motion of those small particles called molecules, not only by the motion of those still smaller particles called atoms, but also by the motion of the grosser, though nevertheless smaller particles called masses. These latter motions may be sufficiently powerful to result in the tearing or rending of solid bodies, like wood and stone, or in the fusion or volatilization of metals. Effects of this character are seen in the lightning flash.

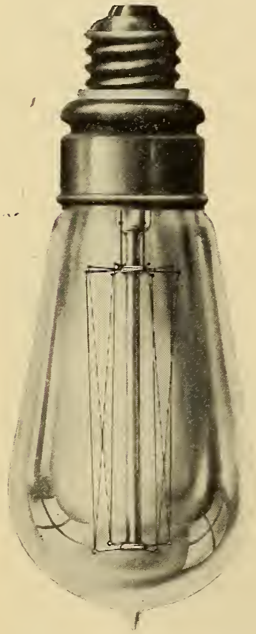


FIG. 33. THE NEW TUNGSTEN LAMP.

The passage of an electric discharge may therefore produce a motion of the masses, of the molecules, or of the atoms; in other words, these motions may be molar, molecular, or atomic.

(6) Physiological effects. The passage of an electric discharge through animals invariably results in an influence on the nervous system producing what is known as a physiological shock and at the same time profoundly modifying the processes of secretion, excretion, etc.

But besides the physiological shock the passage of an electric discharge through an animal produces various sensation of light, sound, taste or smell, by the excitation of the special organs of sight, hearing, taste or smell.

(7) Radio-active effects. Under certain conditions the passage of an electric discharge may result in the breaking up of the atoms of certain varieties of matter, thus producing what are known as fragmentary atoms or corpuscles. As we shall afterwards explain, these split atoms or corpuscles produce various phenomena, to some extent in the materials of the electric circuit, although principally in media outside the circuit, by the action of what are known as X-rays, Roentgen rays, uranium rays, polonium rays, thorium rays, etc. This class of phenomena may be included under the general term radio-active phenomena or radio-activity, and will be afterwards discussed in detail.

Without attempting at the present time to enter into details, it may be said that an electric discharge or current is no longer regarded as passing through the mass of the conductors that form the circuit, but rather through the universal ether which surrounds and fills the spaces between its molecules. For example, in a simple circuit consisting of an electric source connected by copper wires or other metallic conductors with one or more electroreceptive devices, while the electricity is generally spoken of as leaving the source at its positive pole, flowing through the circuits and the electroreceptive devices connected therewith, and returning to the source at its negative pole, in reality, it is through the universal ether lying outside the circuit and not through the gross matter of the conductors themselves that the electricity passes. The part played by the conductors is merely to direct or determine the path the discharge takes. This, however, is only said in passing. We can, for the time being, safely regard the conductors as forming the path of the discharge.

Without, therefore, endeavoring now exactly to define in what an electric discharge of current consists, we shall remain satisfied with the following: An electric discharge or current consists of the passage of something called electricity through the universal ether surrounding a conductor, and to some extent, also, through the ether that fills the spaces between the small particles or masses of which the conductor may be regarded, as well as through the spaces between the molecules or the atoms. Bearing in mind this provisional definition; i. e., that an electric current consists of the flow or passage of electricity, it is evident that there are certain respects in which electric currents may differ from one another, as follows:

(1) In the quantity of electricity that passes per second.

(2) In the pressure or force that causes the electricity to pass; or, as we have already agreed to call it, the electricity moving force, the electromotive force, or, as generally contracted, the E. M. F.

We have already seen that an electric discharge or current closely resembles a current of water flowing through a pipe. The passage of the water through the pipe is due to the action of a pressure that may be called the water-motive force. In this respect a current of electricity and a current of water exactly resemble each other. Indeed, as we shall now see, this resemblance extends further.

In the first place a water current may be constant as regards the amount of water passing per second. A given quantity of water, say a certain number of cubic feet, passes each second. As long as the pressure which causes the water to flow and the resistance that opposes this flow remain constant, the quantity of water passing will remain constant. In the case of the flow of water through the pipes, a constant water pressure, or water-motive force, means, where the flow is due to the action of pumps, that the pressure has been maintained constant by keeping the number of revolutions per second of the driving engine constant.

A constant electric current is produced when the electromotive force and the resistances of the circuit are maintained constant. An example of a constant electric current is seen in the current produced by the ordinary voltaic cell known as the Daniell's or bluestone cell that is employed in telegraphy.

But the current of water may not remain constant. The pressure that causes its flow may vary; it may increase or decrease in strength, so that the quantity of water passing per second, or the water current, may vary. Such would be the case where the pressure is caused by the action of pumps. An increase in the number of revolutions of the driving machinery could produce an increase in pressure, and a consequent increase in the number of cubic feet of water that pass in a given time.

There is a variety of electric current known as the variable current where the quantity of electricity that passes per second varies. This is the variety of electric current found in all circuits fed by dynamo-electric machines. An increase in the electromotive force that follows a change of position of the collecting brushes on the commutator, or an increase in the number of revolutions per second of the dynamo, will, if the resistance of the circuit remains constant, cause an increase in the current strength, or in the amount of electricity that passes per second.

In the case of a variable water current the variations in the quantity of water passing per second may take place slowly, hours or even days being required for the increased discharge to reach its maximum, or the decrease its minimum. They may, however, occur suddenly, so that a great volume of water may be discharged in a few hours, or, indeed, in a few minutes. When water collects in a reservoir, a long or unusually heavy rain will cause the depth of water gradually to increase. The increase in pressure, due to increase in depth, will cause a gradual increase in the amount of flow per second from the reservoir.

Sometimes, as in a cloudburst, a heavy rainfall causes a rapid increase of water and the pressure against the retaining walls of the reservoir may rapidly become so great that the walls burst or break, and nearly all the water is discharged in a short time. Fearfully destructive effects may thus be produced by the sudden discharge of the water. The energy gradually stored up in the water, expended in a few moments, may cause damages that are both great and far-reaching.

Similar discharges may occur in electricity. As in the case of water being gradually stored in the reservoir, with the pressure against its retaining walls gradually becoming greater and greater until at last all the accumulated water discharges in one great wave, so in electricity charges may increase until suddenly, almost all the stored electricity escapes in a fraction of a second. Such discharges are known as disruptive or impulsive discharges. Examples of disruptive discharges are seen in the discharge of the Leyden jar. Here charges of opposite character; i. e., positive and negative, gradually collect on the opposite sides of the glass, until at last the stress exerted becomes sufficiently great to rupture or break the glass. The entire quantity of electricity is then discharged through any circuit connected with the opposite coatings. This discharge occurs in a small fraction of a second and may, if the resistance of the circuit permits it, be of an impulsive character.

Another example of a disruptive discharge is found in the case of a lightning flash where opposite electric charges have gradually collected on the opposed surfaces of neighboring clouds, or between a cloud and the earth. Such a charge resembles a huge Leyden jar. As the opposite charges increase the stress on the air between them increases and at last becomes so great that, no longer able to keep the charges apart, the air is suddenly broken or ruptured, and the discharge passes in the form of a lightning flash. The principal difference between this kind of discharge and that of a Leyden jar is that in the Leyden jar the glass is unable to mend itself, while in the lightning flash the ruptured air at once flows in and is thus ready for additional discharges.

It must not be supposed that the discharge of a Leyden jar takes place by means of a single rush of electricity between the opposite metallic coatings. On the contrary, the electricity flows first in one direction and then in the opposite direction; that is, the discharge is alternating, or oscillatory in character.

There is still another kind of water current; i. e., the tidal current that occurs in rivers that empty directly into the ocean. Here, the water does not continue to flow into the ocean. After having flowed from its head to ards its mouth for a certain time, its direction of flow changes, the water now coming in from the ocean under the influence of the moon's attraction. In the case of tides at the mouth of a river, this change in the direction of flow occurs four times every 24 hours; in other words, there are approximately two flood tides and two ebb tides.

The electric current or discharge may also be of a similar alternating character. It may flow in a certain direction for a given time, and then suddenly change, and flow in the opposite direction. Generally speaking, in the case of electricity, the alternations or changes in direction occur rapidly, there being many changes per second.

Nearly every dynamo-electric machine produces alternating currents as the coils of wire on its armature are rotated or moved through the magnetic fields produced by the field magnets. In some cases, however, these currents are caused to flow in one and the same direction, being changed from alternating to direct currents, by the use of a device called a commutator.

In alternating electric currents the name alternating is given to each to-and-fro motion of the current. A complete to-and-fro motion is called a cycle. The time necessary to complete one cycle or two alternations is called a period. The number of cycles per second is known as the frequency.

Since the character of the effects produced by an electric discharge whether they be magnetic, thermal, luminous, mechanical, chemical, physiological, or radio-active, varies not only with the amount of the discharge and with the nature of the circuits from which the discharges take place, but also with the character of the discharge, it is important that the character of the discharge be taken into consideration.

Attention is therefore called to the following varieties of electric discharges briefly referred to above:

Disruptive discharge, a name given to the sudden and more or less complete discharge that takes place through the intervening non-conductor or di-electric that separates two opposite electric charges. Disruptive discharges are oscillatory, or rapidly alternate in direction and periodically decrease in strength.

Conductive discharges, a name given to a discharge effected by leading off, through a conductor placed in contact with a charged body, the electricity that has collected on its surface. The term conductive discharge is generally employed as opposed to disruptive discharge. Generally speaking, all discharges must be conductive, since, unless the electricity is conducted, or passed from place to place, the discharge could not occur. So far, however, as the term conductive discharge is employed in opposition to disruptive discharge, there is no objection to its use.

Constant current. a name given to an electric discharge the strength of which is varying. The use of the term constant current in the sense of direct current should be carefully avoided. A direct current is a discharge in which the electricity continuously flows in the same direction while a constant current is one in which the amount of the discharge remains constant.

Direct current, a name given to an electric discharge the direction of which remains the same. The term direct current is properly employed in opposition to alternating current. A direct current is sometimes called a continuous current.

Alternating currents, a name given to currents that alternately and periodically flows in opposite direction.

Oscillatory currents, a name given to alternating currents that rapidly alternate or reverse their direction and periodically decrease in amplitude.

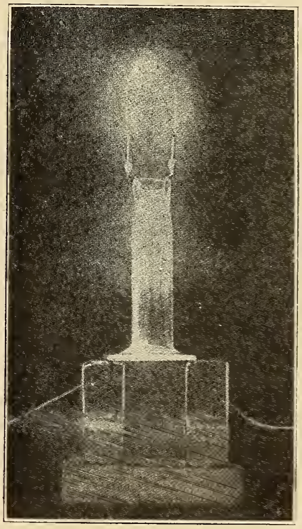
The influence of the character of electric discharges on the effects produced can be seen for example in the case of luminous effects, where alternating currents are employed for the feeding of arc lamps. Since the arc is practically extinguished with each change of direction of the current, the steadiness of the light produced will necessarily vary with the frequency. The flickerings so caused by the changes in the direction of the current are extremely marked and annoying as long as the frequency is less than 35 periods or double reversals per second. As the frequency increases, however, the flickerings become less and less, and when they become greater than 70 cycles, or double reversals per second, entirely disappear.

The character of the discharge must also necessarily produce different chemical effects. Generally speaking, a direct current produces more marked chemical effects than an alternating current, since, within certain limits, any effect produced by the discharge when flowing in a certain direction must necessarily be reversed when it flows in the opposite direction.

(To be continued.)

THE HELION LAMP.

The very latest arrival in the already quite large family of incandescent electric lamps is the Helion lamp. The filament of this lamp is formed by the deposition of silicon upon a carbon core, and when in operation it gives off a white light very nearly like sunlight.



Compared with ordinary lamp filaments, the Helion filament is considerably thicker and stiffer, but in spite of this its resistance is so great that only a short filament is required.

The most remarkable thing about the Helion filament, however, is that it can be burned in air without immediate destruction, although the best results are obtained by burning it in a vacuum bulb. The accompanying cut shows a 110-volt Helion filament burning in air.

ELECTRIC FIRE ENGINES.

The chief of the fire department of Berlin, Germany, has completed a number of tests with an electric fire engine, and found it so satisfactory that several are being installed. For a month the machine was sent out on two journeys every day, not only to points in the city and suburbs but to towns 25 and 30 miles distant. The principal object of these distant runs was to thoroughly test the motors and battery on badly paved roads and up grades. During a single week the engine covered 600 miles.

ELECTRICITY FROM SMALL WATER-POWERS.

Increasing knowledge of electricity is creating desire among those living in rural communities to enjoy its advantages. The question naturally arises, "How is the necessary power to be obtained?" A steam plant is too expensive. The gasolene engine requires attendance and is more or less complicated. There is a source of power, however, that has hitherto been but little exploited, and that is the small water power. Distributed over this country are thousands of small streams having in their courses, here and there, a fall of a few feet. The possible power is not sufficient to attract industrial concerns, consequently they lie untouched. Why should the farmer not take advantage of these natural sources of power to light and heat his home and operate his machinery? This is a question that is being taken up seriously by engineers, and it is prophesied that in the near future such water powers will be developed and prove a valuable addition to the wealth of the country.

As an example of what may be done in this direction, the following description of how a small water power of this nature was developed on the Mississinnewa river near Wabash, Ind., will be of interest.

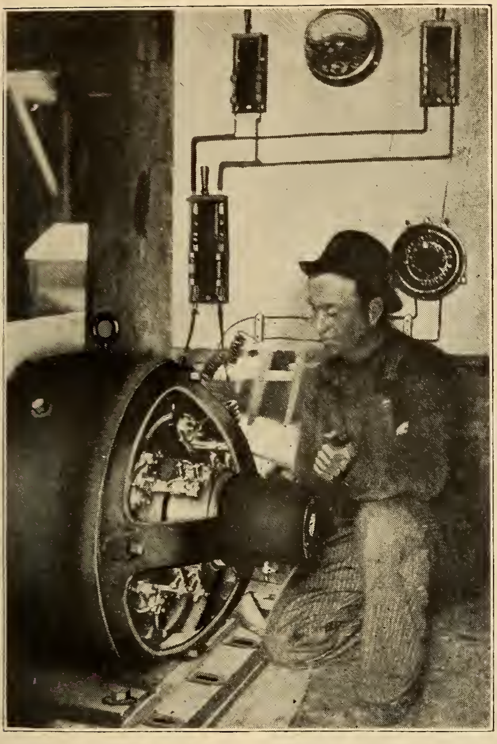
As shown in one of the illustrations, the plant is installed in an old grist mill which occupies a romantic spot on the little stream. It stands just a few miles up stream from the historic burying grounds of the Miami Indians, where Frances Slocum was buried, better known by her Indian name of "White Rose."

This small plant furnishes current for a small amusement resort at this point, and was built at the expense of a few hundred dollars. The waterwheel is of the vertical type, and is capable of developing 40 horse-power with the head obtained, which is about six feet. The wheel, by means of a bevel gear, runs the dynamo by a belt shaft.

THE OLD MILL—UTILIZED TO GENERATE ELECTRICITY.

At present about 150 lights, mostly eight candle-power, are being used. Light is furnished to the stables, the boat landing, bathhouse, amusement hall, refreshment room, band stand, etc.

As the mill is in operation during the



DYNAMO IN THE OLD MILL.

day the electric power generated at night is clear gain. The cost of power is very low, as the regular mill attendant operates the machine and the only expense is for oil (which is a small item) and incidental repairs. The cost does not exceed five cents per kilowatt hour.

The small cut shows the interior of the plant with its one dynamo and the switching arrangements mounted on an improvised switchboard.

LONDON'S SURFACE RAILWAYS.

The electric surface railways of London are for the most part constructed on the slotted conduit system. The cost of the track work alone, with its deep excavation for the conduit, is over $170,-327 per mile of double track. Attempts have been made to get the borough councils to consent to the overhead wire system, which would only cost half the money for permanent way, including poles and wires. These attempts have failed. Millions are being spent in the London electric railroads, miles of horse lines remain yet to be electrified, and additional routes require to be opened up.

GOLDEN JUBILEE OF THE ATLANTIC CABLE.

On August 16, 1858, the laying of the first Atlantic cable was finished, and communications passed between the coast of Kerry, Ireland, and England's oldest colony, Newfoundland. The late Lord Kelvin was the principal electrical engineer concerned in the laying of that cable, and was shortly afterward knighted in recognition of that work. Three years before, the promoters of this Atlantic cable had laid down 60 miles of cable between Cape Ray and Cape North. This was lost in a severe gale.

After the "1858" cable was in use between Newfoundland and Ireland, the time for messages between New York and London was 24 hours, due to the break in communication by telegraph between Newfoundland and the mainland, 80 miles, which was made by steamer.

The rate for messages between New York and London was $1 a word. This first cable was active about one month when it failed to work, and was in trade parlance "dead."

The golden jubilee of Atlantic Ocean telegraphy, to be held at home and abroad in August, is intended to commemorate the cable of 1858.

The world's investments in ocean cables is $225,000,000. The aggregate length is sufficient to make nine girdles around the equator. Forty-two steamships, with an aggregate tonnage of 68,-000 tons, are employed in laying and repairing ocean cables. The longest cable is between the coast of Cornwall, England, via the Cape of Good Hope, and Adelaide, in southern Australia. The steaming time between the terminals of that cable is six weeks; the cable messages take two to four minutes.

Practically there is little difference in the methods of making ocean cables today and 50 years ago. The route for the Atlantic cable was laid down by Maury, and he made the argument for a Federal appropriation for making the soundings on the route. This work was done by the accomplished Lieutenant Brooke, U. S. N. His records of the voyage, and the writings of Maury on the same subject, made the foundations for orography and for the sciences developed by Huxley, Tyndall and Haeckel.

REMARKABLE EFFECT OF A LIGHTNING STROKE.

Twenty-eight head of cattle were electrocuted at Plainfield, Ill., by a bolt of lightning which traveled along a barb wire fence against which the cattle drifted during a storm. If the fence posts had been grounded with wire it is probable that the animals would have been saved, although there is no positive assurance that this would have been the case, for there is no foretelling the action of lightning. Its voltage is so enormous that it seems to overleap the bounds which man is able to set on the comparatively low-voltage currents which he is able to generate and control.

According to some authorities all objects beneath the electrified cloud are supposed to be oppositely charged by induction. If a discharge takes place at any point, from any cause whatever, the cloud is left in a neutral condition, induction ceases, and the objects charged by induction instantly return to a neutral state. It is this return that is known as a return stroke, and often kills men and animals which are at a great distance from the place where the direct discharge occurs. Most of the damage done by lightning is done by this return stroke. It is in guiding to harmless discharge this return stroke that the lightning rod is most effective.

REMARKABLE EFFECT OF A LIGHTNING STROKE.

Electricity from the earth, passing upwards, goes through objects on the earth and generally does the damage before electricity from the cloud can reach the objects on the earth. This must be true, for the reason that attraction is mutual and the quantity of electricity equal. As the objects on earth may be considered parts of the earth and to possess a higher degree of conductive power than that of the atmosphere between them and the clouds, electricity must pass through them before that from the cloud can reach them.

FORMULAS FOR ELECTRICIANS TO KNOW.

Amalgam for Electrical Machinery.—Tin, 25 pounds; zinc, 25 pounds; mercury, 50 pounds.

Solder.—Two parts black tin; one part black lead.

Low Fusing Solder.—Add to common solder three to five drops of mercury to each ounce of solder.

Bismuth Solder.—Equal parts of tin, lead and bismuth.

German Silver for Rheostat Resistance Wire.—Copper, 50 parts; zinc, 25 parts; nickel, 25 parts.

Soldering Acid.—Fill a jar partly full of nitric acid and bury as much zinc in the acid as possible. The acid will commence boiling and the gas formed by the chemical action should be lighted. Continue lighting until the boiling has ceased. The resulting solution is a good acid to be used in soldering to cast iron and other metals.

Glass Bead Insulation.—Rubber insulation will not stand high temperatures, and as a substitute glass beads may be strung on the wire if the current carried is not over 110 or 220 volts. This makes a flexible and heat-proof insulation, and is sufficient for low voltages. It should not be employed, however, with voltages of 220.

AN EFFICIENT ADVERTISMENT.

Here is a building illuminated over its entire exterior with incandescent electric bulbs of eight candle power each. There are over 6,000 of the little globes. The brilliancy of the illumination is so intense that its glow can be seen for many squares and the effect is that of a big fire. It is said that there are more electric lights used upon this building than any other mercantile building in the world, and no other building carries a similar advertisement.

X-RAY BURNS.

Accounts frequently appear of some person being more or less severely burned by the X-ray. It is true that the X-ray, like every powerful force, is capable of doing harm as well as good, and should therefore only be used by those who understand it thoroughly. It is, however, purely and simply a question of dosage. Take strychnine or arsenic, both of which are powerful poisons, and yet both are used extensively in medicines, there probablv being no tonic much more commonly employed than a combination of iron, arsenic and strychnine. The fact that it contains two poisons does not interfere with its use, because they are not used in poisonous doses.

An investigation of the records of various experts shows that in using the X-ray for diagnostic purposes, a burn only occurs on an average of once in 5,000 exposures, and then not necessarily a severe burn. In treatment a burn is rarely produced by a competent operator, unless intentionally, as in some malignant cases. The so-called X-ray burn is really an inflammatory condition of the skin or other tissues set up by the ray.

When the skin has received a full dose of the ray it becomes reddened, itches and may show some tanning, as from sunburn. This, if left alone, soon disappears and merely shows the physician that he has administered a full dose of the ray and tells him to wait until its effects subside. Carried beyond this point it may cause blisters, tiny, warty lumps, painful and slow-healing ulcers and even complete destruction of skin.

The ray does this by first increasing the growth of the various cells making up the skin and other tissues; finally causing their death from over-stimulation. In the case of deep and severe burns the arteries supplying the area with blood are gradually decreased in size, through increase in the cells lining their inner walls, until finally an insufficient amount of blood is carried to nourish the parts, and they die of starvation.

These conditions are now very rare, as the dosage of the ray is much better known than a few years ago, and burns of this kind are either the result of ignorance or carelessness.

ELECTRICITY IN MEDICINE.

BY OTTO JUETTNER, M. D., PH. D.

PART IV.

A form of electrical energy which has risen to a plane of great practical importance in the practice of electrotherapy is the so-called "high frequency" current. We have previously seen that a current which reverses the direction of its flow is known as an "alternating" current. The speed with which these changes of direction recur is the "frequency" of the current. If the speed of change or alternation is very high, say one hundred thousand or more per second, it is called a "current of high frequency" or a "high frequency current."

Fig. 12 illustrates the physical principles underlying the production of currents of high frequency.

The illustration shows two Leyden jars standing on the shelf of a static machine. Above them we see the sliding or horizontal rods between which the primary spark discharge takes place. (G) is the spark-gap. Below the jars we see a coil of wire (solenoid) which is connected with the outer armatures of the jars. The moment a spark jumps across the primary spark-gap (G), a corresponding wave of electrical energy surges through the solenoid. It emanates from the outer armatures where it is generated by induction. This process of induction was considered in Part III. The discharge between the primary terminals is not a continuous flow but is oscillatory in character, each oscillation corresponding to an alternation and coincident with an increase in pressure (voltage) and necessarily a change in the direction of the current. The induced current which surges through the solenoid is likewise alternating and of still higher voltage.

It will be noticed that the solenoid shown in the illustration is divided into three segments. From the extreme end where the wire (B) is attached, to the place where the Leyden jar (to the left) is connected, we get one segment (about one-third) of the solenoid. Likewise, from the other end where the wire (A) is attached, to the place where the Leyden jar on the right is connected, we get a segment. The remaining middle portion forms the third segment. The manner of wiring, shown in the illustration,

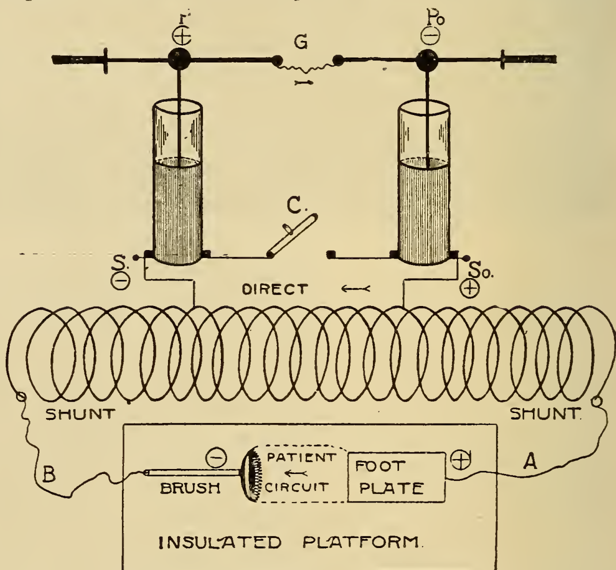


FIG. 12. DIAGRAM OF HIGH FREQUENCY APPARATUS.

illustrates the generation of so-called "shunt-currents" (one from each other segment of the solenoid). The meaning of "shunt" is explained in a previous lesson. The current surging through or oscillating in the solenoid is one of high frequency. If the two wires (B) and (A) were attached to the terminals of an incandescent globe of suitable size, the lamp would light up. If we were to substitute two persons for the two wires (B) and (A) and place the lamp between them, it would light up while the two persons would hardly feel any sensation at all. This brings us to the subject of amperage of currents of high frequency.

The rate at which a current of this kind flows is, of course, very rapid. We

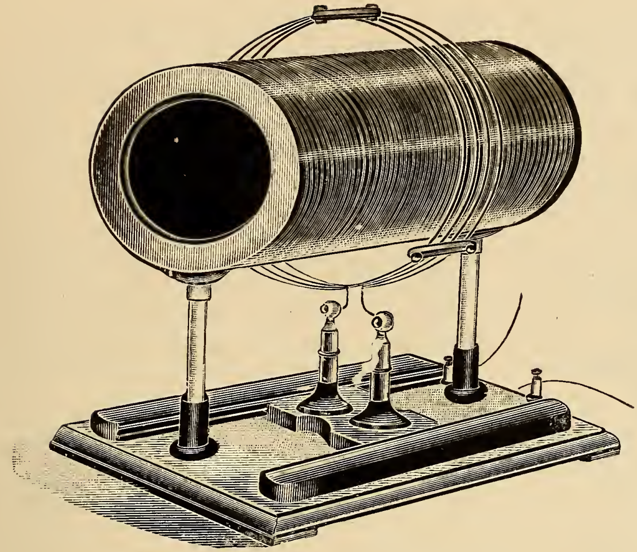


FIG. 13. HIGH FREQUENCY SOLENOID.

know from a previous lesson that an ampere is a coulomb of electricity passing through a conductor in one second of time. Suppose we raise the pressure of the current sufficiently to force a coulomb through a conductor in the tenth part of a second, it is plain that the quantity of electricity passing in one second must be 10 times as much or 10 amperes. Suppose we raise the pressure so as to force a coulomb through a conductor in the hundredth part of a second, it stands to reason that 100 amperes would pass through the conductor in one second. Owing to the fact that the frequency of alternation is very high, the human body in its tissues, particularly in its sensory nerves, does not respond to the rapidly oscillating current. If the current were not alternating but constant, it would be a most dangerous current to handle. The higher the frequency of alternation, the safer the current. This fact explains the physical feasibility of the wonderful experiments performed with these high frequency currents. These experiments have been made on the vaudeville stage much to the amazement of people who are not familiar with the physics of electricity, and imagine that the man who touches an electric light globe and lights it up, must possess some supernatural power.

In a previous lesson we have considered the subject of induction. What we learned at that time will help us to understand another remarkable feature of high frequency. In the ordinary faradic induction-coil the voltage of the secondary current depends on the number of turns in the primary wire and on the frequency of the interruptions of the current in the primary coil. Every interruption, it will be remembered, is coincident with a change in the direction of the current. Let us suppose that an alternating current of two amperes and a frequency of one million alternations is oscillating in a primary wire consisting of two, three or four convolutions of wire. Let us place a solenoid in the magnetic field of this primary wire. What kind of an induced current would be generated in the solenoid? The effect would be precisely the same if two hundred amperes were circulating in a primary wire of two hundred convolutions with a frequency of one hundred alternations. The induction effect on the

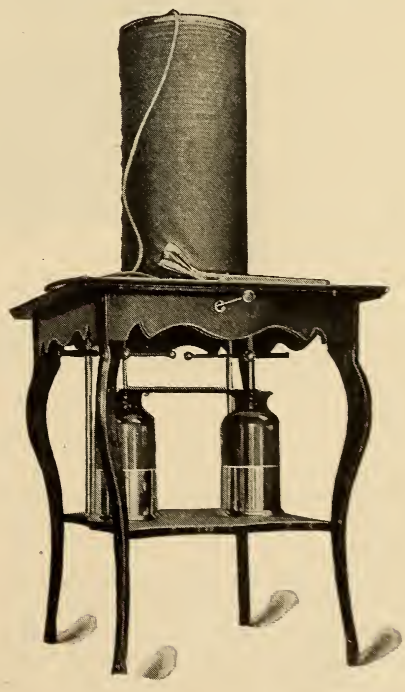


FIG. 14. OUDIN'S RESONATOR.

solenoid depends on the product of the amperage and frequency in the primary wire. We are now prepared to understand why an incandescent lamp of suitable size will light up if it is brought in the magnetic field of a high frequency current. Fig. 13 shows the practical application of this principle. The solenoid is in the magnetic field of a few turns of primary wire carrying a high frequency current.

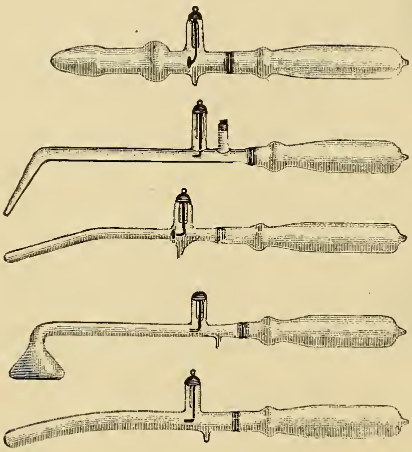


FIG. 15. HIGH FREQUENCY ELECTRODES.

There is still another remarkable physical property which high frequency currents possess. We know that a string of proper length and thickness will vibrate in sympathy with some other string which has been set in motion. Physicists explain this phenomenon of co-vibration or resonance by saying that the two strings must correspond to each other in thickness and length, or that one string in length and thickness, be a simple fraction or a multiple of the other. Electricians have borrowed this concept of resonance from acoustics to express a very similar electrical phenomenon. The waves of electricity which emanate from a circuit of high frequency are capable of setting up an analogous electrical manifestation in another circuit, provided there is a distinct physical relation between the two circuits. The instrument by which these electrical resonance effects are produced is one of the best-known devices for the generation of high frequency currents and is called a resonator. Dr. Oudin, of Paris, constructed a very practical type of this instrument. It is called Oudin's Resonator and is shown in Fig. 14.

High frequency currents are applied either by means of specially constructed electrodes or by putting the patient's body in the magnetic field of the current. Electrodes are made of glass of various shapes and sizes. The glass contains a space which is partially exhausted so that the interior represents a relative vacuum. The electrode is connected with the high frequency instrument by means of a wire. The interior of the electrode lights up with a bluish or purplish glow. The surface of the electrode is placed on or against the patient's

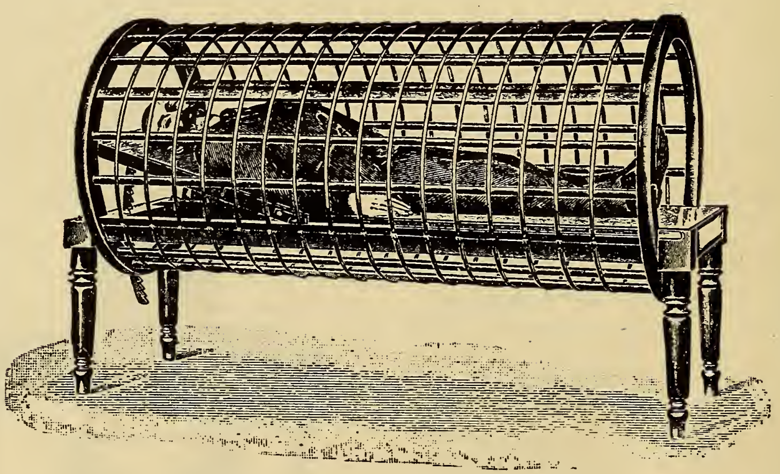


FIG. 16. AUTO-CONDUCTION CAGE.

skin. Sometimes metal electrodes are used. Condensing electrodes are also employed. They are made of hollow glass, filled with pulverized graphite and having an inner coating of tin foil. Fig. 15 shows different kinds of high frequency electrodes.

For the purpose of putting the patient's body in the magnetic field of a circuit, different apparatus and devices are used. A solenoid of immense size may be placed in the circuit of the outer armatures of two Leyden jars, the patient lying, sitting or standing in the solenoid which may be in an upright or horizontal position. The auto-conduction cage, sometimes called "diasolenic cylinder," is shown in Fig. 16.

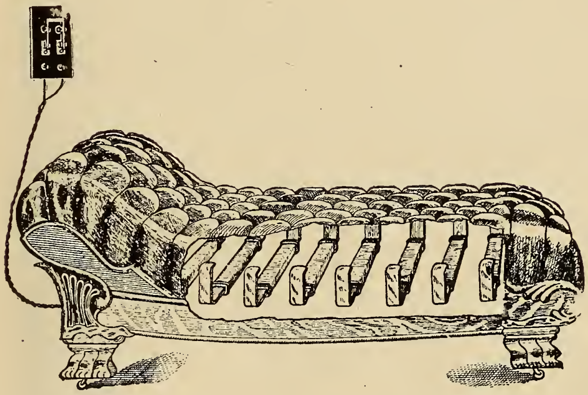


FIG. 17. AUTO-CONDENSATION COUCH.

Another very useful device is the so-called "auto-condensation couch." A metal plate is placed upon the couch and, by means of a wire, connected with one terminal of a solenoid which is interposed between the outer armatures of two Leyden jars. The other terminal of the solenoid carries a wire which connects with a metal handle in the hand of the patient who lies down on the couch. This device is similar to the so-called "electromagnetic couch," which consists of a couch within which a number of large electromagnets are hidden. These magnets are in the circuit of an alternating current and cause a powerful electromagnetic field in and around the patient who reclines on the lounge. The arrangement is shown in Fig. 18.

(To be continued.)

THE EARLY HISTORY OF THE TELEGRAPH.

The first account of a practicable working electric telegraph, described in English, is in Arthur Young's "Travels in France." Young, while a guest of the Duke of Liancourt in France, in 1787, visited a famous mechanical engineer at Clermont, who exhibited an electric telegraph capable of transmitting, by means of electrified wires and suitable instruments, messages to long or short distances. Franklin, and his successor as American minister, Jefferson, saw the same apparatus and described it in their journals.

Among other passages in Young's copy of his writings, presented to George Washington by the author, that the Father of His Country marked with approving marks in the margin, is the account of the telegraph. The comment was: "I judge this to be of prime use for army purposes."

Joseph Bonaparte, brother of Napoleon the Great, when residing at Bordentown, N. J., had a telegraphic apparatus made by the engineer seen by Young at Clermont.

Edward Everett, in welcoming General Lafayette to Harvard College, on his last visit to America in 1824, predicted that within a few years all the commercial communities of civilized lands would be "tied together by an electric cord." This oration was spoken seven years before Professor Henry began his experiments in telegraphy.

The great value of Henry's work to early telegraphy has not been properly recognized in the histories of the industry. In the later years of Henry's life, there was more of his work applied to telegraphy than was in use from the work of Morse. The first work on electrical experiments that turned Henry's thoughts to telegraphy was a memoir of Abbott Gordon, a Scotch Benedictine, who as professor of philosophy at Erfurt, Germany, in 1735, devised an electric signalling system by wire transmission for several miles. He abandoned his experiments because so many birds were killed by alighting on the wires.

ELECTRICITY ON THE FARM.

Naturally enough, it is often supposed that the convenience of cooking, heating and lighting by electricity can be enjoyed only by those who live in or near cities or large towns within reach of the electric light company's lines. This is an erroneous idea, for electricity can be generated on any premises. For the benefit of readers of Popular Electricity who live in rural districts some facts regarding such equipments will be given. The facts were obtained by observation of several isolated installations, two or three of which are extremely unique in character.

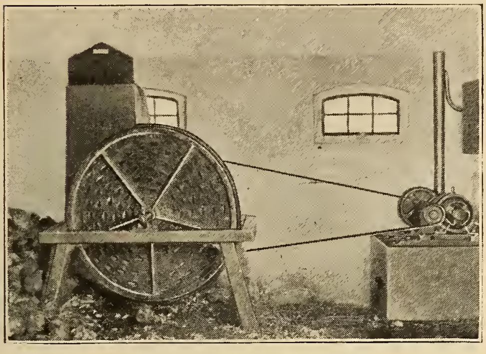
On many farms will be found a spring-fed stream which if dammed up will furnish energy enough to turn a water wheel or turbine of sufficient power to operate a dynamo which will generate the electricity necessary for all purposes. Or the farmer may operate an electric generator from windmill power to charge storage batteries. While this latter method is possible, the service is not very satisfactory, because the wind does not blow all of the time, and the power developed by the windmill is limited and of a variable quantity. The farm dog can do the churning, but his treadmill power would not be sufficient for electric generating purposes. A team of farm horses could develop perhaps the necessary power in the same manner, but this method is not very practical. However, many farmers in the West who have their own threshing machines can easily belt an electric generator to the traction or stationary engine fly wheel and generate the electric current necessary for use in the house, barns and yard. Usually these engines are idle 11 months of the year. Why not let them wear out instead of rust out?

THRESHING BY ELECTRIC LIGHT.

Another method available in many localities, especially in the Northwest, is to use the flow of water from an artesian well to run a water motor, this in turn operating the dynamo. An actual installation of this kind is in successful operation in South Dakota. Should it happen that the regular city water supply is available, the same purpose is served except that the power would probably be considerably less than in the case of the well.

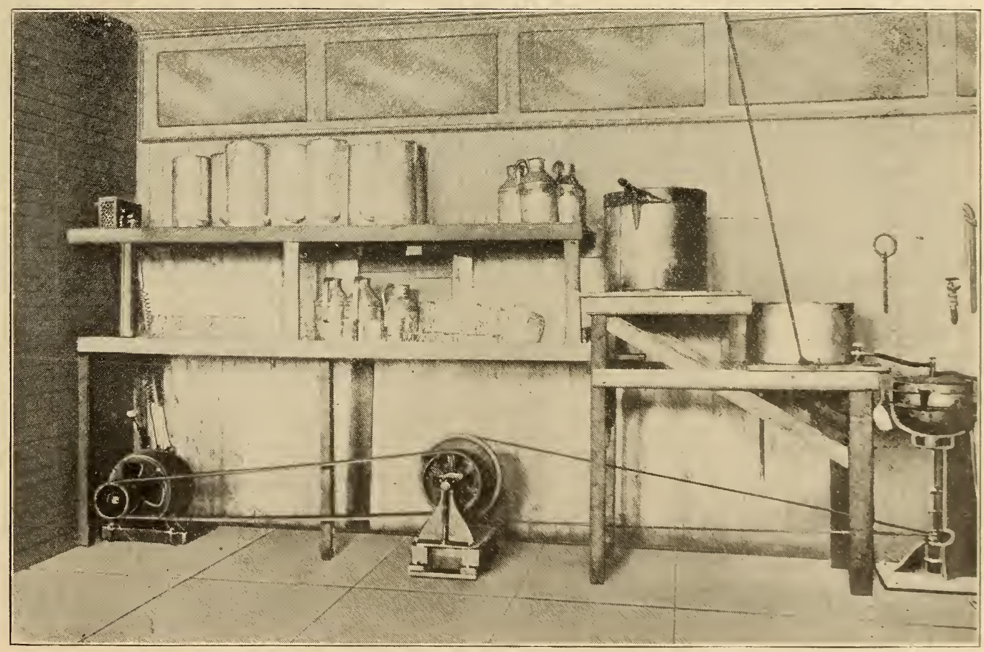
In many parts of the country natural gas is obtainable, and, with the exception of steam where economically available, the most practical method for obtaining power for operating electric generating machinery for this class of isolated plant is through use of the gas engine using natural gas. Artificial gas, distillate, alcohol, gasoline, fuel oil or kerosene are also available for power purposes.

Everyone is familiar with the automobile that is operated by a gasoline engine powerful enough to carry six or eight people over country roads at a high rate of speed. Install practically the same engine directly connected or belted to a dynamo in a country power house (a building 10 by 6 by 6 feet, is large enough), and the house, barns and yards may be lighted, the water pumped for the house and irrigating purposes, the churning, washing and ironing, cooking and baking and most of the housework done, all by electricity at the touch of the button. The electric fan and sewing machine motor then have a place in



BEET AND TURNIP CHOPPER.

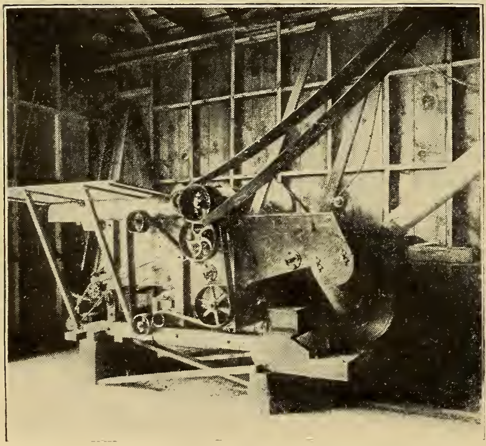
MOTOR DRIVEN PUMP FOR IRRIGATING.



ELECTRICALLY DRIVEN CREAM SEPARATOR.

MOTOR SHED BY THE BARN.

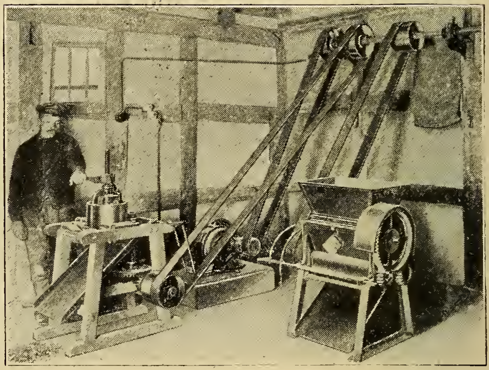
the farm home, and in the barn one or more electric motors will run the corn husker, grinder, cob crusher, beet and turnip cutter, fodder and hay cutter, grain elevator, hay fork, wood saw and grindstone at a very small cost. It may



THRESHING MACHINE.

be that an interurban railway runs close enough so that the electric power can be purchased to operate the motors without necessitating the engine and dynamo.

One Illinois farmer who installed a motor four and a half years ago saws the wood, runs the grindstone and operates other farm tools besides doing the necessary work to feed 65 head of cattle, at an average cost of but $5.00 per month where he buys the current from a nearby interurban electric company. He also says that he can crush and grind



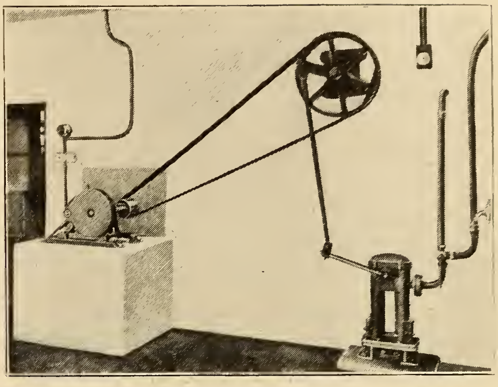
GRINDER FOR BONES AND FERTILIZERS.

50 bushels of corn in 35 minutes. Another farmer who does about the same amount of grinding and sawing, states that the highest bill for purchase of current amounted to $7.00 per month. All are enthusiastic over motor driven farm tools and would not be without them at

CUTTING FODDER BY MOTOR POWER.

twice the cost. Where there is a gas well on the farm the cost of generating the electric current is practically nothing and the cost of operating gasoline engine generating sets, long practice has shown to be very small.

The kerosene oil generating sets are perhaps the most practical for use on the farm where electricity cannot be purchased from a lighting or railway company. Long experience demonstrates that electric current can be generated economically in this way. The engines need very little attention, and after being started up in the morning with the fuel tank full of oil will run until time to shut down. They are made to be connected direct or by belts to the electric generators, and with an installation of this kind the electric current may be carried by two wires to the motor or motors wherever located. Or it may be transported about the barn or farm, and the yards, house and outbuildings may be lighted at night by a turn of the switch.



ELECTRIC HOUSE PUMP.

The heated kitchen where the work is never finished will some day vanish, and the wood box and coal scuttle will be seen no more.

Running water may be had throughout the house, for an electric motor driven house pump can be used to pump water up into a supply tank. Or it may be made to feed directly into supply pipes, and the pressure automatically reg-

THE FARM KITCHEN ELECTRIFIED.

Electric griddle cake bakers, frying pans, double boilers, pots, kettles and ovens for doing all the cooking and baking now have an exalted place in the Twentieth Century country kitchen.

ulated as water is drawn. Then at the sink, wash bowl and bath tub an electric instantaneous flow water heater may be located. A turn of the faucet handle toward "Cold" gives cold water, toward "Hot" in about ten seconds will give boiling water wholesome to use for cooking purposes. Then there is the coffee percolator to make coffee at the table and the chafing dish as well when desired.

By picturing this Twentieth Century home on the farm, it is not intended that country life be robbed of that beauty and unique simplicity that marks it so distinctly from the rush and glamour of city life. Not so! These mystic touches of electricity only help to make it more attractive. The cleaning of lamp chimneys and danger from use of lamps is a thing of the past with the advent of electric light. Lighted grounds are possible now for the lawn party. Dangers of fire from the overturned lantern have disappeared, for now the barn may be safely illuminated. Anyone who has groped about in the dark in cellar or garret can appreciate the conveniently placed electric light or the portable drop light. It may save a bad fall or broken limb by lighting the cellar-way, spring or well house, back steps or stairs. The day has passed then that makes moving to the city a necessity to enjoy modern conveniences.

Many will see at once the best and cheapest method of getting these results with the means at hand. These comforts are within the reach of nearly all. In many cases the cost of maintenance will be practically nothing, the first cost for equipment being all. In other cases, such as with the use of gasoline or oil engine sets, experience has shown the maintenance cost to be very low. It would probably be advisable to install 12 or 15 horsepower oil or gasoline engines. Engines of this capacity are efficiently operated at full load with a consumption, in the case of the kerosene engine, of one pint of oil per horsepower per hour. For smaller installations, there are on the market four and six horsepower engines with an oil consumption at full load of about one quart of oil per horsepower per hour. Smaller installation than this would hardly be advisable.

ELECTRICITY VS. THE SMOKE NUISANCE

As a result of the smoke nuisance in Chicago it becomes necessary to give some of the great office buildings baths at frequent intervals—thorough scrubbings from cornice to sidewalk. Many of the finest structures have facings of white terra cotta or glazed brick, which in a few months become so grimy and blackened as to closely resemble the buildings of brick. The accompanying

GIVING AN OFFICE BUILDING A BATH.

picture shows a large building during the process of cleansing.

But why does this become necessary? Simply because people are not as yet fully educated up to the electric central station idea. The ideal conditions, which will no doubt be realized in time, are these: Large electric power generating plants, situated in the outlying districts where smoke is not a nuisance, and producing electric current at high voltage; transmission lines carrying this current to numerous points within the city; substations at these points for converting this current to current of low pressure available for all industrial power purposes, including the electrical operation of all trains on steam roads entering the city.

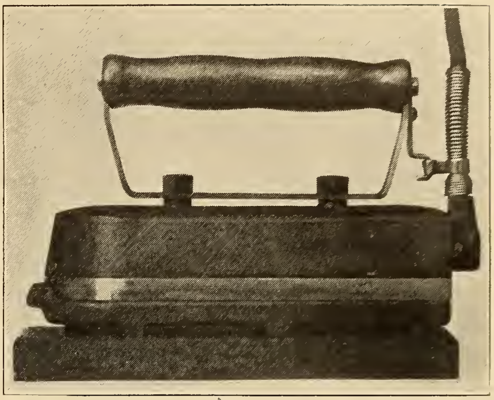
The Commonwealth Edison Co. of Chicago is working earnestly toward the realization of this ideal condition. The great Fisk street generating plant is an example of the outlying generating station, and from it current is transmitted at high voltage to numerous substations where it is made available to everyone. But still there are those who will cling to their little isolated steam plants belching forth black smoke at a thousand stacks. The steam locomotive continues to enter the most congested portions of the city. Consequently property owners must scrub their buildings, and within the "loop" hundreds of thousands of dollars' worth of property are destroyed every year by soot which fills the air and enters the most remote nooks and corners.

There is hardly a mechanical process that could not be done as well or better by electric current and at less cost.

ELECTRIC TAILOR'S GOOSE.

Inconvenience incident to the use of the old style gas heated tailor's goose, which radiates heat almost as fast as a good sized stove, is eliminated by the use of the electrically heated goose which is shown in the cut herewith.

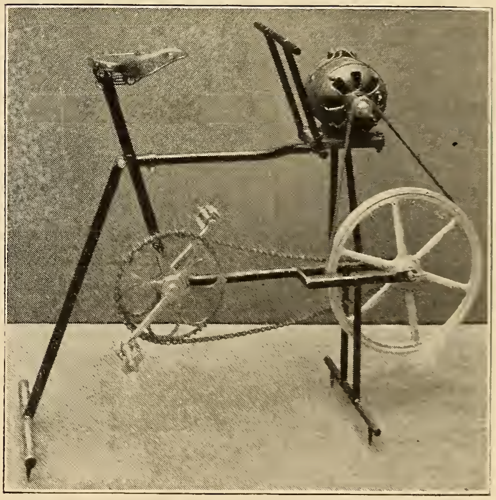
The heating element is a thin steel grid, arranged to distribute the heat evenly over the entire working surface of the iron. This grid is heremetically sealed within a fireproof dielectric of good thermal conductivity, and is held between two solid iron blocks, one of which forms the working surface of the iron, the other immediately above it, serving as a heat reservoir or thermal equalizer, by which the constant input of heat from the heating element is stored up and given out to suit the irregular demands of the work. These two portions of the iron are solidly secured together and in effect form a solid mass, which is separated from the top of the iron by means of an air space which forms an effective heat insulator.



ELECTRIC TAILOR'S GOOSE.

MAN POWER DYNAMO EQUIPMENT.

A novel dynamo equipment for use with military wireless telegraph outfits, consists of a small dynamo mounted on a bicycle frame and connected to the sprocket wheel as shown. A secure foundation is obtained by use of the pointed caulks on the feet of the frame. As the operator pedals his machine the heavy flywheel acts as a governor to give the dynamo a fairly uniform speed of rotation. When a message has been sent it is but the work of a moment to disconnect the dynamo from the wireless outfit and prepare for transportation to another part of the field.



MAN POWER DYNAMO EQUIPMENT.

ELECTRICAL "WIZARDS" OF THE PAST.

BY W. G. PEARCE.

Magazines, popular reviews and sensational newspapers of 30 years ago abounded with allusions to "wizards," "magicians" and "miraculous mechanics" in the new field of electrical engineering. The "wizards" and the "magicians" were much given to prophecy about the condition of electrical pursuits at the opening of the Twentieth Century. "The steam locomotive would be on the scrap heap by that time"; "intensive farming by aid of the electric light shedding its plant stimulating rays on fields would double the crops and make the farmer envied by other sons of toil." "Electric plows, harvesters, binders, reapers, and mowers would be everywhere in use"; "crime in cities would be reduced one-half by the plentiful use of electric lights." Animal traction was to vanish. "Ships propelled by electricity would be on every sea"; "steam engines in factories would be few." "The few gas-making plants that would exist in 1900 would be wholly used for making fuel gas, but as an illuminant gas would be under the ban of boards of health." Matter of that sort was a part of the stock in trade of visionary enthusiasts who were used as tools by sharpers concerned in the flotation of electric concerns created only for the purpose of fleecing unwary investors.

A "wizard" or a "magician" was as much a part of the outfit of a company of the above sort as a suite of richly furnished offices and the names of a couple of respectable dummies on the board of directors. Why? Because for many years traveling shows through the parts of the country where prejudices against theaters existed made much of men called wizards or magicians who performed simple tricks of ledgerdemain before respectable people, some of which required the use of electrical machines. Those wizards generally began the entertainment with a few experiments in electricity, such as Franklin exhibited to his friends. Between Franklin and Prof. Henry there was a long gap in the development of electricity, so far as it was known by the people who attended the popular lyceum lectures.

There was one very popular wizard 40 to 60 years ago who made much of popular experiments in electricity, and from those experiments he followed with the spinning of plates, cooking omelettes in hats, and other simple tricks that amused the people the country over. That wizard was Blitz. A number of his descendants are in electrical engineering today. Blitz was the first exhibitor of an electric railway in lyceums. It was a toy affair actuated by a battery.

After the contest in Hampton Roads between the "Monitor" and the "Merrimac," a famous wizard of the time—Heller—toured the lyceums with a representation of that affair which was wholly manipulated by electricity. The miniature ships were moved to and fro, the guns were pushed out and fired and drawn back and loaded by electricity. To get the effect of lightning on the scene, the wizard made it appear that the battle was fought at night, and he worked the flashes of lightning, and red, white and green electric light signals from Fortress Monroe in great shape. Three automatons followed the battle scene; Washington, General Jackson and Abraham Lincoln, all manipulated by electrical connections.

During the same period Dr. Colton had long experimented with electric battery cars which he had shown before lyceums, and had built an electric railway for Barnum, the circus man. The track was laid around the outside of the circus ring. The midgets, Gen. Tom Thumb and his wife, and Commodore Nutt rode in the little car that traversed the rails, and there was a "wizard" who with incantations and flourishings of his wand was supposed by the children to be the animating principle of the railway.

The name "wizard" in connection with popular electricity had become well established by the early sixties. All the quack dentists who pulled teeth by means of electricity called themselves wizards, and there were other wizards who traveled about with electrical machines for treating every disease suffered by men and horses and kine. It was in this way that the names wizard and magician became associated in the popular mind with men who made their living from the use of electrical machines.

When the present President of Harvard University was first spoken of as a candidate for that office a number of old-fogy New Englanders who thought that no man not in holy orders should be a college president, spoke and wrote of Dr. Elliot as "the wizard." That was because he was a chemist, and had a good knowledge of engineering, and on a number of occasions had given popular addresses on the subject of electricity. Thousands of well educated people in New England at that time considered that the choosing of Dr. Elliot as president of Harvard was as outrageous as if the Board of Overseers had chosen for the place one of the strolling wizards. So strong was the storm that many of Dr. Elliot's friends advised him to take a position as chemist for a large cotton mill in Lowell. The name wizard was applied to the learned president of Harvard by some of the old fogies until recent years.

The name "wizard" was often applied to early graduates of Eastern technical schools who embarked in electrical pursuits. One of these was the late Joshua L. Chapin, a graduate of the first class from the Massachusetts Institute of Technology. Chapin was the first man from that institution who embarked in the making of electric light and power apparatus. Before engaging in that business, he had spent a long time in company with his father and other members of the family in traveling through the Holy Land and Egypt. On returning home and engaging in the electrical engineering field, Mr. Chapin often gave for charitable purposes a lecture on Palestine, in which he appeared dressed like a Hebrew of two thousand years ago. Sometimes he would follow that lecture with a short talk on the then new arc lighting method, making use of a small dynamo and a few lamps dispersed about the hall. He in that way became widely known as the "Wizard of Electricity," and from him the name was transferred by George Parsons Lathrop and Julian Hawthorne to Thomas Alva Edison.

ELECTRICITY FROM ARTISAN POWER.

There is a farm in South Dakota called the "Badger Farm" where the owner is very progressive. He drove a well 980 feet deep and two inches in diameter and was rewarded by a flow of excellent soft water with a good pressure. He has piped the water into the house and also operates a five horsepower water turbine which runs a dynamo. In this way he

AN ARTESIAN POWER PLANT.

generates electricity to cook with, light the house, barn and yard, run his feed mill, grindstone, fanning mill, grain elevator (which elevates from 4,000 to 5,000 bushels a day), milk separator, washing machine and electric iron. He keeps a hose attached to the well, so that on an instant's notice he can throw a large stream of water upon the house or barn in case of fire, to say nothing of keeping his lawn green in dry weather and garden forced to full production.

This farmer is not wealthy, but he is ingenious and resourceful.

ELECTRIC MILK TESTING.

One of the most important duties which boards of health perform in large cities is the testing of milk. The many dangers surrounding the use of impure milk are well known, and these dangers are caused no less by the great risk of disease germs lodging in the milk, owing to careless handling, than to the malicious adulteration of this important item of our daily food.

The testing of milk is not a simple matter, or rather, was not a simple matter, until the application of electricity to this work. The test to determine amount of fat requires the employment of ether, which must be heated to the evaporation point. Ether being a very explosive material—more so even than gasoline—requires very careful handling in boiling. It is impossible to employ gas for this purpose, and the use of steam heat requires constant attention upon the part of the operator.

The problem was solved in New York City by having constructed special Simplex electric stoves, each 3½ inches in diameter and each consuming but 60 watts. These stoves give a somewhat low but absolutely uniform heat, which point, as will be seen later, is of the greatest importance in these tests.

When the milk inspectors have seized samples from milk dealers—and it is well to note that the inspectors seem always to appear on the premises of the guilty milk dealer at the wrong time—they are taken to the Department of Health's laboratories for testing. A small roll of filter paper is carefully weighed and then immersed in a sample of milk. After have absorbed all it will hold without dripping, this paper is taken out and again weighed, so that the chemist knows exactly what quantity of milk he is testing. The roll of paper soaked in milk is then placed in a test tube which is placed in a glass flask over the electric stove. Ether is put into the flask, and the current, controlled by simple snap switches, is turned on. As the ether heats to the boiling point its vapor goes up through a chamber, through which cold water passes, and is condensed again into ether, which drops onto the milk-soaked paper. When the inner test tube is filled, an automatic device permits it to flow back

ELECTRIC MILK TESTING.

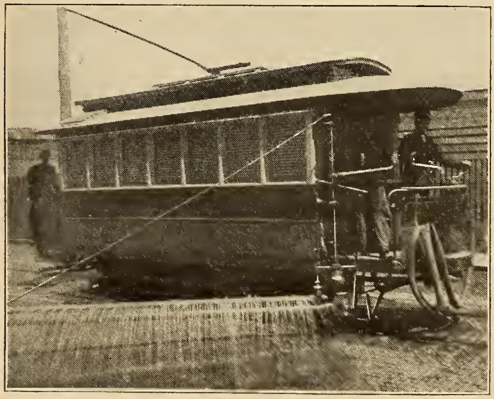
into the flask, taking with it a certain percentage of the fat, which is extracted from the milk.

This operation must be repeated seventeen times within the space of one hour. It must not be done too fast or too slow, or the test is imperfect; that is the reason why only an electric stove will properly perform the work. The electric stove is designed to produce a given amount of heat, and so perfectly does it perform this work that no attention is required by the chemist in charge, other than to see that the switch is turned off at the expiration of exactly one hour from the time the test was begun.

The picture shows the Department of Health Laboratories' Test Room in New York City, in which 24 electric stoves are constantly in use. These stoves were especially made for the work in hand, and have been in operation for ten years, giving perfect satisfaction and reducing to the minimum this class of chemical investigation, which before the advent of the electric heating was extremely arduous and seldom accurate enough to meet the present scientific requirements.

ELECTRIC SPRINKLING CAR.

Electric street car sprinklers are ordinarily used only by the car companies to sprinkle the width of their own road bed. The sprinkler car may, however,



ELECTRIC SPRINKLING CAR.

be arranged to sprinkle the entire width of the street, and a city may profitably arrange with the traction company to sprinkle those streets upon which there are car lines. The accompanying picture shows a type of sprinkler which is used with success in Syracuse, N. Y. A long arm supporting the sprinkler pipe extends out to one side far enough to reach the curb. This arm and pipe are mounted on a swivel so that they may be swung back against the side of the car when not in use, and to clear obstructions. Two men are required—one motorman and one to operate the arm and controlling valve.

SAN FRANCISCO'S WELCOME TO THE FLEET.

Arrival of the Atlantic Fleet at San Francisco was the occasion of a great celebration. Electricity played an important part in the decorations as will be

ILLUMINATION OF THE FERRY BUILDING.

seen by the accompanying picture, which shows the San Francisco Ferry Building as it was illuminated. The tower of this building was outlined with electric lights, and on the Market street side was an immense shield worked out in the national colors. Other buildings and the principal streets were also profusely illuminated, and it is said that all of the electric power plants of the city were taxed to their utmost to supply the necessary current during the hours that the lights were burning.

THE FIRST ELECTRIC RAILWAY.

At the Industrial Exposition in Berlin in 1879 there was exhibited the first practical electric locomotive. The locomotive and its passenger coaches were absurdly small. The track was circular and about one thousand feet in length. This diminutive railway was facetiously referred to by a prominent American magazine as "Siemens' electrical merry-go-round." But the electrical merry-go-round aroused great interest because of the possibilities it represented.

The current was generated by a dynamo in Machinery Hall, this dynamo being run by a steam engine. An exactly similar dynamo mounted on wheels formed the locomotive. A current from either dynamo would run the other as a motor. Dr. Siemens pointed out that if in going down grade the locomotive armature were running with greater speed than that of the stationary dynamo, it would then become the primary machine and generate an opposing current tending to reverse the motion and so act as a brake.

The rails served to conduct the current. A third rail in the middle of the track was connected to one pole of the dynamo and the two outer rails to the other pole. A small trolley wheel made the contact with the third rail. Siemens was asked if the middle rail was well insulated. He replied, "It is insulated in the best possible way, since there is nothing metallic connecting it with the outer rails. When the locomotive is in motion, its metallic parts form a much better conductor than the moist earth. If the connection is broken, the small leakage current which flows through the earth is not sufficient to keep the dynamo in action. Its magnetism disappears and with it the leakage current."

FIRST ELECTRIC RAILWAY—BERLIN EXPOSITION, 1879.

Dr. Siemens pointed out further that his machine was self-regulating. With a light load the armature of the motor revolved rapidly, generating a strong opposing current or, as we should now say, counter electromotive force. With a heavy load the motion was slow and a weak opposing current was generated in the motor.

The success of this experiment aroused great interest, not only in Germany, but throughout Europe and America.

America's greatest inventor, Edison, took up the problem. Edison, no doubt, had in mind the problem of electric traction before the report of the German invention reached this country, but the advantage in point of time must be conceded to the German inventor. The German "electrical merry-go-round" was built in 1879, Edison's experimental railway in 1880. In 1882, Edison built an electric railway which was actually used for traffic, but in this he was beaten by one year for the Berlin-Lichterfeld line was put in operation in 1881.

Edison employed only the two rails of the track as conductors, sending the current out through one rail and back through the other. Of course, this meant that the wheels must be insulated from the axles so that the current could flow from one rail to the other only through the motor windings or, as we should now say, so that the axle would act as a shunt.

As in Siemens' experiment, the motor was of the same construction as the dynamo. The rails were not insulated and it was found that, even when the track was wet, the loss of electric current was not more than five per cent. Edison found that he could realize in his motor 70 per cent of the power applied to the dynamo, whereas the Germans were able to realize only 60 per cent. The improvement was largely due to be improved winding. Edison was the first to use in practical work the compound wound dynamo for maintaining a constant voltage and this was done in connection with his electric railway.

The question of gearing was a troublesome one. The armature shaft of the motor was at first connected by friction gearing to the axle of two wheels of the locomotive. Later a belt and pulleys were used. An idler pulley was used to tighten the belt. When the motor was started and the belt quickly tightened, the armature was burned out. This happened a number of times. Then Mr. Edison brought out from the laboratory a number of resistance boxes, placed them on the locomotive, and connected them in series with the armature. This solved the difficulty. The locomotive would be started with these resistance boxes in circuit, and after reaching full speed the operator could plug the various boxes out of circuit and in that way increase the speed. The opposing current then generated by the motor would prevent the burning out of the armature. Finding these resistance boxes a nuisance, scattered about under the seats and on the platforms as they were, Mr. Edison threw them aside and used some coils of wire wound on the motor field magnet which could be plugged out of the circuit in the same way. This was

FIRST COMMERCIAL ELECTRIC CAR.

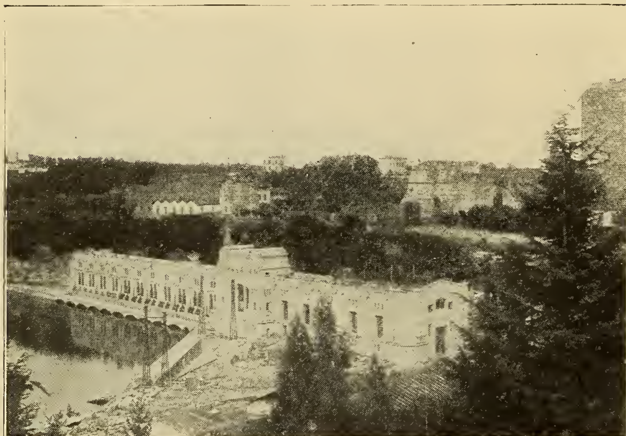
the origin of the controller now used on street cars.

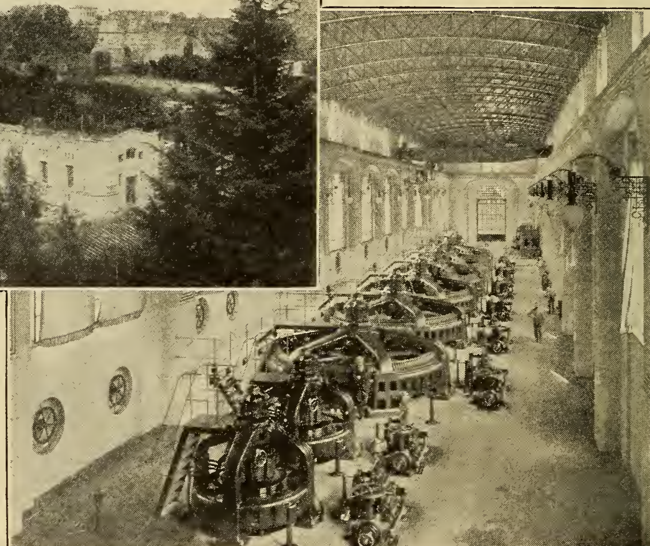
Knowing that the news of the little railway in the Industrial Exposition in Berlin had been noised abroad, and having received inquiries from all parts of the world, indicating that efforts would be made in other countries to develop practical electric railways, the firm of Siemens & Halske determined to build a line for actual traffic, not for profit, but that Germany might have the honor of building the first practical electric railway. The line was built between Berlin and Lichterfeld, a distance of about 1½ miles. A horse car seating twenty-six persons was pressed into service. A motor was mounted between the axles. A central station dynamo exactly like the motor was installed. This electric line replaced an omnibus line and was immediately used for regular traffic and thus the electric railway was launched upon its remarkable career.

AN ITALIAN ELECTRIC POWER PLANT.

Hydro-electric power plants of Italy are recognized as among the best, not only from the standpoint of the design of the electrical equipment but also from the fact that the beauty-loving Italians pay much attention to beautiful surroundings and artistic architectural effects in the building of their plants.

One of the most important power transmission plants of Lombardy is the Trezzo hydro-electric central station which may even be said to be one of the most noteworthy of all those installed in Italy in the course of the last few years. This plant shows a few features distinguishing it from all those inaugurated in recent years, both as regards the machinery and the richness and grandeur of its architecture. The outside view of the power house reproduced herewith will give an idea of the aspect of the building, constructed according to decorative designs by Gaetano Moretti.





The lower view in the group shows the main dynamo room in this power plant. The dynamos are of the vertical type—that is, their shafts are vertical and extend down to the vertical water wheels in the pits below.

Alternating current is generated by the dynamos, each alternator seen in the lower illustration being capable of developing 1,000 K.W. or about 1.300 H.P.

THE ARC LAMP CRATER.

As everyone knows, an arc light is formed by causing an electric current to pass between the points of two carbon rods. One of these is called the positive and the other the negative electrode, and the current passes from the former to the latter. Particles of carbon are carried away from the positive electrode until its end becomes cup-shaped, while the negative electrode is built up in conical or pointed form. The positive carbon is made the upper one so that the crater will throw the rays downward.

Between the two electrodes a little cloud of vaporized carbon is formed; and this vapor gives forth a golden yellow light. But it is overpowered by the light of the crater itself, which has a violet tinge due to the incandescence of solid particles of carbon. The arc of light extended from one electrode to the other also has an avis of violet color, which is its most brilliant part, and furnishes the most light of any part of the arc outside of the crater itself.

The fact that most of the luminosity comes from the crater explains the reason why the light does not appear equal in all directions. It is the brightest from that point of view which shows the largest portion of the crater.

WIRELESS TELEGRAPHY MADE SIMPLE.

BY V. H. LAUGHTER.

PART IV.

AERIAL WIRES.

In previous chapters we have treated of the construction of a wireless telegraph set, the transmitting ends, receptors and the tuning. The erection of aerials will now be taken up so that an exact idea may be had of all the parts involved in the operation of a wireless telegraph set. Standard antenna elevation of the present day consists of a number of different types used by the different systems. The De Forest "T" type is commonly used for both ship and shore work. Aerials of the adjustable loop antenna are also employed by a number of systems where special selective effects are desired. One of the main points in aerial elevation is to have a large "air contact," that is, a large spread of wires which catch the waves and conduct them down to the receiving instrument.

Types of aerials may come under the following headings: (1) The "T" type; (2) the single ended "L" type; (3) the inverted "U" or loop type. While there are a number of other kinds of aerials the ones named are generally adopted. As was mentioned above the inverted "U" aerials are used with certain receiving circuits, those of De Forest and Shoemaker. For ordinary use the "T" or inverted "L" aerial is adopted, which offers little difficulty in construction.

In some cases the aerial arrangement can be suspended from the roof of a house with wires leading down to the instruments. This plan, however, is not recommended where long distance work is an object, as it is best for a station in this case to be isolated from the high buildings, which to a certain extent interfere with the operation of the instruments. Considering, however, that an aerial for experimental purposes is desired, and the roof of a building is to be utilized for erecting the masts, the following plan may be followed.

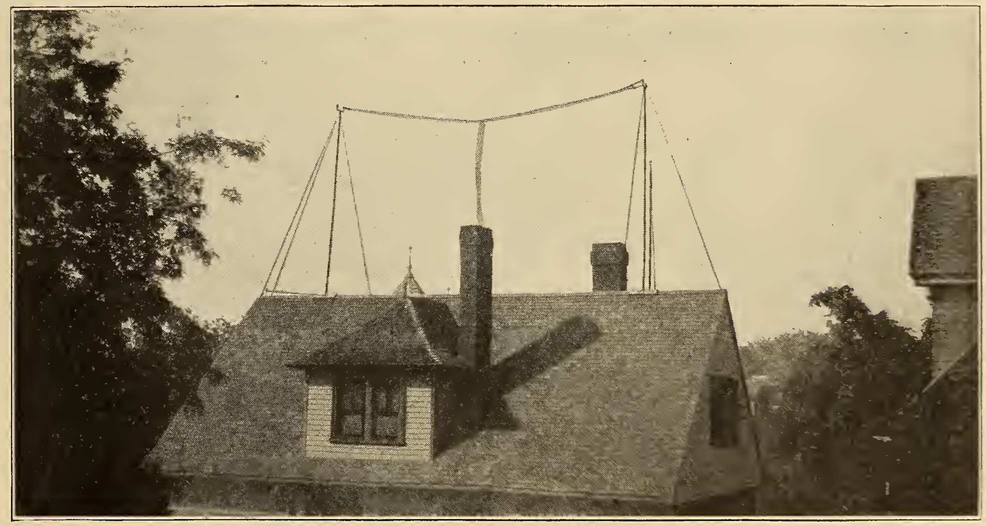


FIG. 22. DOUBLE-ENDED "T" TYPE ANTENNA.

In Fig. 22 is shown an aerial of the double ended "T" type. In this case, however, the ordinary wire aerial is replaced by a wire netting, one foot wide, the object being to use the aerial for a wireless telephone as well as telegraph work. The mast for supporting the aerial wires is first erected. The type of the mast to use will depend on the requirements. For ease in handling a two-inch iron pipe is best, that is, if the height does not exceed 12 or 15 feet above the top of the building. A 10-foot two-inch pipe may be used for the first length and five-foot one-inch pipe for the second. When it is desired to erect high masts of this type, conditions arise which make the work very difficult and it is advisable to use a wood mast, although, for a height of 15 feet, the iron mast is suitable and easily handled.

At the bottom of each of the larger pipes is first placed an inverted V-shaped wood base which holds the pipe and fits

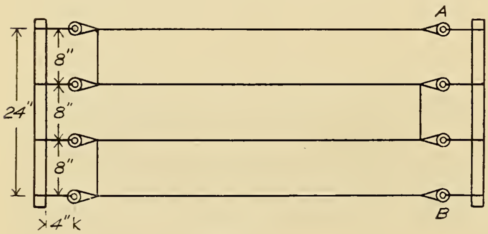


FIG. 23.

over the roof. The pipe can be fastened to the base by means of claws and screws.

Before erecting the pipes place in the tops of each a wood pin with high tension insulator screwed on. The pins should make tight fit in the pipes. A small metal pulley is now suspended from the insulator by means of a well

placed on each and guyed to the two sides and back.

The aerial arrangement may consist of the single ended "L" or double ended "T" type, according to the location of the operating room, the difference in the two

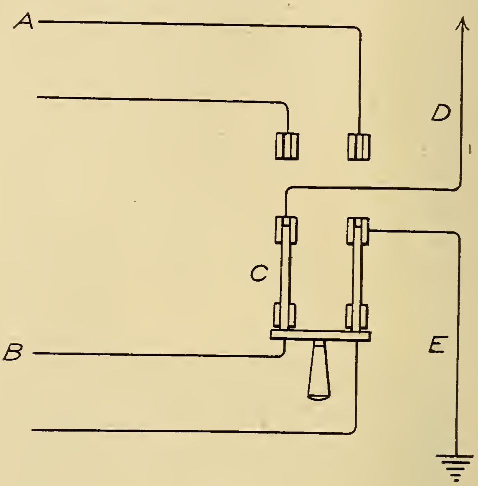


FIG. 24.

types lying only in the connecting of the wires leading from the instruments. The "L" type will be described which can be readily changed to the "T" type if desired.

Two well seasoned oak stringers, two by two inches and 24 inches long, are used to suspend the wires between the

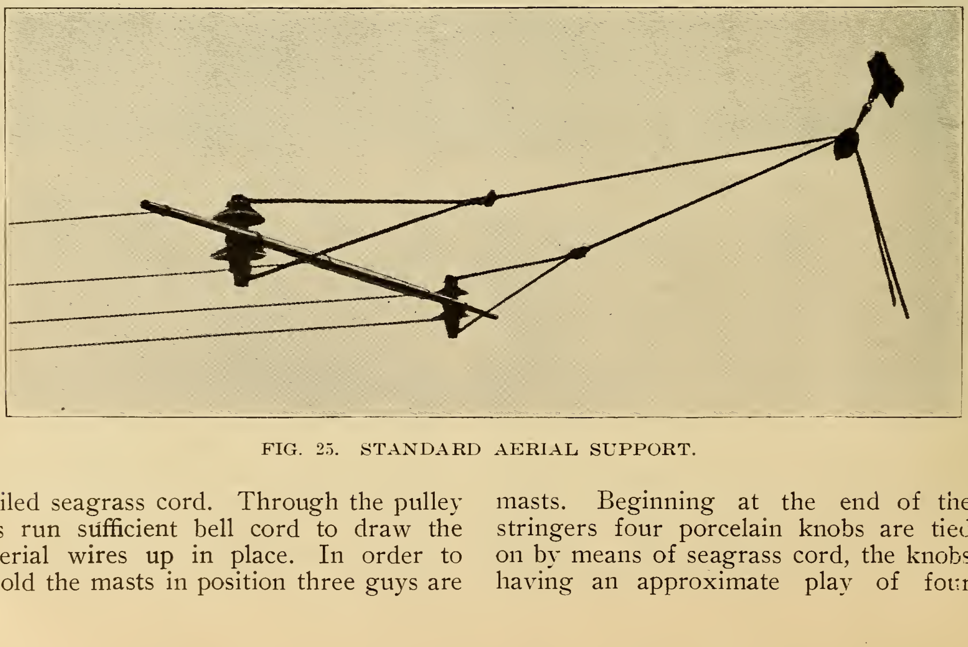


FIG. 25. STANDARD AERIAL SUPPORT.

oiled seagrass cord. Through the pulley is run sufficient bell cord to draw the aerial wires up in place. In order to hold the masts in position three guys are

masts. Beginning at the end of the stringers four porcelain knobs are tied on by means of seagrass cord, the knobs having an approximate play of four inches. If the distance between the two masts is 20 feet, four times this distance or 80 feet of No. 14 bare copper wire is needed. The wire is run in four lengths from stringer to stringer as

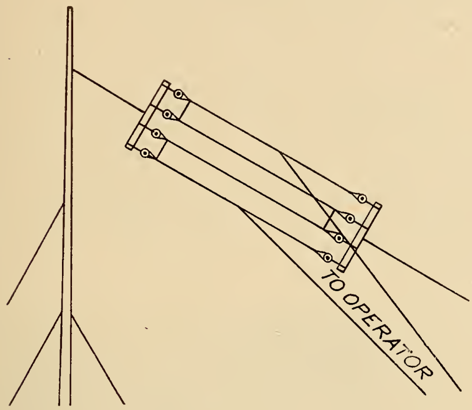


FIG. 26.

shown in Fig. 23, making the end connections around the knobs and other connections as shown. For the lead-in to the instruments No. 14 weatherproof wire is used, soldered on at (AB) Fig. 23. The lead-in should be made as clear as possible, that is, avoid the use of numerous insulators, as each tends to dissipate a certain amount of the high tension current which affects the efficiency of the sending. Where the wires lead in through the wall to the set, tape the wire well and pass through a thick porcelain

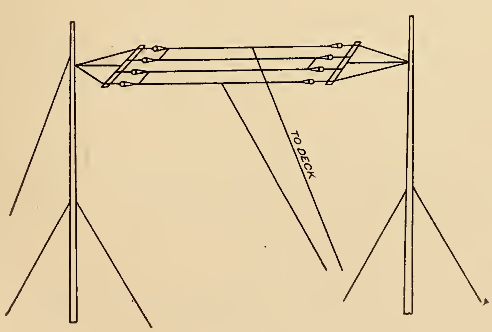


FIG. 27.

tube, or better still, drill a hole through the window pane and lead the wire through.

The placing of a ground wire is equally as important as a good aerial and care must be taken with each to secure the best results from the set. On shipboard the ground is an easy matter, it being only necessary to solder to the frame of the engine which in turn makes contact with the water through the propellor. This plan, however, is not available for land use, and other means must be provided. The conditions of the soil around the station will largely determine the depth to which the ground should be placed. In any case the ground plate should be placed deep enough to make contact with the permanently damp earth. Zinc sheets buried in the ground give ideal results. At least 50 square feet should be used. The sheets can be arranged horizontally, with a projecting strip to which the lead from the switch is soldered.

The complete arrangement of ground, aerial and switch is shown in Fig. 24 in which (A) leads to the sending trans-

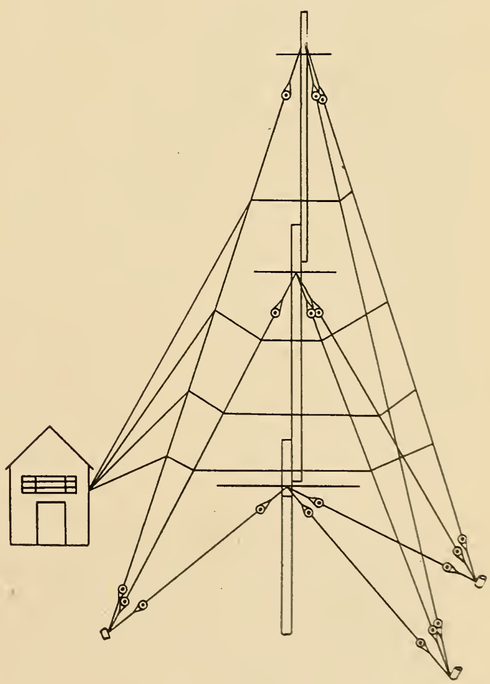


FIG. 28.

former and (B) to the receiving end. (C) is a double pole, double throw switch used to throw the sending or receiving end on the aerial at will. The standard method of supporting the aerial wires is shown in Fig. 25 and employs porcelain high tension insulators. Aerial arrangement on shipboard usually takes the forms shown in Figs. 26 and 27.

For long distance use the erection of the high masts becomes quite a difficult matter and brings in use derricks, "dummy" poles and other lifting apparatus. There is yet no standard height for erecting masts as it depends on the range of the set, however, for long distance use a mast from 175 to 200 feet high is in general use. Masts are usually built up in sectional spars, three to four masts spliced together comprising the total height. For instance, a 90-foot mast necessitates three spars; the first six by six inches in diameter and 40 feet long, the second five by five and 30 feet long, the third four by four and 20 feet long. The spars can be spliced by half grooving, bolting, and wrapping with No. 10 steel wire. To hold the masts in proper position when erected, three guys should be placed on each. Two will answer, yet the three are recommended for safety.

In erecting, a "dummy" pole is first put up which should be about 20 feet high to erect an 80-foot mast. The mast with three spars spliced together is placed with the butt to the butt of the dummy pole. Three blocks are now run from the top of the dummy pole to the top of each spar, this is done in order to divide the pull equally along the spar, otherwise it will break under it's own weight. When the mast has reached an angle of about 45 degrees the guy wires which have been previously placed on are taken by hand and the mast lifted straight. The guys are now led to stubs and pulled tight and wrapped.

The guy wires for supporting the masts can also be utilized for the aerial spread, this plan being usually adopted for long distance work. In this case the mast and ground are insulated from the guy wires by interposing porcelain knobs near the stub and mast. Insulating knobs are inserted the same as for the aerial spread shown in Fig. 23. Connecting wires are run to the various parts of the guys and back to the operating room as shown in Fig. 28.

Much attention is being devoted at the present time to portable aerial arrangements. A very simple form of mast is made up of iron pipes which can be quickly elevated to a height of 45 feet. The aerial spread is of the same plan as given above. It is asserted that such sets can be transported by one mule, and are adaptable to military service.

(To Be Continued.)

ELECTRIC BLEACHING OF FLOUR.

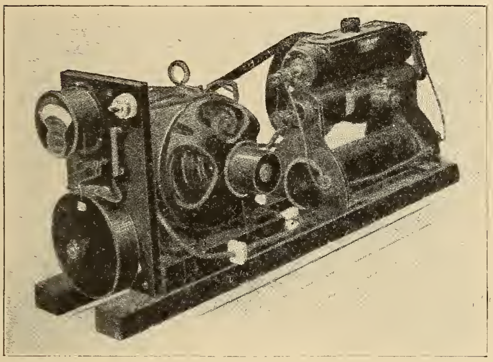
In an interesting paper recently read before the Chicago Electrical Club, Mr. F. J. Postel, consulting engineer, explained many facts concerning the electric bleaching of flour which are new to the average reader.

The electric bleaching of flour is a subject about which but little is known even among men interested in the electrical field. The process is of recent invention, being only about four or five years old. The process as practiced to-day consists of thoroughly mixing some bleaching agent in the form of gas with the flour to be treated. The result is a flour much whiter than before treatment, but otherwise differing very little if any, from the flour in the original condition. There are still a number of millers who claim that the bleaching of flour as practiced to-day is detrimental. Others, and it may be said the majority of progressive millers of to-day, refute this argument with tests by some of the best known chemists in the United States, showing that whatever slight changes do occur in the chemical analysis, are beneficial rather than injurious. In fact these tests show that flour properly bleached, keeps better and gives better results in baking than unbleached flour.

In this connection it is of interest to note that while flour responds readily to this bleaching process, cornmeal shows no effect whatever after treatment with the strongest gas.

Shortly after this process was introduced a number of bleaching machines were put on the market, but to-day the number has been greatly reduced through patent litigation and combinations. Some of the machines operate entirely independently of electricity, but among the electrical machines the Alsop machine shown in the illustration is the most widely used and the best known. This machine is built by the owners of the original patents covering the bleaching of flour.

The machine consists primarily of a 500 volt dynamo, an induction coil, two pair of electrodes and a pump. The induction coil is connected in series with the dynamo and serves therefore to hold down the current at the moment the electrodes are brought into contact, and conversely, produces a long-drawn-out arc as the electrodes separate. The electrodes consist of metal, usually of copper and are enclosed in an arcing chamber. The pump draws air through this chamber and discharges it into the mixing reel, where the gas is brought into intimate contact with the flour to be treated. The gas consists simply of air which has passed through this electric arc.



ELECTRIC FLOUR BLEACHER.

The cost of treating the flour by this process is trivial and a small machine of from three to five horsepower is amply large for the average mill.

Among the other machines which have been put on the market were some depending on the electrolysis of certain acids, the gas being then mixed with the flour. Another machine which is interesting, although not an electrical machine, produces its active gas by passing a mixture of air and a so-called "alkaline gas" through a heated platinum tube.

On account of the satisfactory results obtained by bleaching, it may be safely predicted that some process of bleaching will be in use in 90 per cent of the mills in this country within five years from the present time.

THE SKYSCRAPER OF 1950.

A modern skyscraper is a marvel to any European, even to our American countrymen who have never been in large cities. Future skyscrapers, however will surpass everything ever dreamed of. Let us now take a visionary glance into the future skyscraper, the skyscraper of 1950. We will enter one of those monstrous buildings of the future and glance around as we pass through the great crowd that moves up on one side and down on the other.

As soon as we have entered the building and left behind the heavy noiselessly moving iron gates we find ourselves in a most wonderful place, strangely illuminated. Before us are rolling and moving floors, some fast, some slow, to carry both the hustler and the easy-going visitor or idler. Some of these moving steps carry the people upstairs, others lead to the local and express elevators running up to the 45th floor, from whence the passengers can only be accommodated by rolling steps, up to the 50th floor.

In the center of the main hall there seems to be a source of light, yet we cannot see any lamps, the light appears to us as coming from various parts of the building. We notice red, green, blue, purple, orange, yellow and other colors of light uniting in the center to one glorious light array which looks very much like the daylight, and yet no lamp is visible. We are observed as being visitors, and a guide offers to show us around the building. He proposes to have us start in the basement and go up to the top. At the very bottom of the basement we find ourselves 20 stories below the surface of the ground. Enormous tube systems lead the water pipes, electric cables, etc., to the upper floors. Just above this floor we find smaller tubes, which carry the mail and small parcels. These run to a central office on the same floor. Here there are U. S. Post Office clerks sorting out the mail for this building. Every office up to the 50th floor is connected with this Post Office branch. Hundreds of tubes and boxes are seen, and each carries the mail with lightning speed to the various offices. Those letters which want to be mailed are sent down to the same office by another electric shooting service very much like a letter drop, yet much faster, and with power. All letters which are not stamped are shot up and back to the office.

On the basement floor above we find an automatic telephone central. On the basement floor above this central station is a safety deposit vault. Every office in the building has the right to use one of the vaults. They seem to be the most perfect safes that human brain can devise. First a man has to know the number of a combination lock before he can enter his compartment. If he has succeeded in entering his vault he has to unlock another combination lock in order to be able to unlock the first door. Now he stands before an electric apparatus which, as soon as the vault was opened, gave a signal to the vault controlling office. His picture is transmitted to the office and an indicator shows the photograph of the person who is authorized to enter the vault. The operator will be able to compare the two. If the person is "all right" he turns on the electric current which allows the party to make use of the first key. This done, a red light appears in the office, showing that the party had the right key. Immediately an alternating current is thrown in permitting the party to use the second key, with which he is able to finally open the vault. Electric radiographs show in the office upstairs all valuables which the man puts in or removes from the vault.

Above this vault floor is the machine floor. But, alas, we are afraid to enter this locality. Here are huge generators and high frequency transformers revolving at a terrific speed, sometimes throwing flashes and sparks several feet into the air. An enormous amount of ozone is produced by these high frequency machines and transformers, and this, we are told, is not wasted, but used in purifying the air in the halls and offices, and also for cleaning and purifying the drinking water of the entire building.

The various machines produce various colors of light. Upstairs the office people have switches to use either color they require or may find suitable for their purpose. The guide tells us that science has long proven the fact that the color of the light has an enormous influence over our temperaments, and consequently also on our nerves. Those who need physical energy will use a deep red light, those who have to work strenuously for a short time will use the ultra violet rays. Those who need a rest both for eyes and brain will turn on the green light. They, however, who have to do light work, which has to be extended over a long period of time, use the blue rays, which have a preserving effect upon the system. Although all this is most interesting to us, we are told to move on as we would never get through the building by noticing all such minor details.

So we move on to the next floor. There is not much to be seen here, yet that which may be seen is of the highest interest to us. There are enormous plates extending over the whole floor, completely covering it. These plates are there to produce the cold light in the various offices. We are informed that another plate like this is located in the ceiling on the top floor. The space between these two plates is what they call the electric field. The plates are charged with high frequency currents of millions of volts. Nicola Tesla, who was the inventor of this theory and who lived 50 years ago, is given the credit for this invention. In this electric field, that is, throughout the whole building, there are lamps which throw forth cold light. These lamps have no filament and do not need any wires attached to them. They may be carried around in the whole building always being lit. By covering the lamp with a metal screen it ceases to emit light, because the metal screen is wave tight. These lamps are used in addition to the colored lamps to which we just alluded. Both of the lamps mentioned throw forth cold light. The guide puts on his thinking cap, then tells us that long ago the people had a very poor way of producing electric light. They heated a wire, or several of them, until they became white hot, thus throwing forth a glimmering light, which flickered with the generator, and if the latter did not run fast enough, the lights would sometimes only be dimly red. "They did not know any better then," he said.

We are anxious to know how the

building was heated, and as we saw no steam pipes we are at a loss of how the heat is produced. Our guide divines our thoughts and gives us the information. In every office or other locality there are heating devices. They are electric, of course, and when not in use are covered. The more the screen is opened the more the heater is exposed to the electric waves from the plates alluded to, and these heat the air in proportion. We ask what there is on the other floors in the basement and are told that they are used for storing various goods.

In one floor are also the freight depots for the building and above it the express electric subway, above that the locals. On the floor just below the main floor there is a large restaurant, we are told. As we are hungry and need a rest, we enter to refresh ourselves. The thing that strikes us the most forcibly is that we see nothing but machinery and no one to serve. The guide notices our embarrassment and says with a smile: "There is an old saying 'God helps him who helps himself.'" As we sit down an electric instrument presents to us a bill of fare beautifully illuminated. By placing our hands on a metal handle and throwing a small coin into a drop, the machine not only tells us our temperament, but, gives us on a printed chart all about our state of health. We read it carefully and with the liveliest interest. But before we are half through with reading the complete meal is spread before us. The guide tells us that we were reading extremely slow and that it takes the people who serve us just half the time to read, because they have trained their eyes to such an extent that they read with both eyes at the same time at different places, thus employing the whole of the brain all the time. The meal is made up in such a way as to comprise all the chemicals which we require to build up our exhausted nerve energy. Thus when we placed the coin in the slot we not only made known our state of health, but also ordered our meal to suit our needs. As our meal arrived on a beautiful porcelain tray, we noticed other trays disappear as soon as the corresponding seat was vacated.

When we left the restaurant and arrived at the main floor we found that we have been spending four hours in the basement. Now there was a whole building of 50 stories left for our research and so we decided not to visit this upper part of the skyscraper until a future time.

ELECTRICITY RIDS POWER PLANT OF EELS.

A recent run of eels in the rivers and creeks in the section of northern California, near Ukiah, is said to have exceeded any known for years. The canal built by the Snow Mountain Power Company, from its power houses in Potter Valley, swarmed with them, and they piled up at the power station in a manner that threatened to clog the wheels. There seemed to be no way of getting rid of them until electricians sunk a large meshed piece of wire netting in the canal where the eels congregated, and when it was well covered, turned several thousand volts into it. The eels were then gathered up and hauled away and buried. Several wagon loads of them were killed, according to the account. The Fish Commissioners are particularly interested in this method of killing eels, as they are one of the greatest destroyers of young trout known.

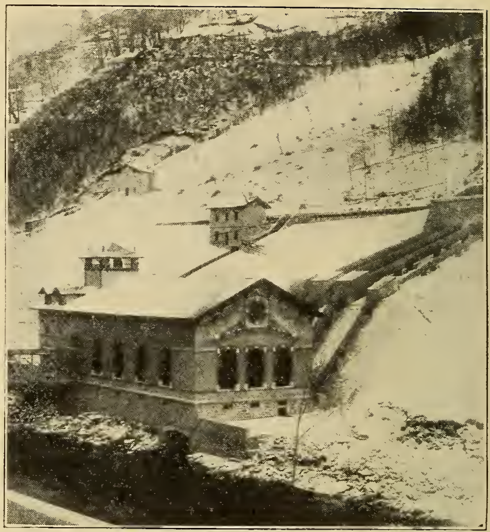
ELECTRICITY AND FOG.

In a letter to La Nature Mr. Charles Chree throws a little new light on the conditions under which fog is formed. He believes that the earth's atmospheric envelope is a reservoir of electricity; a natural storage battery. The charge is sometimes positive and sometimes negative, but within certain limits its strength increases with elevation. Records obtained by Mr. Chree with automatic registers (at the Kew Observatory) indicate that the increase is conspicuously rapid when a dense fog prevails. Here is evidence that the development of fog is to some extent an electrical phenomenon. The fact tends to confirm the belief of Sir Oliver Lodge, based on laboratory experiments, that fog could be abated by mechanically generated electricity, and that its formation could even be prevented by the same agency.

PICTURESQUE ITALIAN RAILWAY.

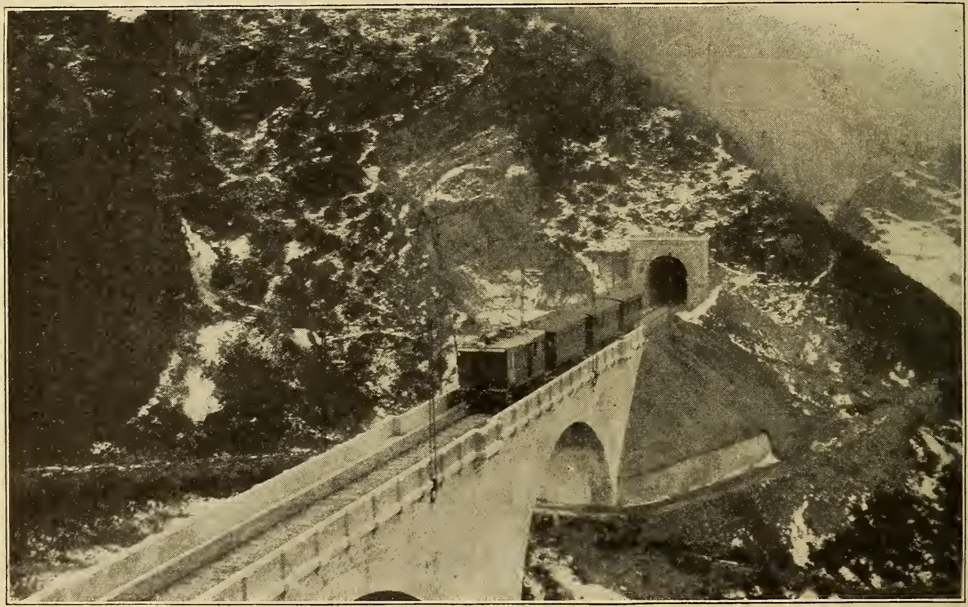
The extremely sinuous Brembo Valley, situated between two ramifications of the Alps, is one of the most picturesque valleys of Upper Italy. The villages situated in this valley, part of which are rather important, are among the most frequented Italian health resorts. The two principal cities in this region are Bergamo and San Giovanni Bianco, and they have recently been connected by a modern electric railway which operates upon what is known as the single phase system.

Owing to the mountainous nature of the country, no less than 17 tunnels were required in the 20 miles traversed by the railway. One of the accompanying illustrations shows the entrance to one of these tunnels, showing also the substantial nature of the roadbed and the finely appointed trains which operate upon this line.



POWER HOUSE OF THE BERGAMO RAILWAY.

A hydraulic power station, which utilizes a head of about 90 feet, generates the electric power required by the line. Water is brought down the mountainside from the reservoir in heavy steel tubes which terminate in the power house.



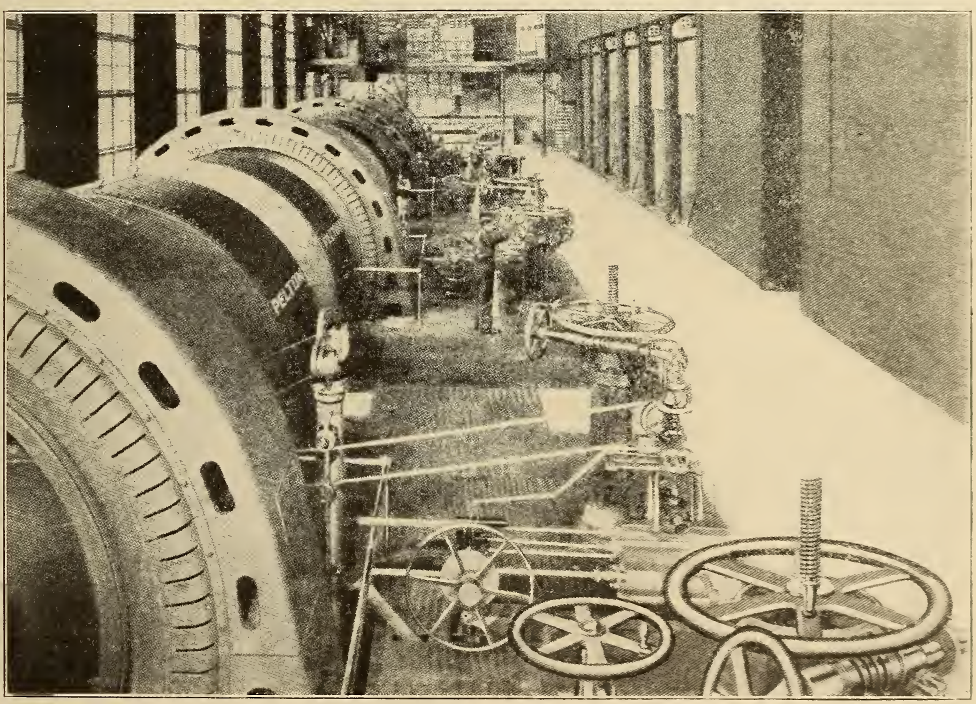
PICTURESQUE ITALIAN RAILWAY.

The cars are not operated by individual motors, but are drawn in trains by electric locomotives. Instead of the usual trolley wheel for collecting current from the wire, what is known as a pantograph collector is mounted on each locomotive. This consists of a frame work of steel which is held against the trolley wire by springs and which is lowered by a compressed air apparatus under the control of the motorman.

ELECTRIC POWER FROM A GLACIER.

The most important and interesting hydro-electric plant that has ever been installed in connection with impulse water wheels is that of the Puget Sound Power Company It is interesting not only from a hydraulic standpoint, but representing the highest development and refinement in the construction and application of electric power transmission. The plant is located on the Puyallup River, 32 miles from Tacoma, Washington. This river has its origin in the glaciers and snow peaks of Mt. Rainier, the highest mountain in the United States. As a consequence an unfailing source of water is assured from the melting snow and ice.

The water scheme consists of diverting the Puyallup River and carrying its flow by means of a flume 10 miles long to a reservoir located on a high plateau, and thence by steel pipes to the Pelton impulse water wheels, affording a head of 865 feet. The flume and reservoir are constructed with a view to the ultimate development of 60,000 horsepower, and the present equipment consists of four 3,500 kilowatt generators, also two 150 kilowatt exciters. Each wheel unit has an overload capacity of 7,500 horsepower, making the present output of the station 30,000 horsepower. This power is transmitted to Tacoma and to Seattle, 48 miles distant, being used for the various industrial enterprises in that section, and particularly for operating the extensive system of suburban electric roads in the vicinity of Seattle.



INTERIOR OF THE GLACIER POWER PLANT.

Where great heads of water are utilized to develop power, as in this plant, the impulse type of water wheel is used to the best advantage. The water is led down from the heights above in great steel tubes which grow heavier and heav-

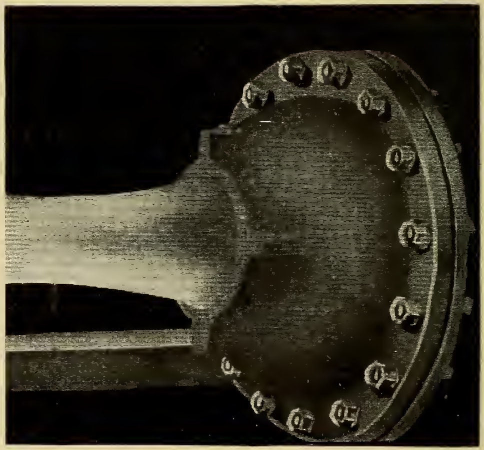
THE FORCE OF THE WATER IS FINALLY SPENT IN A GRAND RUSH.

ier toward the bottom, to withstand the enormous pressure which increases with the height of the column of water. The power house is located at the foot of the tubes, and the latter terminate in nozzles which direct streams against the buckets of the water wheels. The buckets are cup shaped and mounted on the rims of the wheels which revolve with great speed.

One of the illustrations shows a stream as it emerges from one of the nozzles. There is no spattering or splashing, for so great is the pressure that the water emerges almost as a bar of steel. If an attempt were made to cut this stream by striking it with a crow-bar, or an ax even, the tool would be whisked away as a feather would be thrown from the stream of an ordinary garden hose.

A great deal of energy remains in the stream after it has passed through the wheels, as will be noted in the picture showing the exterior of the power house.

The interior view of the power house shows the electric generators at work. The ultimate installation is to consist of eight units and the entire equipment is so arranged as to provide for complete pilot control of both water wheel and electrical apparatus. This is accomplished



WATER ISSUES FROM THE NOZZLE LIKE MOLTEN STEEL.

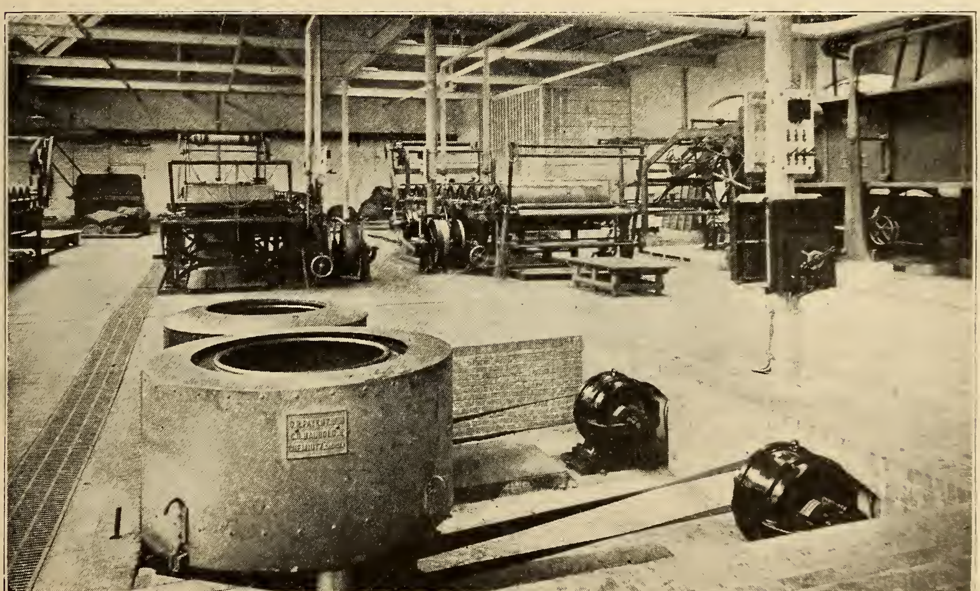
from the switchboard at the farther end of the building and the complete equipment of eight units will ultimately require a building considerably over 200 feet in length.

ELECTRICAL OPERATION OF CENTRIFUGAL MACHINES.

In certain mechanical processes, such as finishing and drying in printing establishments and the refining of sugar, centrifugal machines are used extensively. For the operation of these machines electric motors are of particular advantage owing to the peculiar requirements of the case. Belt transmission either from a line of shafting of constant speed of rotation, or, in the case of very large apparatus, from a special prime mover, a steam engine, or the like, was the usual method of driving until quite recently. Steam engines, owing to the reciprocating motion, exert a harmful action on the whole of the gearing, while turbines or Pelton wheels, which would be otherwise suitable for the operation of such machines, can be used advantageously only in the cases where natural water pressure is cheaply available. Moreover, steam engines as well as hydraulic motors are suitable only in the case of large sized units.

Electric motors are designed to have the high numbers of revolutions required in the case of centrifugal machines, while their uniformity in working and the fact that they can be raised to full speed immediately after starting, warrant a uniform and safe operation of the centrifugal machine. On account of their low space requirements, they can be arranged either above, below or beside the drum. Lastly, in the case of electric operation, a centrifugal machine cannot possibly exceed a given maximum number of turns, thus excluding any risk of explosion due to excessive speed. On the other hand, there is a possibility of altering the speed within different limits below the maximum figure, which is required for full load operation.

Different methods can be made use of in the operation of centrifugal machines —viz., belt operation, either individual or in groups, and direct operation, the driving motor being coupled rigidly and immediately to the axle of the machine. The latter alternative has the advantage, that, owing to the absence of belts, a saving in first cost, operating expenses and space is secured.



The accompanying illustration is an interesting view in a large printing establishment in Germany, where the centrifugal machines are installed in the finishing and drying works. Cleanliness and neatness are characteristic of this installation, as in all others where electric drive is employed.

ELECTRICAL PRODUCTION OF IRON AND STEEL.

In recent years various practical methods have been developed by which electrical energy is used in every process of the metallurgy of iron, from the production of pig iron from the ore in the blast furnace to the preparation of the finest grades of malleable iron and steel. The following extracts from a review of this subject by Victor Englehardt in Die Umshau will be found interesting.

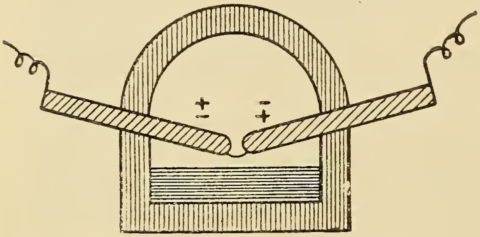


FIG. 1. STASSANO FURNACE.

Apparatus employed in this branch of electrometallurgy may be classified in three groups, of which the prototypes are the arc lamp, the incandescent lamp and the alternating current transformer.

In regard to the first group which operates on the principle of the arc lamp it is evidently impracticable to put either of the carbon electrodes in direct contact with the iron to be melted because of the solubility of carbon in molten iron.

In Stassano's refining furnace, Figs. 1 and 2, the arc is placed near the surface of the metal, which it heats by radiation, the direct radiation being augmented by the radiant heat reflected by the dome of the furnace. The immediate effect is confined to the superficial stratum of the fused metal, but this stratum is continually renewed by the rotation of the entire furnace about an eccentrically placed vertical axis.

Heroult produces electric arcs between massive carbon electrodes and the fused metal, which constitutes an intermediate electrode, but protects the metal from contamination with carbon by a floating layer of fused slag (Fig. 3). In this case, also, the heat is applied only to the surface.

In Girod's refining furnace (Fig. 4) the molten iron is connected with one pole of the dynamo by an iron rod which passes through the bottom of the furnace and is prevented from fusing by currents of water. The arc is formed between the molten iron, which is covered by a layer of slag, and a carbon electrode a little distance above its surface. The general direction of the current through the metal is vertical in Girod's and horizontal in Heroult's furnace.

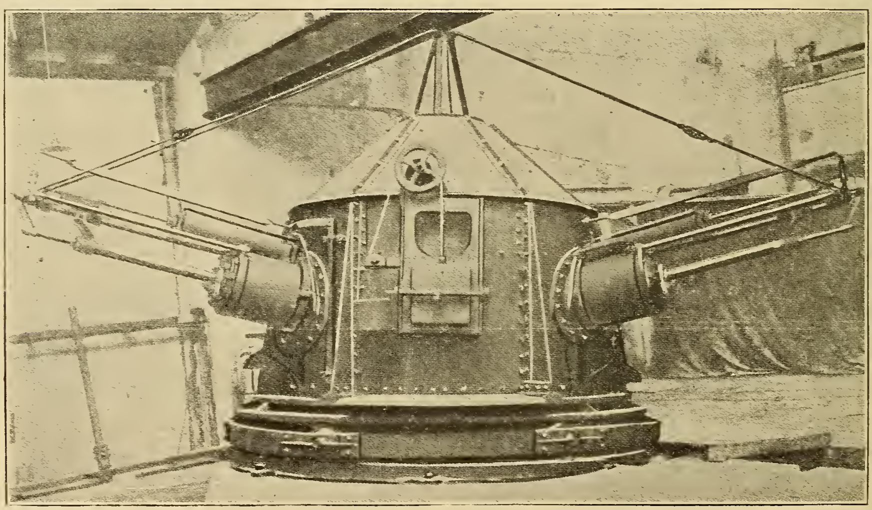


FIG. 2. STASSANO FURNACE IN OPERATION.

The Stassano, Heroult and Girod furnaces are the principal devices of the arc lamp type that have come into practical use.

An example of the second or incandescent lamp group is afforded by Gin's resistance furnace in which iron, contained in a trough of small cross-section, is melted by the heat developed by the resistance which it offers to the passage of a current flowing through it between solid electrodes at the ends of the trough. This action is similar to the heating of an incandescent lamp filament. Apparatus of this type has failed in practice because of the difficulty, or impossibility, of finding suitable material for these electrodes. Carbon cannot be used for the reason already given, and the employment of metallic electrodes would necessitate the addition of intricate and impracticable cooling devices. There remain only conductors of the second class, as they are called, such as are employed in the Nernst lamp. These substances have high resistance when cold and become efficient conductors only at high temperatures. With electrodes of this character, however, the furnace could not be started until the electrodes had been heated and this preliminary heating is impracticable on a large scale.

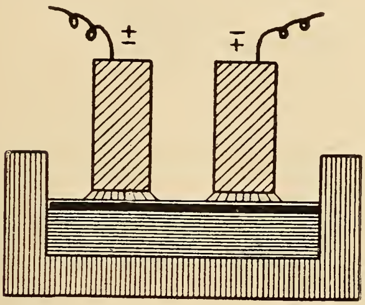


FIG. 3. HEROULT FURNACE.

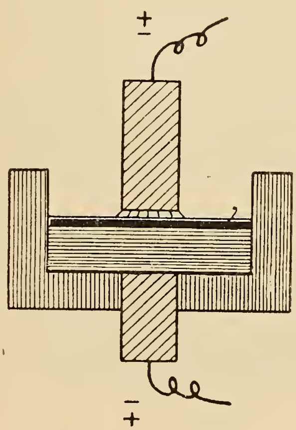


FIG. 4. GIROD FURNACE.

All the difficulties connected with electrodes and contacts are avoided in apparatus of the transformer type. Electrical energy is most economically conveyed over long distance in the form of alternating currents of high voltage and small volume, and these currents are converted into alternating currents of low voltage and great volume by means of "step down" transformers, inserted between the line wire and the groups of lamps or motors which they supply. Such a transformer (Fig. 5) consists of a soft iron core surrounded by two coils of wire. One of these, called the primary coil contains numerous windings of fine wire, while the other, or secondary coil, contains a few windings of coarse wire. The primary coil connected with the line wire, the secondary with the lamps or motors. If the number of windings

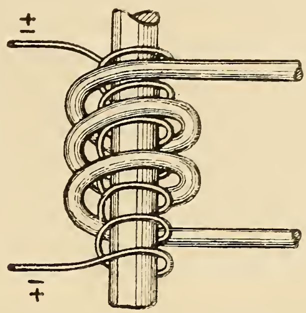


FIG. 5.

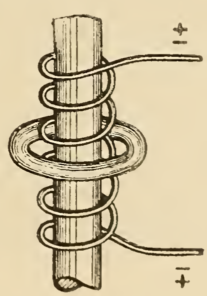


FIG. 6.

in the secondary coil is reduced to one (Fig. 6), and this single turn of wire is short-circuited by connecting its ends to form a closed ring, the ring can be melted by the heat developed by its resistance to the secondary or induced current which flows through it. It is but a step from this arrangement to Kjellin's induction furnace (Fig. 7), in which iron contained in a ring shaped trough of infusible material is melted by its own resistance to an alternating current induced in it by the alternating current of a primary coil which surrounds an iron core in the axis of the trough.

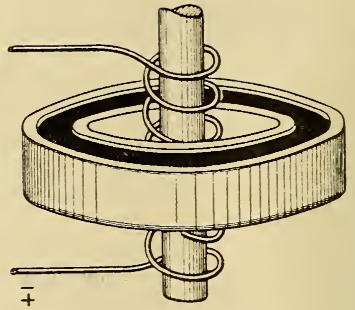
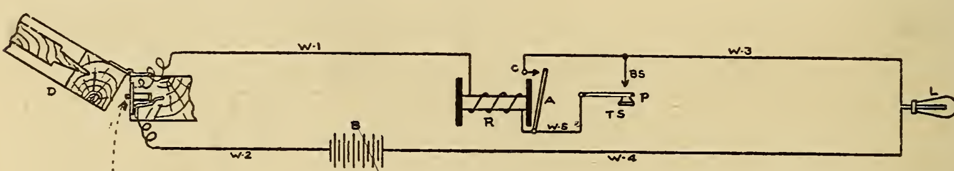


FIG. 7.

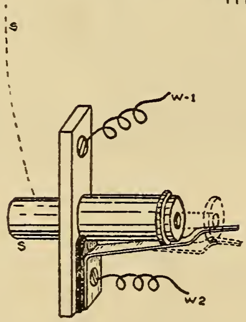
All the operations of the metallurgy of iron and steel can now be conducted in electrical furnaces. How much of the work may advantageously be done by electrical process will depend mainly on the cost of electrical energy. The economy of the various processes will also be influenced by the type and size of electrical furnace employed and the price at which electric current can be bought.

LIGHTING CIRCUIT FOR TELEPHONE BOOTHS.

The circuit arrangement which is shown by the illustration below may be used in all places where a lamp signal is required only for a short length of time. It is especially applicable for use in telephone booths. Many arrangements have been designed for lighting a lamp only during the time a telephone user is in the booth, but all such plans light the lamp, as a rule, even though it is not wanted.



LIGHTING CIRCUIT FOR TELEPHONE BOOTHS.



The arrangement illustrated consists of a lamp (L), supplied either by a set of batteries or directly from the house lighting circuit. The door of the booth is provided with a normally open circuit closer. A relay is also supplied, together with a push button, and even the push button may be eliminated by suitably mounting the relay armature so that a direct pressure against the armature will perform the necessary operation.

The operation of the lighting circuit is as follows:

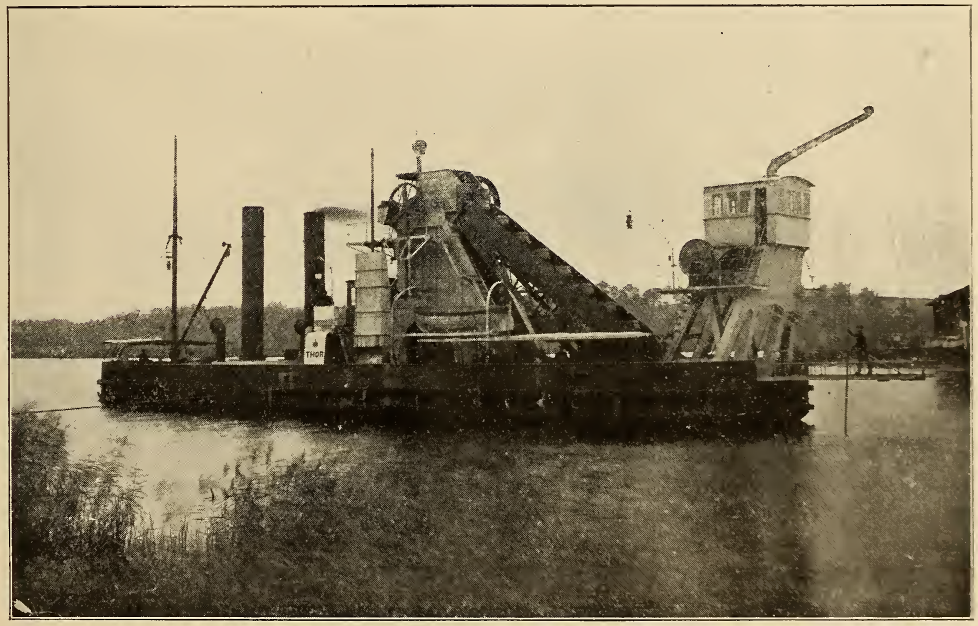
The telephone user enters the booth and after closing the door (D), and finding that light is required, presses the push button (T-S); this connects together the points (T) and (B-S) and causes a flow of current from the battery through the lamp (L) and relay (R). This current while lighting the lamp also draws up the armature (A) of the relay (R) and keeps the lamp burning, even though the push button (T-S) is released. But when the telephone user leaves the booth, he must necessarily open the door, and this results in opening the circuit of the lamp and relay, causing the relay armature to let go, and even should the door be closed again, the lamp will not burn unless some one inside of the booth presses the push button.

It will be observed that this arrangement completely eliminates the possibility of wasting current through having the lamp in the booth lighted when it is not actually required. Nor will it be possible to light the lamp and waste current by closing the door of the booth after leaving it. In other words, the lamp will be lighted only when it is actually wanted and at no other time.

GERMAN ELECTRIC DREDGE.

The great German electric dredge, "Thor," which is used in widening and deepening the mouths of navigable rivers is typical of the latest development of electric dredge design. The dredge itself is moved from place to place by steam power, but all other operations are performed by electricity which is generated by dynamos carried on board.

The electric lighting equipment includes 40 incandescent lamps and 16 arc lamps, also a large searchlight. Two electric cranes handle the anchor. The capstan takes a 7½ horsepower motor. The winches are operated by motors, as are also the dredging buckets and the conveyors. It is stated that this is one of the most complete electrically driven dredges in existence, and is said to work both economically and with reliability, while its installation for electric power generation makes it independent of all outside sources for electrical energy.



GERMAN ELECTRIC DREDGE "THOR."

ELECTRIC COW MILKERS NEEDED IN ITALY.

According to a recent consular report an electrical cow-milking machine is at present sought in Italy, especially in Lombardy, the chief agricultural center of the kingdom. Nothing of the kind is at present in the Italian market and now seems to be the right time for the American manufacturer to exploit his article. A similar apparatus is offered by foreign agents, but Italian importers wish to get directly in touch with the manufacturer. The constant labor movements in Italy make a machine of this kind of the greatest need. Electrical cow-milking machines weighing more than 2,204 pounds each are dutiable at $3.09 per 220 pounds; those weighing 2,204 pounds or less are dutiable at $4.82 per 220 pounds.

PHOTOGRAPHS OF ELECTRIC DISCHARGES.

Interesting photographic investigations of electrical sparks and discharges have been carried out in the past at Nantes, France, by Dr. Stephane Leduc and the illustrations on the opposite page show some of the more recent photographs made by this investigator. The effects produced are not unlike those of the most beautiful crystals of snow or ice, or those given by the kaleidoscope, the most exquisite ornamental figures in wonderful variety being obtained by the electrical process.

Practical use has been made of these photographs as designs for decorative purposes, various patterns being first provided for the general outline, for wall paper, carpet or rug patterns.

The outline of stars, letters, figures or other patterns is first cut out and placed on a photographic sensitive plate, then metallic oxide, starch or other fine powder is sifted over the sensitive surface of the plate, after which the pattern is taken from the plate, leaving the tracings of the openings thereon. Exposure to the electric discharge is made in a dark room, and the sensitive plate developed as in the case of ordinary negatives exposed to sunlight or other light in a camera.

With these electric photographs no camera is required, as the plate with the outline in fine powder is placed on a metal foil, tin foil or lead being employed, and joined to the outer coating of one of Leyden jars of a frictional electric machine. The other jar is connected to a point in the middle of the tracing above the sensitive surface. The electric static machine then has its two poles connected to the inner coatings of each jar respectively, a screen being provided for protecting the surface of the photographic plate from the discharge of sparks at the machine.

As will be noted from the accompanying illustrations, very interesting photographic prints are obtained from the negatives after development, the designs being varied according to the patterns used, the arrangement of powder, the strength of current and the form of metallic conductors employed. It is maintained that the tension or voltage of the current makes a great difference in the results obtained, as well as the temperature and dryness of the atmosphere.

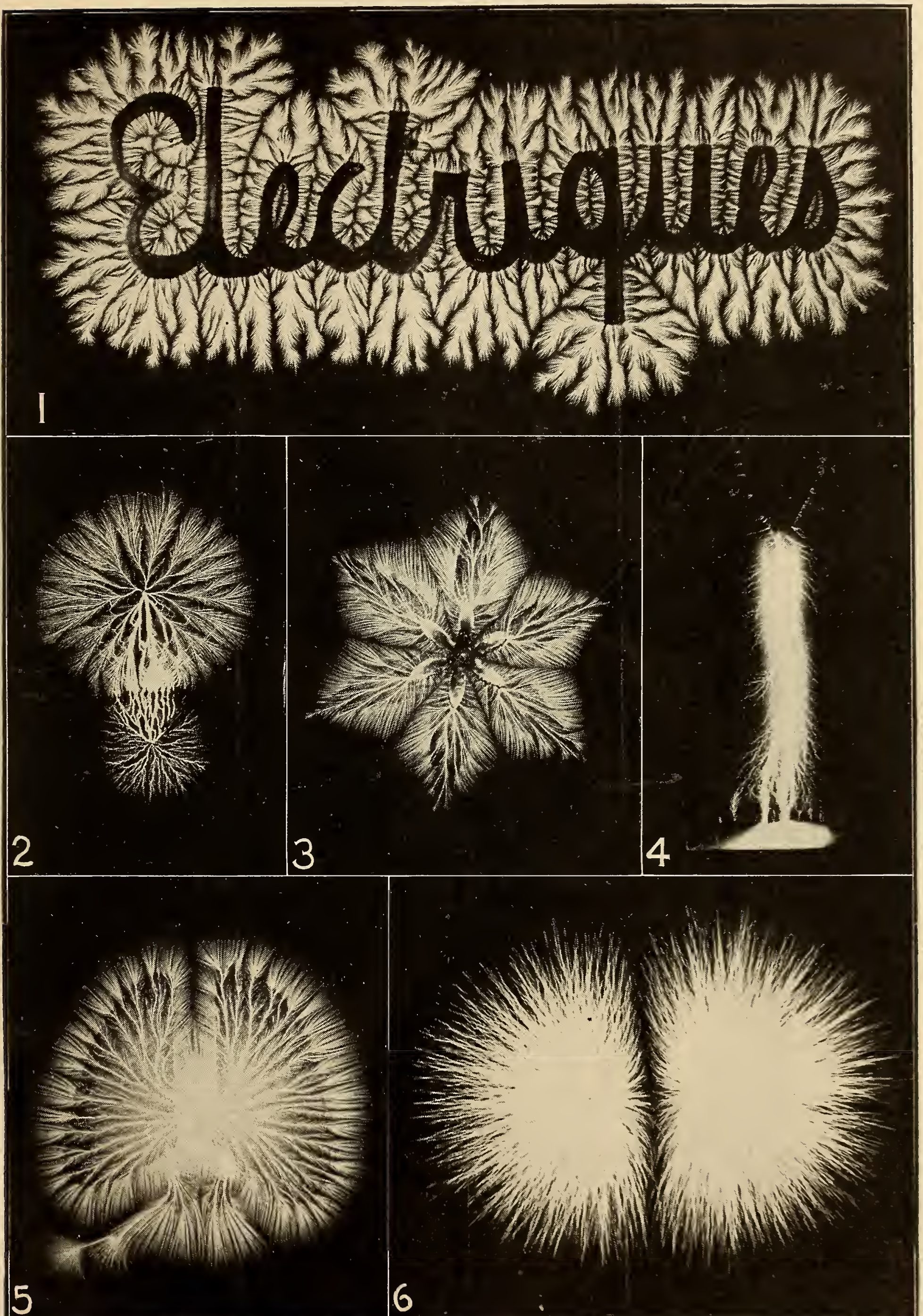
Some important investigations have been made of electric fields by this photographic process of Dr. Leduc. Images of electric spectra have been obtained by photographing silent discharges of electricity, by placing the metallic point and sensitive plate in the same positions as when using the ornamental patterns, the plate and point being again connected to the outside metal coating of the Lyden jars.

By using a single point a photograph of a monopolar field is obtained, when two points are employed a bipolar field is obtained, etc., the photographs produced giving somewhat similar designs to iron filings with magnetic fields. Photographs of unlike poles show lines drawing together and connecting the poles, while with poles of the same sign or electrical polarity the photograph of the electric discharge resembles the filings outline of two magnetic poles which are alike, either both positive or both negative.

By employing a number of points multipolar electrical fields are photographed, and by placing the points perpendicular to the plate or parallel with the plate interesting changes are noted in the results. It is necessary to employ special plates in order to avoid the veil due to the spark and obtain the best results.

It is also stated that red oxide or mercury is employed to advantage, the plate being immersed in the compressed oxide while the discharge is taking place. There is also a great difference in the figures produced on the plates if the point is positive and the plate negative, the former connections having been reversed.

Some of the most interesting and unique designs of lettering have been produced by this process of photographing electric discharges, with patterns of letters and words as noted in the illustrations.



PHOTOGRAPHS OF ELECTRIC DISCHARGES.

(1) Word traced out by spark discharges. (2) Discharge between two points, one above and one below plate. (3) Star design. (4) Discharge between a positive pole and negative plate. (5) Heart shaped design. (6) Discharge between two poles of like polarity.

"WELCOME" IN DENVER.

When the delegates and visitors to the National Democratic Convention stepped from their trains at the Union Station in Denver, the first greeting they received as they passed through the portals of the station into Seventeenth Street was from the "Welcome" arch, the pride of Denver, "The City of Lights," and the only arch of its kind in the world.

This arch is a symbol of the hospitality of Denver. It is dependent upon electricity to a large extent for its uniqueness, was erected in 1906 by private subscription, and dedicated July 4, 1906. It cost $25,000.

Delegates to the Elks' convention in 1906 were the first to be greeted by the huge inscription, "Welcome," on this wonderful arch. Since that time it has been and in the future always will be "a beacon of peace and herald of hospitality."

The arch, an illustration of which is shown herewith, weighs 70 tons, is 80 feet in length over all, and 59 feet from the street level to the highest point. The center driveway is 34 feet wide and the side wings are 11 feet wide and 26 feet high. The seal of the city and county of Denver, shown at the top above the center span, is 16 feet high, and weighs six tons.

The arch is built of a combination of metals that insures strength and durability. It is bronze plated, three tons of bronze having been used, and it is finished with a coloring of verde antique resembling the green of old copper.

There are 1,800 electric incandescent lights outlining the arch, but the full number is only used on special occasions; 1,600 being the number burned until midnight, every night in the year. The cost of the current is paid by the city.

There is an adjustable drop sign matching the design of the arch, which is patterned after the white poppy of Colorado, swung from the center of the arch, and upon this can be placed, in incandescent lights, the name or motto of the order assembled in convention. The cost of the current for the drop sign is always paid from the convention fund.

Thousands of tourists and delegates to national conventions have passed through this arch and have marveled at its beauty and commented upon the hospitality of a people who in this magnificent way welcome the stranger within the gates of their city. E. C. S.

ELECTRICITY IN THE HOUSEHOLD

THE ELECTRICAL VACATION.

FOR days Ned and Carrie lived on that vacation trip. At each cosy meal as well as at all other times they followed the route on the pages of the railroad folders and in the big atlas. They had planned, with much enthusiasm, to take the boat at Chicago for Georgian Bay; then to go by rail to Ottawa and Kingston; then by boat down the St. Lawrence, past the Thousand Islands, through the La Chene rapids to Montreal and the quaint old city of Quebec, and the big cliffs of the Saguenay. Their pleasure was not to end here, however, for they were to go down through Lakes Champlain and George, down the Hudson to New York, to Boston, Philadelphia, and to Baltimore, where they were to run over and visit Ned's ancestral home on the eastern shore.

So the days wore on and the charmed date came nearer.

Who was it wrote those fatal words, "Man proposes, but fate and the boss disposes?" It does not matter much, but they have played havoc with many a long cherished plan. It was on a warm August evening that Ned stepped from the car at his corner and walked the two blocks to his home as though he was trying his best not to get there. Carrie was watching for him and wondering at his lateness, he was usually so prompt. She saw him a block away and noted his slow gait.

"Oh, Ned, what is it? What's happened?"

"It's all off, Carrie. Jennings has left and I will not be able to get away. I get a raise out of it, but it kills the trip."

For a moment she stood and looked at him, the great tears welling up and filling the soft brown eyes. Then without a word she turned and taking his arm with [illegible] old time manner walked with h[illegible] the house.

That evening was a quiet and scarcely a happy one, and next morning Ned, notwithstanding the enlarged pay check, went down town with a heavy heart to a decidedly heavy task for hot weather.

It was probably the heavy task in the heat that made him think of it, for the electric fan on his desk carried his thoughts to Carrie at home in the tiny flat where he knew the hot wind was blowing and little relief to be had. Then the idea came to him that as they could not use the money so patiently saved as they had planned, a part of it at least could be used to make the summer happy at home. So he turned to his telephone, called up the lighting company and ordered a fan sent to his flat. When he got home that evening it was there, and in a moment it was out of its packings and at work cooling the dining room. And as they ate their dinner in the refreshed air Ned told Carrie of his idea and of its birth with the fan on his desk.

"We saved the money for our summer fun, Carrie," he said as they talked it over, "and it is no more than fair to use it for our pleasure and comfort even if we do have to stay at home and work."

For a moment Carrie said nothing,

her disappointment was too great to disappear in a moment, but the good sense of Ned's plan was too apparent to pass unnoticed and she started to reply, when her eye caught sight of a piece of paper that lay on the floor beside her, and stooping, picked it up and with a glance handed it to her husband. It was a little printed slip that had been wrapped with the fan and had fallen unnoticed, a little advertisement setting forth the convenience of the electric flat iron as a summer comforter. As soon as Ned saw what it was he read it aloud, ending with:

"All right, Carrie, you shall have one tomorrow."

They tell us that tomorrow never comes, but that flat iron did, for Ned keenly felt Carrie's disappointment, and was anxious to do all in his power to relieve it. When he got home in the evening he found Carrie at work with the iron, her face not wearing the heated and tired expression that was always a part of ironing day, which this happened to be.

That evening they went over the catalogue of electrical household utensils Ned had picked up at the electric light office, and as they looked grew more and more interested and jotted down article after article; a chafing dish for making rarebits and newbergs; coffee percolator for making their coffee right at the table; tea kettle to replace the alcohol heated one Carrie had used until the exploding alcohol stove had set fire to her dress; shaving mug, so Ned wouldn't have to worry about his shaving water; waffle iron, for Ned came from that land of the epicure, the eastern shore of Maryland; curling iron heater, so Carrie could heat her iron without getting it black; toaster, for use at the table, and a tiny motor for the sewing machine—all of them together, including the fan and flat iron, not costing as much as it would have cost them to get as far as Montreal on their trip. These they bought within the week and Carrie set up as an electric housekeeper, soon learning the little there was to be learned about the utensils, and handling them much more easily and comfortably than ever she had handled her heavier stove pieces, and doing her work in a kitchen much cooler, as there was no radiation from a stove.

So their summer was not so terrible, though the beauties of Georgian Bay and the St. Lawrence, the historic charms of Champlain and the intense human interest of the great eastern cities was not for them just yet. And each night Ned came home to find Carrie happier and brighter and less tired and worn looking than the early summer had seen her, for her little home was more comfortable and her work lighter.

It was on a very warm night in early August that she met him on the steps and leading him into the refreshing fan cooled air of the flat, remarked:

"Ned, dear, do you know, I almost am glad we did not go away?"

"What!" was his natural exclamation, "Have you so soon forgotten the old desire?"

"By no means, dear boy, but we could not have had these lovely electric things if we had gone, and you cannot realize what they have done for me this hot weather. The flat is so cool and nice all the time and the work is so easy. It has been a regular electric vacation. Do you know, the electricity that runs these things seems to ooze out of them into me and make me feel just like dancing." And catching her still warm husband by the arm she pirouetted about him, half dragging him with her.

Then a brilliant idea came to Ned. "Next week's your birthday, Carrie."

"Yes."

"We'll use these things and have an electric spread."

Carry jumped at the idea. Suggestion followed suggestion. They talked about it through dinner, and all the evening it was the principal subject of conversation. And when they switched off the last light before giving up for the day, every detail was threshed out from the invitations to the croquettes, and a set of minature decorative lights was placed on the list of supplies to be purchased.

The great day came. The little flat was a bower of summer flowers and, although the day was warm, the fan was taken from room to room as needed. The dining room was softly lighted with the tiny decorative lamps, the colored lights gleaming and glinting through the leaves and petals of the plants, the piece de resistance being a great cut glass bowl filled with clusters of white clematis, with the light rays playing through them. And everything was electric except the humor of the guests, and that was ecstatic.

It was an evening affair and the guests were not many, the tinyness of the flat seeing to that. But they made a jolly party—old school chums of Carrie's for the greater part. Some of them knew something of electric spread necessities, but some of them knew nothing, so they were the more pleased.

The fireless and flameless chafer cooked the croquettes and the equally fireless coffee urn brought the aromatic bean to the acme of taste and filled the room with its delicate odor. The fairyland appearance of the room and the daintiness of the viands pleased them, and the simplicity of preparation and execution astonished them. So they wondered. And their wonder led to inquiry. And their inquiry led to investigation. So the flat iron, the waffle iron, the shaving mug, the curling iron heater and the rest of the electric outfit were brought out and experimented with amid exclamations of delight. And when it was all over and the front door closed behind the guests, Carrie looked up into the face of her husband and exclaimed: "Oh, Ned, it was just lovely!"

WOMAN'S FIELD BROADENED BY ELECTRICITY.

A phase of the art of electrical engineering which has not been fully considered is the restoration of women to many trades from which they were long ousted by men. The popular belief is that, within a few years, women have largely encroached upon industries that belonged by ancient right to men. Nothing is further from the truth. Within a hundred years men have almost eliminated women from industries in which they were once almost supreme—for instance, spinning, weaving, the making up of fabrics, hat making, brewing, baking, candy making, soap and perfumery making, candle making, and many other branches of manufacture in which the lighter parts were once wholly made by women. In colonial times the majority of shops were kept by women, as is the case to-day in several European countries.

As soon as steam machinery came into general use in English speaking countries, women were displaced in many industries because of the machinery required. To compete with steam and hydraulic machinery installed in all countries during the development of the factory system that followed the improvement of the steam engine by Watt, hand looms and lathes were made larger, and in consequence, heavier, and that necessitated the employment of strong men or boys, and resulted in the narrowing of the fields of work for women. Since the introduction of electric power distributed over large zones and at low cost has become general, and a scientific system of daylight and artificial illumination has been introduced, a tremendous increase of employment for women has followed in factories and shops.

A number of large employers of skilled labor in important fields who have been interviewed upon this subject give it as their opinion that since the electric motor and the methods of gas and electric illumination have been perfected, the ratio between men and women in factories has been largely increased in favor of women. Most of the tools used in connection with electric power are light and easily managed by a deft person. Women are quick to learn the best methods of working with such tools, and they are particularly attracted to factories in which such machinery is used, as there is an absence of the noises and the ill odors that are in shops and factories that use old-style steam machinery with dirty belting run from shafting to machinery soaked with filthy lubricants.

Many manufacturers tell their friends concerned in bettering the conditions about factories that a factory which is properly lighted, not too little, nor too much, attracts and keeps a fine class of women workers.

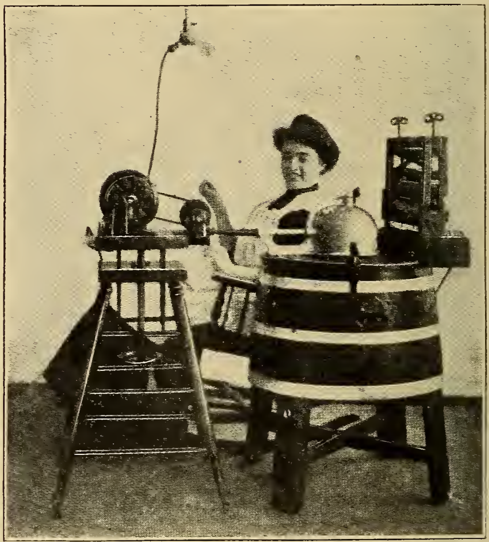
In a very large, light hardware factory in New Jersey, which is well lighted with electric lamps depending from an old style type of iron gas fixtures, the girls recently "chipped in" and bought some rolls of parti-colored tin foil, with which they covered the ugly fixtures, and then suspended little colored clay pots filled with artificial flowers from each chandelier and bracket. The effect was very pretty, and was so pleasing to the president and his fellow directors that, to add to the artistic lighting effect, they placed in the women's assembly room where luncheon is served, a beautiful gilt chandelier and six brackets, all fitted with decorated glass shades good enough for anybody's parlor. These efforts to interest the girls in their surroundings had a marked effect, as will be noted by the remarks of the president.

The president said that the comment of the forewoman to the girls when the beautified room was opened to them for the first time, was: "Oh, girls, let us try to live up to these lovely fixtures." He did not realize the meaning of the words until some time afterward, when in telling the story to a friend who is the chief director of a famous museum of art, that artist said: "There is a good deal in that remark. Women from the earliest days of art seem to have admired beautiful lamps. The proof is the paintings and the sculptures that have come down to us from the ancients. Rude lamps were good enough for the soldier and for the seats of the law givers. But see what art was expressed in the lamps made by the Egyptians and the Greeks and the Romans for the places where women were prominent. Ancient poetry and literature abounds with references to beautiful lamps. The liking which women in our factories of to-day have for handsome lighting fixtures is inborn. It is a phase of the love for the beautiful which is making for the uplifting of men and women in industrial life. Modern lighting has produced an incalculable amount of good in direct and indirect ways in industrial life. Statistics of crime show that in all cities that have introduced perfected systems of street lighting, crime has diminished. A remarkable verification of the truth of the scriptural words, 'They prefer darkness rather than light, because their deeds are evil.' Perfected lighting in shops and factories has led to other improvements which have resulted in better feeling between employers and employes."

THE ELECTRIC MOTOR IN THE HOME.

A small portable motor in the home can be made to perform such a variety of operations that there hardly seems to be an excuse for its absence in these days of moderate priced machines and cheap electric power.

When you analyze the unpleasant part of housekeeping, if you can do away with the labors of washing day nothing else would seem to matter much. The picture of the motor operated washing machine is not at all overdrawn. Any housekeeper can do her own washing with little or no labor. After the washer is



THE MODERN WASH DAY.

filled and the electric current turned on, she is free to attend to her sewing or other work for 10 or 15 minutes, as the washing will take care of itself and the clothes will come out absolutely clean without any wear or tear. The small Steiner motor on its portable stand is moved up and connected in a moment to the shaft of the washing machine. Electricity does the rest.

When the clothes are clean the motor may be connected to the wringer shaft and the otherwise arduous task of wringing the clothes is accomplished with a minimum of labor.

The motor also finds an equally useful application in culinary operations. There are many fine dishes which require mincing of meats and vegetables. Applied to a mincing machine, as shown in one of the cuts, the motor will turn out fine mincemeat, home made sausage, Hamburger steak, and prepared materials for croquettes. The cutter may be attached instantly to any table and the adjusting of the motor is but the work of a moment.

Don't wear your few years of life away when you can get a machine to do it the modern way. While a motor may be classed as a luxury by some, it is really an economical necessity. A strain or overwork to women often means years of illness and expense which can be avoided by spending a few dollars in proper conveniences.

The motor will make ice cream in ten minutes—the finest you ever ate. Whips cream better than by hand. It is no trouble at all to make ice cream and ices with this outfit. There is nothing which is so wholesome and so much appreciated as pure home made ice cream. Let the children eat as much as they want of it because it will not make them sick, as adulterated factory ice cream is liable to do.

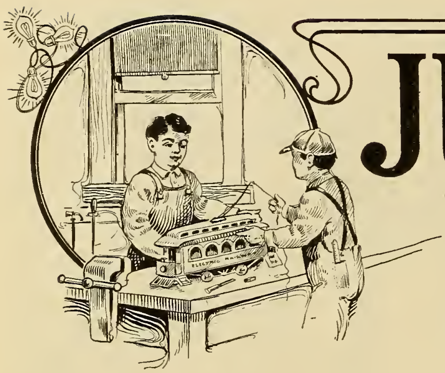
ELECTRIC MEAT CHOPPER.

Just set the freezer on a box or chair and adjust the motor shaft and you will not have to go near it again until the cream is done. No need of holding or bolting the freezer, as it will stand by itself.

ARRANGEMENT OF DINING ROOM LIGHTS.

No room in the house is deserving of more attention in the matter of cheerful and abundant lighting than the dining room. The evening meal is perhaps the only one during the day at which the entire family congregates to throw off the cares of the day and linger around the table, and a well lighted room adds much to the feeling of comfort and good cheer.

An example of good lighting is shown in the beautifully furnished dining room illustrated herewith. The ceiling lights give ample general illumination to set off the sideboard and other furnishings. The center fixture which is suspended from the ceiling casts a cheerful and more intimate radiance over the table itself. This ornamental fixture contains electric lamps within the shade, while a candelabra effect is obtained by the electric "candles" arranged around the outside of the shade.



JUNIOR SECTION

SIMPLE CURRENT DETECTOR FOR WIRELESS WORK.

To boys experimenting in wireless telegraphy it might be valuable to know how to make a simple current detector, to be used in place of a coherer in the receiver. A very simple and effective current detector may be made practically without cost in the following manner:

Secure the carbons out of two old battery cells. After cleaning them thoroughly cut them off about an inch and a

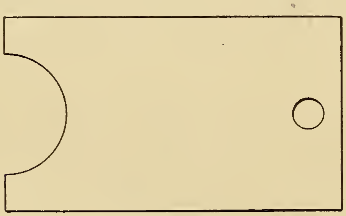


FIG. 1.

half down from the binding posts. Then grind their ends in, concave, to the depth of about half an inch, as shown in Fig. 1. Mount the two pieces on small blocks about an inch long by half an

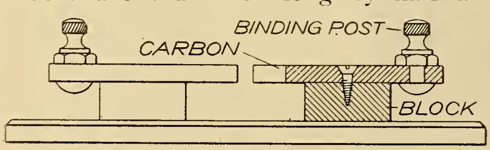


FIG. 2.

inch high. Glue the blocks on a base of suitable dimensions (Fig. 2) so that the ends of the carbons are about one-eighth of an inch apart. Place a common sewing needle between the carbons and the current detector is ready to be connected as shown in Fig. 3.

This detector is connected in the same way as the coherer which was described in the May issue of Popular Electricity in the article by Mr. Laughter.

One advantage of this detector is that it eliminates the use of a tapper on the

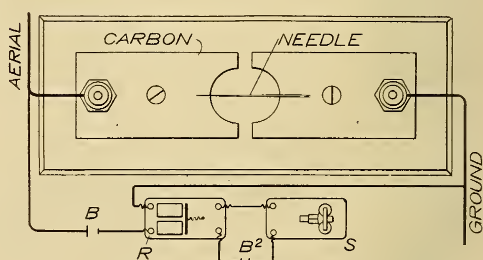


FIG. 3.

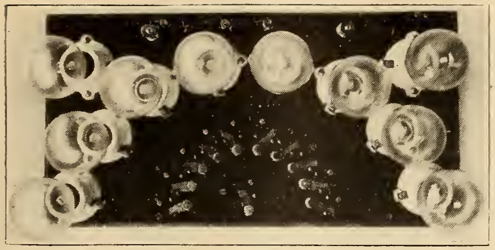
coherer. A telephone receiver or Morse recorder may be used on the relay instead of a bell tapper. If dust is kept off the carbons this detector will prove satisfactory.

References to Fig. 3 are: (A), binding posts; (B), battery; (R), relay; (S), receiver, or Morse recorder. It might be well to state that (B^2) had best be a crowfoot battery.

E. J. Friedlander.

LAMP RHEOSTAT FOR 110 VOLTS.

After the boy who is using electric lighting current in his experiments has made a small switchboard (as described in July issue) to quickly and easily manipulate the current, he will need some piece of apparatus to regulate the quantity of current. The apparatus universally employed for this purpose is the rheostat, the best, cheapest and most easily made form of which is that in



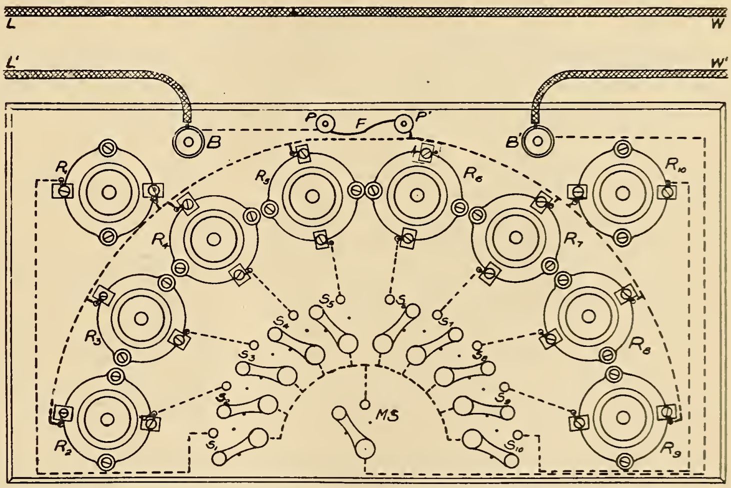
LAMP RHEOSTAT.

which incandescent lamps are used for resistance.

The material required for making the one shown in Fig. 1 is a dry, hardwood board, 20 inches long by 10 inches wide; ten Edison base receptacles (the cheapest, with exposed binding screws will answer); 10 16-candlepower incandescent lamps; 11 one-point wood-base switches; two small and two large binding posts, and some wire. The cost of above should not exceed $2.50 without the lamps, which may be taken from fixtures in the house.

The ten receptacles, (R_1), (R_2)—(R_{10}), the two small binding posts, (P) and (P′) and the two large binding posts, (B) and (B′) should all be fastened to the board in the positions shown in Fig. 2, then the bases from the 11 switches should be removed and the arms and points (MS), (S_1), (S_2)—(S_{10}) mounted on the board as shown. (These switches may be screwed to the board on their bases if time is short and best appearance is not desired). The connections shown by the dotted lines are to be made with annunciator wire fastened to the under side of board by staples, and passed throught holes in the board to the binding screws. Small pieces of wood should be fastened to the under side of board at the corners to keep the wires from touching any surface upon which the board is resting. A piece of five ampere fuse wire, (F), should be connected between the posts (P) and (P′), and the wires (W) and (W′) run to the binding posts of the switchboard or to a socket, while (L) and (L′) are connected to a small motor or any other apparatus it is desired to operate.

Supposing a motor is connected to (L), (L′), the lamps having been put into the receptacles, and (MS) turned on. Now if (S_1) is turned on, the lamp in (R_1) will light, and the motor run slowly; if (S_2) is also thrown on, the lamp in (R_2) will light, and the motor will run faster; and so on for all the switches. If (MS) is turned off the current ceases to pass through the lamps and motor. About four lamps are enough to run a small motor at a high speed, so if it is desired to operate only a small motor, as for a toy electric railway, a rheostat with but four or five lamps and switches should be made along the same lines. A 10-lamp rheostat should be made where it is desired to operate a small arc lamp, or produce strong electromagnets, or heat fine wire. With a lamp rheostat one always knows how much current is passing because one 16-candlepower lamp passes ½ ampere, two pass one ampere, 10 pass five amperes, etc.



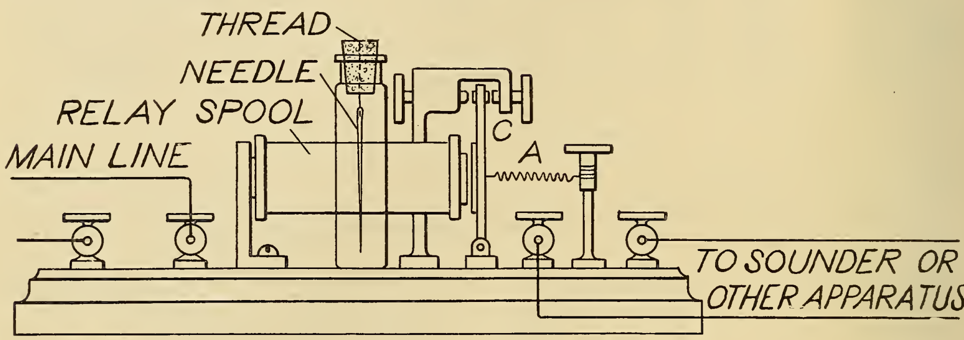
CONNECTIONS OF LAMP RHEOSTAT.

This simple piece of apparatus works on the same principle as the regular motor starting rheostat now in commercial use, the principal difference being that the lamps take the place of coils of resistance wire.

Louis H. Roller.

CURRENT DETECTOR FOR RELAYS.

In the operation of relays used in telegraph work the condition of a partial ground on the line may reduce the current flowing through the relay coil to such an extent that the armature will not be attracted. If the operator knows that such a ground exists he may remedy the trouble by adjustment of the spring which holds the armature. Nine times out of ten, however, he does not know of the trouble and he consequently believes that no one is on the line, whereas other stations may be trying to call him.



CURRENT DETECTOR FOR RELAYS.

A very simple device to warn the operator that there is a ground on the line and that feeble impulses of current from other stations are flowing through his relay, is shown in the accompanying diagram, which illustrates a scheme thought of by Mr. Geo. W. Richardson of Chicago. The device consists of needle suspended within a glass tube by a thread passing through the cork. The tube is mounted near the relay spool and even a feeble current, too insignificant to attract the armature (C), will cause the needle to swing back and forth. This attracts the attention of the operator, who then adjusts the spring (A) to a less tension so that the armature will be attracted and the message may be read.

CHICKENS HATCHED IN A STOCK TICKER.

William Adams, a telegraph operator of Columbus, Ohio, is sure that his invention for hatching chickens is better than an incubator or the old-fashioned hen, because these agencies of incubation never claim to make a 100 per cent hatch, whereas by his invention, on the very first trial, this result was attained.

Sixteen eggs were placed under the glass cover of a stock ticker in the operating room of the telegraph office, with an electric wire connection to furnish the heat, a thermometer to record the degrees and a thermostat to watch the thermometer. The apparatus was set at work and after three weeks 16 little chickens were found under the glass, all well and happy.

NOVEL WIRELESS TELEPHONE.

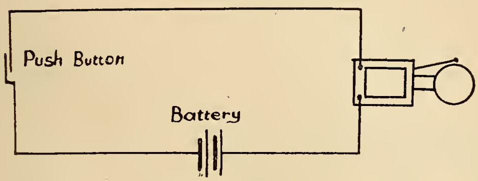
Quite a lot of interest is being shown at the present time in the new art of wireless telephony and it is very interesting to follow out other novel means by which articulate speech can be transmitted without the usual connecting wires.

Many readers of the Junior Section are familiar with the plan of grounding the terminals of a battery and transmitter, with grounds say 25 feet apart at a depth of about five feet. By grounding the terminals of a telephone receiver exactly opposite, and at the same distance apart, the words spoken in the transmitter will be clearly heard at the receiver. This plan can be changed by a novel method of driving two common nails in trees and soldering onto the nails the terminals of the telephone receiver, it being supposed that the trees are far enough apart for good results. If the trees are a distance of 25 feet apart the transmitter is placed at this distance from them and grounded. When the words are spoken in the transmitter a wave motion is set up which is picked up by the roots of the trees and the sap, which is partial conductor, and led up to the receiver, where the words are reproduced.

HOW TO INSTALL ELECTRIC BELLS.

Installation of electric bells is a very simple operation and does not require the services of an expert electrician. Any boy in fact may become the "bell engineer" of the household and soon become advanced enough along this line to install bells in his own home as well as his neighbors.

Considering that a bell is desired in the bedroom and the push button to be located on the front door, and the distance is 35 feet. For this will be needed about 40 feet of duplex braided wire, allowing five feet for connections and waste; ; one common wood push button; electric bell; two dry cells; double pointed tacks; screwdriver; hammer; plyers,



and drill. All of the above named supplies can be bought from any local electrical dealer, while the tools are usually found around the house.

Begin by placing the push button at the desired place on the front door frame. The ends of the braided wire are now run through a hole drilled in the door frame, directly behind the push button. The insulation of cloth and rubber is now scraped off of the wires one-half inch, and the bare ends screwed under the two screws which are visible on the push button when the cover has been removed. The wire is now tacked up along the wall to the place where the batteries are to be placed. The batteries should be placed in a perfectly dry place.

One side of the wire is now cut and the insulation scraped off from the two ends as for the push button. The batteries are connected up with the carbon pole to the zinc as shown in the diagram, in which the carbon pole is represented by the long thin lines, the zinc by the short heavy ones. The free binding posts of the batteries are connected to the two wires cut and scraped for this purpose. The two wires are then continued on to the bell and the free ends connected to its two binding posts.

BOOK REVIEWS.

Engineers Charts. By Joseph G. Branch. Chicago: Rand, McNally & Co. 1908. 75 pages with 25 illustrations. Price $1.00.

These charts are valuable to any operating engineer since they present to him in direct and simple form the theory and development of the steam boiler, the steam engine and the electric generator. The book is divided into three parts under the above three headings and consists of a series of charts in colors, representing each step in the development of the boiler, engine and generator, accompanied by full explanatory text. For example, the story of the electric generator begins with Oersted's discovery in 1819 of the relation of electricity and magnetism. Then come Faraday's famous experiments extending over a period of 10 days in which he discovered the great principle of magneto induction, leading in his last experiment to the construction of an actual working dynamo. From there on the development of the modern dynamo is explained in the same graphic manner. The treatment of the steam boiler and the steam engine is taken up in much the same manner. The author is to be commended upon the originality of his treatment of these subjects, and so clear, simple and instructive are his explanations that the book will be greatfully received by the busy engineer who wishes to be informed on the principles which underlie the machinery which he handles, and who finds the reading of heavy textbooks on the subject an effort after a hard day's work.

Practical X-Ray Therapy. By Noble M. Eberhart, M. D. Chicago: G. P. Engelhard & Co. 1907. 135 pages, with 20 illustrations. Price, $1.00.

The busy practitioner who has installed an X-ray outfit in his office will find this a good working manual covering the practical application of the Roentgen ray to diseased conditions. What diseases can it be used in? Does it cure them or only give temporary benefit? How long and by whom has it been used successfully? Shall a high or low tube be used, and how far shall it be placed from the patient? How long and how often shall the treatments be given? These and many other practical questions the author has answered satisfactorily.

A B C of the Telephone. By James E. Homans. 1908. 346 pages with 268 illustrations. Price $1.00.

This is the second edition of a book which has already met with favor among those interested in any phase of the telephone industry. It contains 29 chapters covering the principle features of telephone engineering practice including a brief survey of the theory of sound and its telephonic reproduction, the construction of telephone apparatus, switchboards, battery systems, circuits, line construction, etc. It is a thoroughly practical book and the new edition has been revised and brought into keeping with the latest developments in the telephone field. For sale by Popular Electricity Publishing Company.

Stationary Engineering, Vols. I, II & III. By Joseph G. Branch. Chicago: Rand, McNally & Co. 1908. 393, 373 and 273 pages and 126, 125 and 68 illustrations, respectively. Price, $2.50 per volume.

The day is not far distant when stationary engineering as a profession will be considered as one of the most important branches of engineering, and the stationary engineer worthy of the highest reward for his services and well-known devotion to his duties. This work is written by a man who is not only thoroughly grounded in engineering theory but has close knowledge of stationary engineering from practical experience and experience as chief of the Department of inspection of boilers and elevators, and as member of the board of examining engineers of St. Louis. Vol. I is a practical and thorough book on the construction, operation and management of the different types of steam boilers and their attachments. The development of the steam boiler is shown, from the crude apparatus of Newcomen, known as the "Balloon Boiler," to the most modern types of both fire and water tube boilers. Vol. II presents in a compact form the principles which underlie a thorough knowledge of power and heating plants, together with such data on the subject of mechanical and electrical engineering as is deemed essential to the successful operation of power and heating plants. Vol. III fully describes the process of mechanical refrigeration, and the construction and operation of every type of the modern elevator and steam turbine, making it an invaluable hand book for the engineer.

A Brief Guide to Vibratory Technique. By Noble M. Eberhart, M. D. Chicago: G. P. Engelhard & Co. 1908. 122 pages, with one illustration. Price, $1.00.

This handy little working manual will be appreciated by the busy physician who is employing vibration in his practice. It gives just enough theory to make the technique intelligible, but does not tire the reader with too lengthy particulars; while the technique is careful in detail and gives all necessary working points, progressively arranged. The author is head of the Department of Electro-therapy of the Chicago College of Medicine and Surgery.

On the Canal Zone. By Thomas G. Grier. 1908. 158 pages, with 150 illustrations. Price, $1.00.

The exact condition of affairs on the Canal Zane is set forth in an entertaining manner, and thoroughly by one who has spent considerable time investigating the work on the great canal. The author is well and favorably known to the electrical public and is an author of repute on subjects outside of the electrical field. Work on the Panama Canal is being pushed at the present time with vigor and characteristic American enterprise. A book of this sort, carefully prepared by a consciencious observer will therefore meet with the favor of the reading public. Orders for the book will be received by Popular Electricity Publishing Company.

There are 6,300 electric lamps installed on the Lusitania, giving the enormous total of over 100,000 candlepower. For heating the first-class quarters 60 electric radiators have been fitted, to say nothing of some 43 heaters in bathrooms for use during the cold weather.

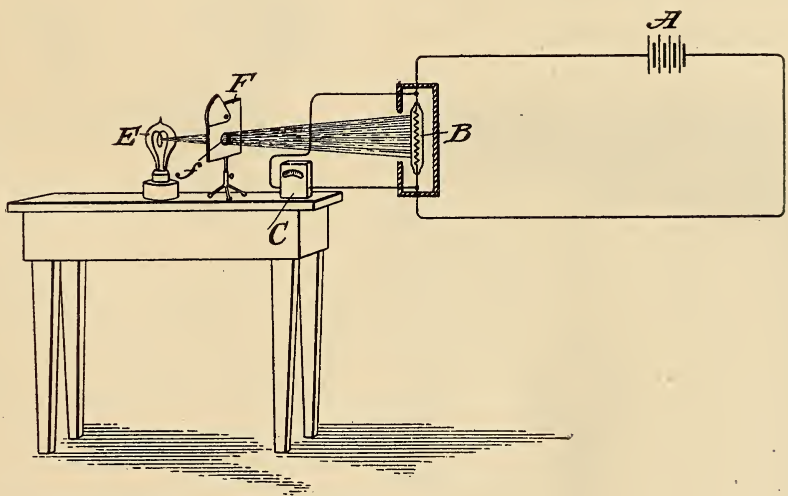
NEW ELECTRICAL INVENTIONS

METHOD OF MEASURING LIGHT.

It is important for large users of incandescent lamps to know whether or not the product which they buy is up to standard as regards candle power. Similarly the manufacturer must ascertain whether his output is of uniformly high grade. This has led to the development of an important branch of electrical engineering, i. e., photometry. In making a phometrical test of a lamp to ascertain its candle power it is common practice to compare the intensity of light which it gives with that given by a standard lamp of known candlepower. Such tests, however, have the disadvantage of the fallibility of the human sight. No two persons see exactly alike and therefore photometer tests or comparisons made by different persons may not agree.

William J. Hammer of New York City, a well known electrical engineer, has patented a system by means of which the measurement of light is reduced to an exact mechanical process. The accompanying diagram shows his apparatus.

The lamp whose light is to be measured is shown at (E). Light from the lamp passes through a hole in the screen (F) and falls upon the selenium cell (B) at a fixed distance from the source. Selenium is a substance, something like sulphur, the electrical resistance of which varies widely with the strength of the light which falls upon it. This cell is placed in circuit with a battery (A) and a voltmeter (C) is connected across the two terminals of the cell. Some current flows through the

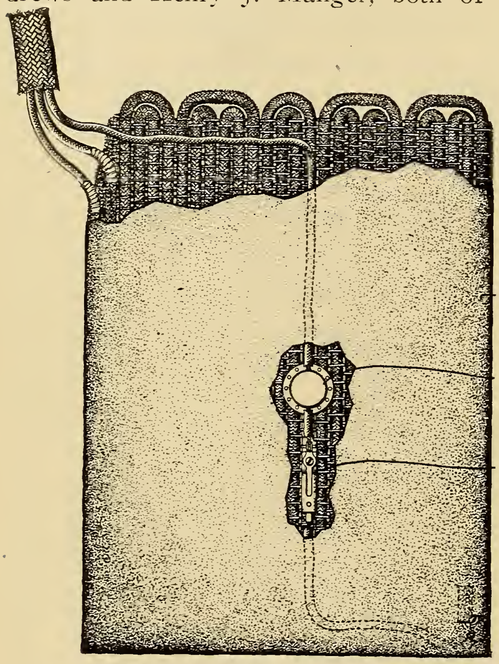


cell all the time and the resistance of the cell causes a drop of potential, or in other words a difference in electrical pressure or voltage between the two terminals of the cell. The needle of the voltmeter registers this drop in pressure. Now when light from the lamp falls on the cell the resistance is changed and the voltmeter reading is different. Standard lamps are first used to calibrate the voltmeter, the scale being marked so as to show where the needle point falls for lamps of different known candlepowers. Then the device is ready for the testing of unknown lamps. An unknown lamp is put in position; the light falls on the cell; the voltmeter needle is deflected, and then the candlepower of the lamp may be read directly from the voltmeter scale.

ELECTRIC HEATING PAD.

Electric heating pads to be used in place of the old-fashioned hot water bottle meet with universal favor as they maintain an even temperature for any length of time desired and never leak. In order absolutely to prevent any danger of the pad becoming heated above the danger point it is desirable to furnish the pad with an automatic arrangement whereby the heating coils will be cut out when their temperature rises above a certain predetermined point.

A safety device for the above purpose has been patented by William S. Andrews and Henry J. Manger, both of



Schenectady, N. Y., and consists of a thermostat arrangement located within the pad, also a cut-out which opens the circuit in case the thermostat fails to operate. The cut-out consists of thin strips of metal in the circuit of the heating wires. These strips are held together by a low-fusing solder. If the thermostat refuses to operate and the temperature rises high enough to melt the solder, the two strips fly apart and open the circuit.

PHYSICIANS ELECTRIC HEADLIGHT.

A unique novelty recently invented by a Maryland man is the headlight shown in the illustration, for use more especially by physicians and surgeons. The light is carried on the head of the wearer, the rays are obscured from the eye, but are thrown on the object under examination, such, for instance, as the

larynx of a patient. The headlight is attached to a spring clip adapted to fit the head of wearer. At the back of the head is an enlarged plate, to which connection can be made to a convenient electric light socket to obtain the necessary electrical current. In the headlight is a lens for concentrating the rays and by which the light from the lamp can be focused on any desired spot. A reflector is also placed in the headlight. This simple and effective device can be readily applied and removed and does not interfere in any way with the movements of the wearer.

NEW ELECTRIC HEATER.

A new scheme for electric heating is to use an ordinary stove in which electric heating units are used in the fire box instead of coal or wood. The interior of the stove comprises an electric radiator, which, owing to the air circulation produced by draft, will raise it rapidly to a high temperature, producing an accumulation of heat.

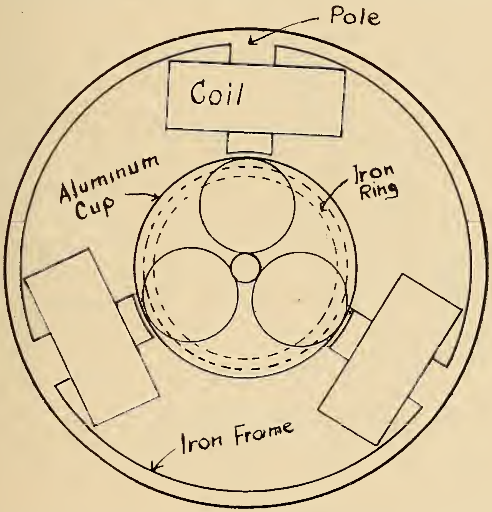
QUESTIONS AND ANSWERS.

Readers of Popular Electricity are invited to make free use of this department. Knowledge on any subject is gained by asking questions, and nearly every one has some question he would like to ask concerning electricity. These questions and answers will be of interest and benefit to many besides the one directly concerned.

ROTATION INDICATOR.

Question.—I wish to make an instrument to tell me when a three-phase, 60-cycle power circuit has been reversed. In other words, a small instrument designed for 220 volts, 60-cycle three-phase, so I can connect the three wires to it and get the direction of rotation before and after the change.—H. H. P.

Answer.—Take an aluminum cup from a small Fort Wayne meter and mount between two ordinary steel bearings. Place around it an iron ring or



frame with three iron poles projecting inwardly very close to the disk. The poles should be 120 mechanical degrees apart.

Wind on each pole about 2,000 turns of No. 26 magnet wire and connect in start; that is, connect the inner ends together and bring the outer ends of coils each to a separate terminal for line connections. Inside of the aluminum cup place an iron ring which will fit close to the inside of the cup without interfering with the rotation of the cup. The aluminum cup will rotate in a direction depending upon the rotation of the three phase circuit. The size of the iron ring inside of the cup and the iron frame outside can be determined from the size of the aluminum cup that is used.

The current should not be left on the instrument any longer than is necessary to get the rotation of the line, to prevent overheating of coils. If the coils should heat too much, even when current is on for short periods, additional resistance can be added in series with each coil to cut down current.

If the questioner finds this instrument too difficult to construct we can refer him to parties who manufacture rotation indicators at a moderate price.

CAN A BASEBALL TAKE UP LINES OF FORCE?

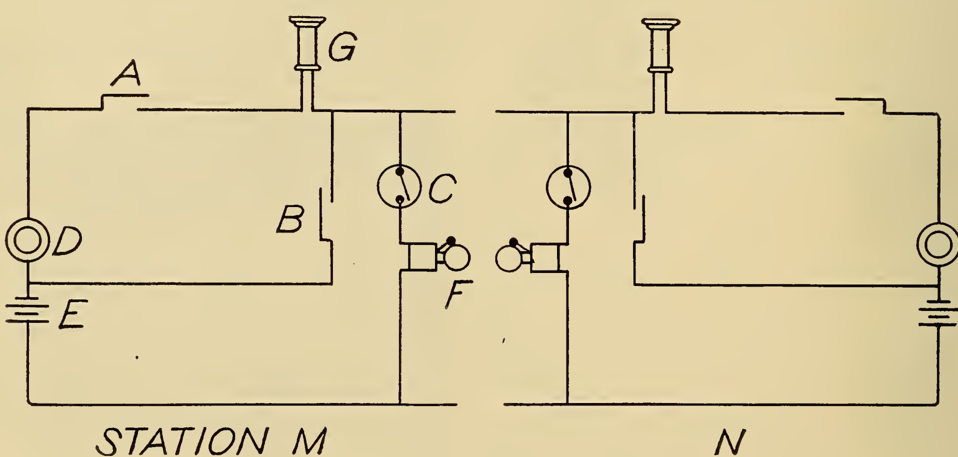
Question.—During a few hours recreation my brother and myself were playing catch in the street in front of my home, and I threw a regulation league $1.25 ball. In ascending it struck a primary wire of a circuit and the ball seemed to adhere to the wire, and followed the wire for a distance of 10 feet or more on the under side. How would you account for the phenomenon? The only way I see would be that the ball in rotation, and being made of compressed yarn, took up some of the lines of force about the wire, and happened to be whirling in the direction of the flux, or field, and as a consequence was held to the wire till the speed of the revolution decreased, then dropped.—C. B. T., Kokomo, Ind.

Answer.—Your explanation of the phenomenon is wrong. Although there are magnetic lines of force surrounding a wire carrying current they have no effect on such materials as yarn, leather, etc., of which a baseball is made. The reason the ball followed the wire was no doubt due to the fact that when it struck the wire it was rotating rapidly in a direction to overcome the reaction or "bounce" which would naturally follow. The phenomenon may be more readily noticed in a tennis ball. If you "cut" the ball so that it rotates rapidly in a certain direction, when it strikes it will spin along the ground without bounding at all. Cut it so that it rotates in the opposite direction and it will bound in a much more pronounced manner, sometimes back toward the server.

HOW TO WIRE A TELEPHONE SET.

QUESTION.—Kindly publish in the Question and Answer Department how to wire a telephone set having but two lines, these two lines to be used for ringing and talking circuits, using battery for ringing.

Answer.—A simple circuit for such a set is shown in the diagram. (A) represents a switch, (B) a common push button, (C) a single point switch, (D) a telephone transmitter, (E) the batteries, and (F) an electric bell. When not in use the switch (C) is left closed. To call station (N) open switch (C) and press button (B) which will allow the current from the batteries to flow out on the line and ring the bell at station (N). The operator on answering opens switch (C), and picks up the receiver, which may be so arranged on the hook that the switch (A) will be closed when the hook goes up. The battery current now flows through the transmitters and receivers of the two stations. When the transmitter is spoken into, a mass of carbon granules are made to vibrate in the same proportion, thereby affecting the battery current flowing in proportion to the sound waves, which acts on the diaphragm of the receivers and reproduces the spoken words.



READING A WATTMETER.

In the answer to the question on "How to Read a Wattmeter" printed in the June issue of Popular Electricity an erroneous impression is conveyed since the dials of the ordinary wattmeter, from right to left indicate units, tens, hundreds and thousands of kilowatt hours respectively, instead of tens, hundreds, thousands and ten thousands as stated. This of course threw the answer to the example given forward one decimal place. The correct answer in this case should have been 158 instead of 1,580 kilowatt hours. The method of reading the meter, however, is as stated in the example.

IS ABSOLUTE ETHERIC VACUUM OBTAINABLE?

QUESTION.—That mass is a state of electrical inertia; that electricity, heat, light and valence are simply vibrations of the ether depending upon the difference of the wave length of their vibration for their physical properties, and that the ether is composed of ions, sometimes called corpuscles, is acknowledged quite generally by a great many scientists. I would like to ask this question: Is there any known method by which these ions or corpuscles may be deflected from space even two inches, so that we might have an absolute etheric vacuum and hold it so for any length of time, leaving the atmosphere out of the consideration?—R. E. C., Des Moines, Iowa.

Answer.—Rapidly moving corpuscles or electrons may be deflected from their course by a magnet, but this does not produce an absolute etheric vacuum. There is no means of producing such a vacuum. According to the electron theory, every atom of matter is made up of electrons but this is not true of the ether. Electrons are of two kinds, one kind bearing a positive electric charge, the other a negative charge. Electric waves, used in wireless telegraphy, radiant heat, and light are vibrations of the ether. An electric current in a metallic conductor is believed by many scientists to be a stream of electrons moving in the spaces between the molecules or from molecule to molecule throughout the conductor.

STORAGE BATTERIES.

QUESTION.—Will you kindly give me the formula for the number of cells of storage battery required when connected in series when the external resistance is 350 ohms, the current strength of the circuit is .025 ampere, the batteries electric Chloride accumulators "BT" type voltage 2.5 volts?—T. F. H., Albany, N. Y.

Answer.—Apply Ohm's law, $C = \frac{E}{R}$. Then $E = C \times R = .025 \times 350 = 8.75$ volts, which is the voltage required to produce a current of .025 amperes in your circuit. Taking the voltage of each cell as 2.5 volts, $8.75 \div 2.5 = 3.5$; the number of cells. Of course, it would be necessary to use four cells. If the requirements of your circuit are such that you must have exactly .025 amperes, you, of course, would have to use some resistance in series with the batteries. The above assumes the voltage of each cell to be 2.5 as you state. As a matter of fact, the chloride accumulator type "BT" cell gives about two instead of 2.5 volts, and it would, no doubt, be necessary for you to use five of these cells.

QUESTIONS OF VOLTS AND WATTS.

QUESTION.—What is the voltage on a line which would supply a 450 watt lamp at ¾ ampere? If a circuit is capable of carrying 150 amperes at 1,100 volts, how many 400 watt lamps would it supply, disregarding losses?—F. E. C., New York, N. Y.

Answers.—Supposing these to be examples in direct current or non-inductive circuits, Ohm's law, or a modification of it, would apply. In the first instance the formula $W = CE$ would apply, in which W = watts, C = current and E = volts. Then we would have $450 = \frac{3}{4} \times E$, or $E = 600$ volts. In the second case the same formula would apply, and we would have $W = 1{,}100 \times 150 = 165{,}000$. This is the total capacity in watts. Dividing 165,000 by 400, the quotient is 412 approximately, which is the number of 400 watt lamps that could be supplied.

THE THEORIZER'S CORNER.

Many of us have a pet theory that we are aching to give to the world at large. There are others who feel it their duty to run down and "explode" such theories wherever possible. We are, therefore, going to set aside a corner in Popular Electricity where the theorizer and the "exploder" may meet on common ground, and we await with interest the "fire works" to follow. The department will be devoted to theories concerning electricity and allied sciences, and if any one has any objections to these theories let them be set forth in cold type.—Editor.

CAUSE OF THUNDER AND LIGHTNING.

The explanation of the cause of thunder and lightning by "R. S." in the July issue, does not seem to be satisfactory in view of actual observation.

Lightning is the result of electrical discharges from the clouds. Evaporation from the surface of the earth, changes of temperature in the atmospheric vapor, decaying vegetation, chemical action on the earth's surface, and the friction of volumes of air of the different densities against each other are the only causes of lightning. The reason these phenomena produce electricity is because they disturb the equality of the electric force, and produce lightning. The flash of lightning and the report of the thunder really happen at the same time, and the thunder is nothing more than the noise that succeeds the rush of the lightning fluid through the air, and is caused by the vibrations of the air as it falls together and seeks to restore its own equilibrium.—C. O. M.

R. S.: It seems that your conceptions of the ether differ somewhat from the rules and laws laid down and accepted by the scientific world. The ether does not begin where the air or atmosphere ends, or else the scientists are wrong when they describe the light rays and the electrical (wireless) waves as being oscillations in the ether. They claim that neither light nor electrical waves can propagate without ether. Thus, according to your conception, the light would stop where the atmosphere ends, hence there would be no light on the surface of this earth of ours. The fact that we can send and receive wireless messages on ether waves and receive them in the atmosphere proves that the ether does not stop where the atmosphere ends but that it exists within the air.

Then, too, if your theory were correct, friction would be produced in winter as well as in summer, thus we ought to experience lightning and thunder all the time, for the air always revolves with the globe and thus would rub against the ether. But praxis shows that when the sun rays have heated the air abundantly the little air particles have become electrified and have arranged themselves according to the electrostatic laws, at intervals seeking equilibrium in the form of huge sparks. The thunder is the cause of the lightning.—A. E. J.

———

The theory advanced by R. S. in the Theorizer's Corner of the July issue in regard to the cause of thunder and lightning is an objectionable one when considered from the viewpoint of modern science.

"Ether" is a word applied by modern scientists to that medium which transmits light and heat waves. Air is the medium through which sound waves pass, but it is evident that heat and light waves do not use the latter as their medium, for, if they did, the sun would not be able to warm and light the earth, because there is not a continuous body of air from the sun to the earth. So there must be some other medium which fills space and is contained in our atmosphere, and in all transparent bodies, like glass and water, and which has this power of transmitting heat and light waves. It cannot be seen, heard, tasted, or felt, but it can be given a name, and it is called the "ether." Therefore there is no place where the atmosphere ends and the ether begins; the ether is present everywhere in the universe. Science also has found that, try as it might, it could not measure the density or elasticity of ether, as can be done with air or water, and therefore has come to the conclusion that ether does not react in any measurable way with mechanical forces such as pressure, torsion, etc. Therefore, since there is no pressure to the ether, there can be no friction between it and the atmosphere

A vacuum is a space devoid of gases. An electric incandescent bulb is an almost perfect vacuum, and, since there is no air there, and whatever is in it is capable of transmitting heat and light waves sent out by the filament, one concludes that it contains ether. Therefore, ether is present in a vacuum, and so the statement that "a huge vacuum is left between it (the atmosphere) and the ether" cannot possibly be supposed.

L. H. R.

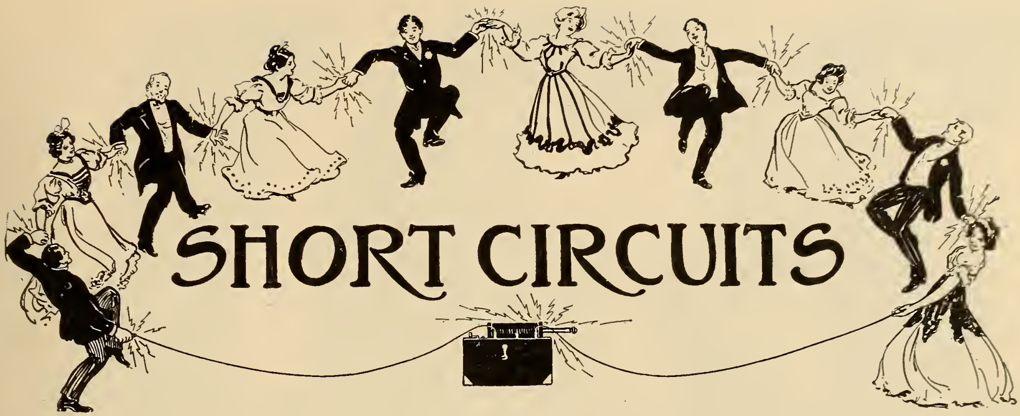
ELECTRICITY THE LIFE PRINCIPLE.

It is not to be wondered at that men are allured by the smiling, sunny nature of springtime which brings them to the consciousness that new life, new energy is awaiting them? And what miraculous energy is it which opens a nut-shell that requires more than 300 pounds of weight to crack it.

There may readily be detected in all this the operation of a law which is working toward one great end. As the evening devours the morning, love the hatred, age the youth, so we find in nature two forces, one being opposed to the other, and yet without both we find that nothing can be done. For how could we speak of light if there was no darkness, or how of good if there was no evil, how of strength if there was no such a thing as weakness?

Physicists have already arrived at the conclusion that there exists but one power which rules the universe, and chemists are slowly following them with their opinion that all matter consists of one and the same substances, which is influenced and has grown under different circumstances and pressure. According to the latest researches of science we would find thus one substance (smallest particle) possessed by one life power (electricity), governed by one almighty intelligence (eternal God). These three factors working in harmony constitute the universe.

A. E. J.



SHORT CIRCUITS

An Irish assessor, in making his rounds, assessed one man $8 for his goat. The man strongly protested against so heavy an assessment, as the goat only cost him $5. But the Irishman said it was the law, whereupon the man insisted upon being shown. So the Irishman brought forth the book of ordinances with a flourish, and read therefrom: "All property butting on the street shall be assessed four dollars per front foot."

* * *

"Papa, what does a United States senator earn?"

"The average senator does not earn, my son; he amasses."—Puck.

* * *

Paxton had saved Wensen from drowning. Accordingly when he reached the celestial gate St. Peter directed him to a large room which was set aside for those who saved others from the terrors of the waters. When Paxton had partly finished telling the story of his accomplishment, as he had been instructed to do, the good Saint returned and inquired how he was progressing. Paxton replied:

"All right. But the more interested I am in telling it the more frequently that old man" (pointing to an old man with long, flowing, white whiskers) "says, 'Oh, pshaw'!"

"Oh, never mind him," said St. Peter, "that's Noah."

* * *

They had just finished the operation and had sewed up the incision when they found that their scalpel was missing, so they reopened it and took out that instrument and resewed the cut once more. This time a small mirror was lost, so they repeated the process. About this time the patient was coming out of the effect of the anesthetic and remarked: "If you have to do that again, put buttons on my back."

* * *

The Chicago Girl—"Plague take this Eastern culture."

Her Boston Aunt—"What is the matter, my dear?"

The Chicago Girl—"I've really become interested in Shaw. I think he's bully. I take to transcendentalism without any trouble; I'm getting used to eyeglasses, and I dote on dignity; but I can't get over saying 'skiddoo!' instead of merely elevating my eyebrows."

* * *

The Reverend Dr. Fourthly was reading the evening lesson from the Book of Job.

"Yea, the light of the wicked shall be put out——"

At this instant, by one of those inexplicable accidents that sometimes happen, the current went off, leaving the church in total darkness.

"Brethren,' said Dr. Fourthly, without a moment's pause, "in view of the startling and sudden fulfilment of this prophecy, we will spend a few moments in silent prayer for the electric lighting company."

Knicker—"Are they a bridal couple?"

Bocker—"No, by his devotion I should judge she is a cook he is taking out to the suburbs."

* * *

"Mamma, is that bay rum in the bottle on your table?"

"Mercy, no, dear" she replied. "That is mucilage."

"Oh!" said little Johnny, "perhaps that's why I can't get my hat off."

* * *

Little Jack's grandmother told him that he must ask God to make the weather warmer so her rheumatism would be better. So at the close of his prayer that night he was heard to say, "And, oh, yes, dear Lord, make it hot for grandma."

* * *

A farmer had a horse he was anxious to sell, and one day while driving with a prospective buyer the horse stopped so frequently that the buyer asked:

"What ails your horse that he stops so often? Is he balky?"

"No," replied the farmer, "he's all right. It's simply he's so darned afraid somebody will say 'Whoa,' and he won't hear it, that he stops to listen."

* * *

A Sunday school teacher had instructed her class that each child should repeat a verse of scripture when the offering was made. The plate containing many pennies had gone down the line, when the child next the last said, "The Lord loveth a cheerful giver," depositing a nickel.

Either the verses had given out or the child at the end of the bench was overcome at her neighbor's generosity, for she said: "A fool and hith money are thoon parted!"

* * *

"Augusta," said Mr. Wyss when the quarrel was at its height, "you have devised a great variety of ways to call me a fool."

"Merely a matter of necessity," replied Mrs Wyss. "You have devised so many ways of being one."

* * *

"I had to leave my last situation because the missus said they were going to lead the sinful life, and they wouldn't want any servants about the place."

* * *

A meddler monkeyed with a switch—
'Twas marked "500 volts."
When consciousness came back to him,
He said it should read "jolts.'

* * *

"If the man in the moon were a coon," howled the street organ.

"Wisht he wuz," muttered Meandering Mike. "Maybe a feller could git a park bench to sleep on onct in a while these here spoony nights."

ELECTRICAL DEFINITIONS.

Alternating Current.—That form of electric current the direction of flow of which reverses a given number of times per second.

Ampere.—Unit of current. It is the quantity of electricity which will flow through a resistance of one ohm under a potential of one volt.

Anode.—The positive terminal in a broken metallic circuit; the terminal connected to the carbon plate of a battery.

Armature.—That part of a dynamo or motor which carries the wires that are rotated in the magnetic field.

Circuit.—Conducting path for electric current.

Circuit-breaker.—Apparatus for automatically opening a circuit.

Commutator.—A device for changing the direction of electric currents.

Condenser.—Apparatus for storing up electrostatic charges.

Direct Current.—Current flowing continuously in one direction.

Efficiency.—Relation of work done by a machine to energy absorbed.

Electrode.—Terminal of an open electric circuit.

Electrolysis.—Separation of a chemical compound into its elements by the action of the electric current.

Electromagnet.—A mass of iron which is magnetized by passage of current through a coil of wire wound around the mass but insulated therefrom.

Field of Force.—The space in the neighborhood of an attracting or repelling mass or system.

Fuse.—A short piece of conducting material of low melting point which is inserted in a circuit and which will melt and open the circuit when the current reaches a certain value.

Galvanometer.—Instrument for measuring current strength.

Inductance.—The property of an electric circuit by virtue of which lines of force are developed around it.

Insulator.—Any substance impervious to the passage of electricity.

Kilowatt.—1,000 watts. (See watt.)

Kilowatt-hour.—One thousand watt hours.

Leyden Jar.—Form of static condenser which will store up static electricity.

Motor-generator.—Combined motor and generator for changing alternating to direct current or vice versa.

Multiple.—Term expressing the connection of several pieces of electric apparatus in parallel with each other.

Ohm.—The unit of resistance. It is arbitrarily taken as the resistance of a column of mercury one square millimeter in cross sectional area and 106 centimeters in length.

Poles.—Terminals of an open electric circuit.

Potential.—Voltage.

Relay.—Instrument for opening or closing a local circuit, which is operated by impulses from the main circuit.

Resistance.—The quality of an electrical conductor by virtue of which it opposes the passage of an electric current. The unit of resistance is the ohm.

Series.—Arranged in succession, as opposed to parallel or multiple arrangement.

Shunt.—A by-path in a circuit which is in parallel with the main circuit.

Solenoid.—An electrical conductor wound in a spiral and forming a tube.

Spark-gap.—Space between the two ends of an electrical resonator.

Switch.—Device for opening and closing an electric circuit.

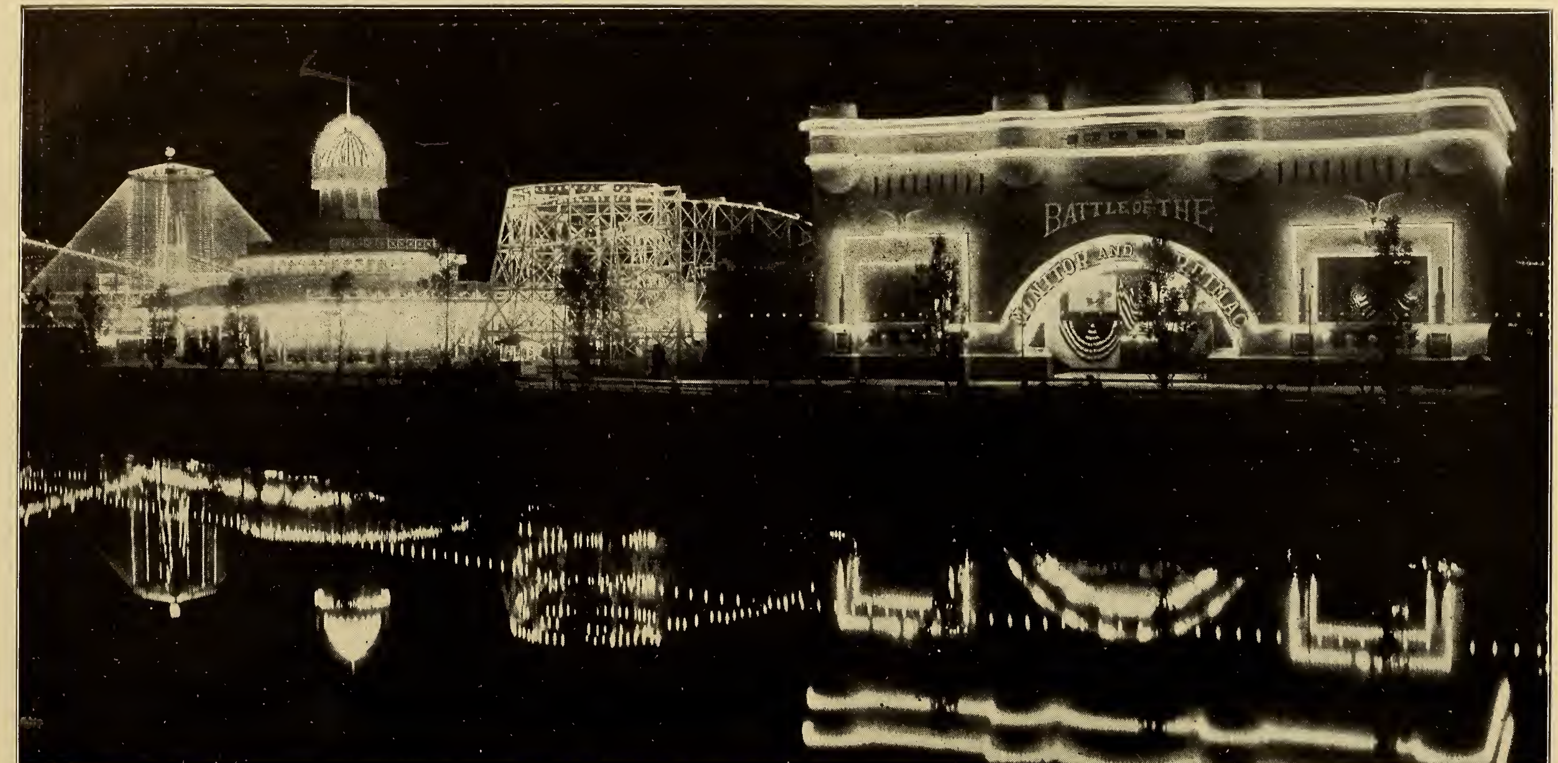
Transformer.—A device for stepping-up or stepping-down alternating current from low to high or high to low voltage, respectively.

Volt.—Unit of electromotive force or potential. It is the electromotive force which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

Voltage.—Potential difference or electromotive force.

Watt.—Unit representing the rate of work of electrical energy. It is the rate of work of one ampere flowing under a potential of one volt. Seven hundred and forty-six watts represent one electrical horse power.

Watt-hour.—Electrical unit of work. Represents work done by one watt expended for one hour.



ELECTRICAL SPLENDORS OF RIVERVIEW.