POPULAR ELECTRICITY
IN PLAIN ENGLISH

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FOLLOWING A TELEPHONE CALL.

BY STANLEY A. DUVALL.

PART I.

THE average person in every walk of life is familiar with the telephone instrument and understands its operation and its many valuable features, but beyond that the entire telephone system is a complete mystery. It is the purpose of this article to tell in plain, simple language the fundamental principles underlying the operation of the telephone exchange and correct a number of erroneous opinions that prevail among telephone users at large.

From each telephone, no matter where it is located, or how inaccessible the locality, a pair of wires are carried from the top of the instrument to and terminate in some form of a signaling device. In up-to-date and modern exchanges, such as shown in the illustration herewith, these signals consist of miniature incandescent lamps. Each lamp is mounted in convenient form and is furnished with a small bull's eye or opal, upon which is marked the number of your telephone. When you remove the receiver of your telephone and place it to your ear, this little lamp is lighted, and it gives three-fourths of a candlepower, which is amply sufficient to attract the operator's attention. With each lamp there is furnished a coupling device, which is known among the telephone men as a "jack," and bears the same relation to your telephone line as a car coupler bears to a railroad coach, and is always used for connecting your line to any line for which you may call. At this point, it must be borne in mind that each line has its lamp and jack, and right here it might be well to define what is meant by "line."

A line is the circuit from your telephone to your signal, and must consist of two conductors or wires, which make a continuous path for the electrical current. This is the fundamental principle of all electrical work. There must be a complete circuit to and from the source of energy, and in modern telephone systems, the telephone exchange, which consists of switchboards, charging machines and ringing machines, is the source of energy. You will hear it frequently spoken of as a "common battery" or "central energy exchange."

We will now return to your small lamp signal and coupler which is located at the switchboard. As we said before, these are miniature lamps, and in a space of one foot square over one hundred of such signals can be placed, to which can be connected a like number of lines or, to express it more plainly, a like number of telephones, or what are known in the telephone office as subscribers.

To connect your line, say that your number is No. 1, with your neighbor's line, which we will say is No. 2, it is necessary to have some intermediate link for coupling, or, to use the correct phraseology, for connecting these two lines together. This is always in the shape of what is known as a "switchboard cord." This cord is about the size, and looks a good deal like a sash cord, but instead of being made of hemp, it consists of two flexible wires which are covered with a number of layers of woven linen. On each end of this cord is fastened what is known as a "plug." This is really the coupling pin for the jack on your line. There are 20 to 30 of these cords and plugs, and as the cords are about six feet long, it would not be neat or workmanlike to have them laying around in a careless and unsystematic manner. The cords are mounted inside of the switchboard and are provided with weights and pulleys, just as the sash cord is equipped in your window frame. When they are not in use by the operator, they automatically drop down and out of sight, and all that appears on the front of the switchboard are the plugs themselves.

The operator has a connection with each pair of cords, by which she can connect her own telephone to any one of the cords at leisure, and by a little switch she can turn the connection from a talking circuit to a ringing circuit. If you will stop a moment and think, you will see that it will be necessary, after you have lit your lamp at the exchange by the removal of your receiver, for the operator to couple her telephone with your line by the use of one of these coupling pins or plugs. She then turns her switch over to the talking position and, after ascertaining from you the number you want, she takes the free end or the coupling pin or plug that is on the other end of this cord and inserts it in the jack or the coupler of the line that you want, say your neighbor's line No. 2. Thus she has coupled together two telephone lines in a manner similar to that of coupling two railroad coaches together, and in telephone phraseology the operator has made one connection. She again moves her little switch over to another position, which automatically turns on the ringing current on line No. 2, and this rings the bell of your neighbor's line. "Yes," but you say, "I understand this all right, but how do we get loose when I finish talking with my neighbor, and does the operator listen all the time, or does she have to listen part of the time, and will she overhear some of my conservation?" No, she does not. When she finishes ringing No. 2, her little switch springs back automatically in its normal position and she pays no further attention to it.

Now we will go back to our cord which is provided with the two plugs or links. In addition to the little switch of the operator's which is connected to this cord, there are two little lamps attached to the cord. Remember they are not attached to your line or to your neighbor's line, but are attached to this connecting cord. One lamp is called the answering lamp and the other is called the connecting or supervising lamp. Now when a connection is made with this cord and two plugs, these lamps are not lighted, but as soon as you have finished your conversation and you and your neighbor hang up your receivers, these two lamps light up. The operator then knows that you and your neighbor have left your telephones, and she takes the connection down without calling your attention to the fact or without listening to see if you have finished. The connection is broken just as a brakeman would pull the pin out of a car coupler and disconnect two railroad coaches.

From this short explanation it can be readily seen that a telephone operator never has the slightest reason or incentive to listen to a conversation, unless a subscriber wishes her to do so.

What does a telephone exchange room look like in your mind? No doubt you thi[illegible] very noisy place and things [illegible] run somewhat carelessly and the general appearance of things is "topsy-turvy." And no doubt you think the operators have a great deal of fun and pass many a pleasant moment in conversation among themselves; but let us see if this is really so. We will now presume that we are entering an exchange room of one of the large and modern telephone exchanges in some moderate sized city of this country, and it would be well to state here that the telephone systems and exchanges in this United States of ours are far superior in design, workmanship and service to those of any other country in the world.

As we step into the exchange room, we notice a large, long cabinet which resembles somewhat in outline the modern upright piano, only it is a great deal longer. At the cabinet are seated, closely together, 20 or more operators. This is the main switchboard, and somewhere on this board is located the end of your line, which terminates in the small lamp about which we have spoken.

All is quiet and orderly. Now and then we hear the subdued "number please," but there is hardly a sound above this necessary question.

In front of the main board, we notice two or three flat topped desks, which are equipped with telephone apparatus and at each of which is seated a young lady operator, who has graduated from the service at the main switchboard and has become a monitor. She has a certain number of operators to look after and supervise; to see that the operators promptly answer the calls. Her desk is equipped with certain devices with which she can cut in on any of the operators and ascertain if they are handling their work in a proper manner. At another desk is the chief operator, who has entire control of the exchange room. Sometimes it is part of her work to answer complaints and adjust any trouble that may arise; but her work is generally the supervision of the conduct and services of all the operators.

SWITCHBOARD IN A MODERN TELEPHONE EXCHANGE.

There are always a certain number of relief operators who come and go during the twenty-four hours and there is therefore a constant changing of operators at the main switchboard. Nearly all exchanges are furnished with a recreation room, where the operators can spend their recesses during the day, resting and reading, and these recreation rooms are made as comfortable as possible, and indeed they are very handsomely furnished. Neither time nor money is spared by the telephone companies in taking care of the physical and mental welfare of its operators and other female employes. Indeed in some large exchanges a matron is furnished to look after the welfare of the lady operators. Of course there are other offices in connection with the telephone exchange, such as the complaint office and information bureau, which is sometimes presided over by the manager. Then there is the office of the wire chief, who has a room all by himself, which is equipped with many strange looking instruments for measuring currents, testing the lines, and in fact this office has the general supervision of all the wires and instruments in the exchange. This office is always held by a man, as this is entirely technical work. Connected with the wire chief's office are the inspectors who, of course, are also men. These men not only inspect the instruments, but they also inspect the service. This inspection is made by inspectors calling up over certain lines and, unknown to the operator, a report is made to the wire chief or manager giving the number of seconds which are taken by the operator in making connections.

No doubt when you have stood at your telephone sometimes and thought that you had been there several minutes, you would have been surprised to find, if you had been provided with a stopwatch, that the period of waiting had not been over 10 seconds. The average time consumed in making the connection is about eight seconds, and where the time runs over 15 seconds the operator is subject to a reprimand, and a certain number of bad marks per month mean dismissal. In some exchanges prizes are offered for operators who have the least number of demerits to their record during the month.

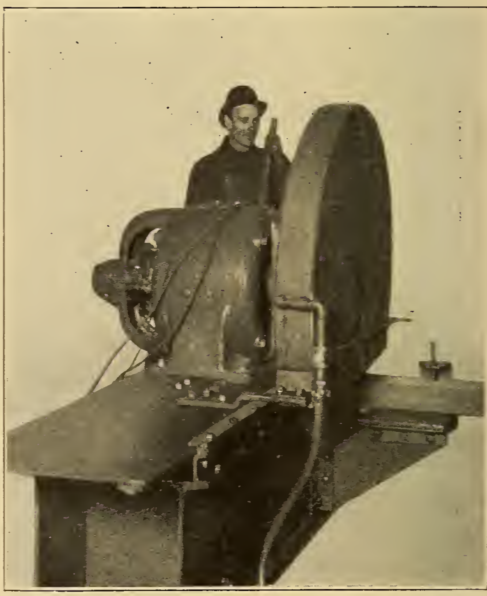
Now you will see that it is the business of the operator to make connections and to transact no other business; so if you endeavor to question the operator about something not appertaining to the number for which you call, you are simply robbing your fellow subscribers of the operator's time and she is not performing any act of discourtesy when she switches you unceremoniously on to what you think is another operator, but which in reality is the information bureau or whatever department the nature of your inquiry may require.

The main-board operator's instructions are to first, inquire "number please" and then repeat after you the number called. This is done to check the call. She has no other work to do or no other words to use, and if she stops and has any further conversation with you she is simply disobeying instructions.

(To Be Continued.)

SAWING THROUGH STEEL.

Saws that eat their way through steel rails as they would through a pine log are now common in all steel mills. In modern steel plants, electricity is the



motive power used in driving the various machines such as rolls, saws, punches, etc. The electric motor is particularly adapted to this work, since it can be made to drive the machines direct, without the use of belting or shafting.

The accompanying picture shows a motor driven saw cutting a heavy steel rail. The saw, as will be seen, is mounted directly on the end of the motor shaft, and is almost entirely enclosed to protect the operator from the flying particles of steel.

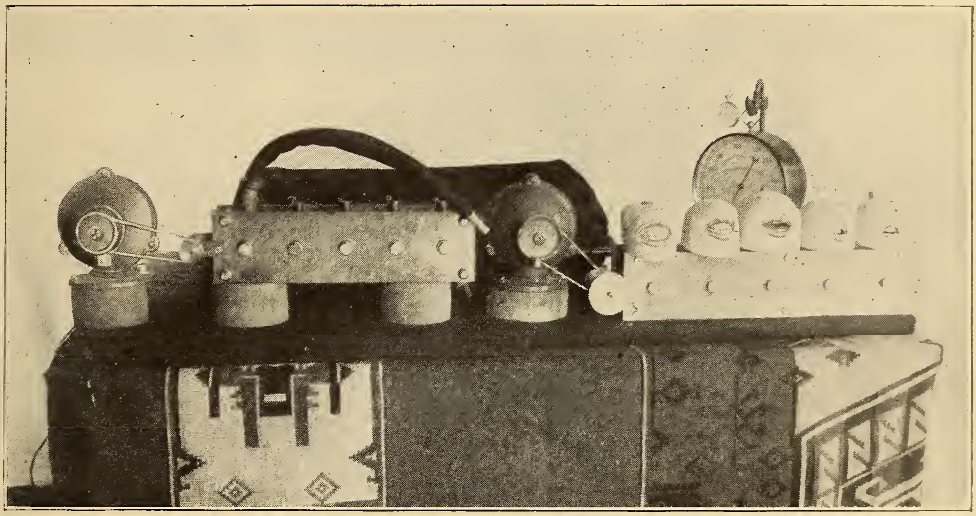
FRENCH ELECTRIC TALKING SIREN.

The accompanying illustration shows the French electropneumatic talking siren, invented by Dr. Marage, for testing the hearing and to aid in teaching the deaf. The French apparatus differs from the phonograph, which simply records and reproduces what is spoken into it, in that it produces sounds accurately imitating those of the vowels used in speaking and singing.

Dr. Marage made a careful study of the human tongue, lips and teeth and their position in producing the various vowels. He then constructed artificial mouths, as shown in the illustration, for producing the vowel sounds, a, e, i, o, u. His apparatus consists of an electric motor for compressing air used in the operation of the siren, together with rheostat and switches for connecting with an ordinary lighting circuit. The manometer and the mouthpieces for producing the vowel sounds are shown on the right in the picture. A rotating circular disk produces the sounds. It is provided with slots in groups of 1, 2 and 3, the vowels being distinctly heard when the air is blown through the slots.

These sounds, as produced by the apparatus above mentioned, give the vowels as sung, but when the special molds are used, imitating the form of the human mouth, the spoken vowels are obtained. The artificial mouths have lips and teeth adjusted in precisely the same position that the human mouth takes in pronouncing the vowel.

The talking siren was originally constructed for testing the sharpness of the sense of hearing for different persons. There are three different forms of apparatus in common use for this purpose, producing vibrations of spoken words, musical vibrations and noises. These devices, it is said, were not satisfactory in gauging the sharpness of the sense of hearing, and Dr. Marage devised the talking siren as a substitute. This siren produces sounds, the intensity of which is proportional to the pressure of air, and is therefore accurate in determining the keenness of hearing of different individuals.



FRENCH ELECTRIC TALKING SIREN.

The manometer, which is something like a steam pressure gauge, is shown in the accompanying illustration. It indicates the pressure of the air operating the siren. The sound intensity is gradually increased with the increased pressure of air, while the ear to be tested is placed at a definite distance from the instrument.

ELECTRIC SELF-REGISTERING TARGET.

The electric self-registering target shown in the accompanying illustrations is the invention of Lieutenant-Colonel George A. Peters of Toronto, Can., now deceased. The target is so arranged that each shot which strikes the target is registered by an electrically operated annunciator at the firing station. Fig. 1 shows a view of the face of the target, Fig. 2 the operating mechanism of the target, and Fig. 3 the annunciator at the firing station.

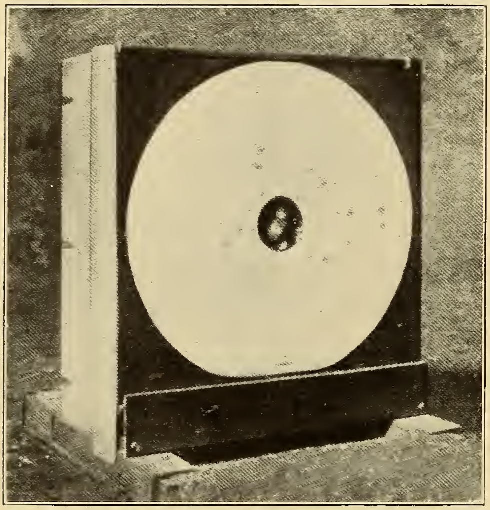


FIG. 1. FACE OF ELECTRICALLY OPERATED TARGET.

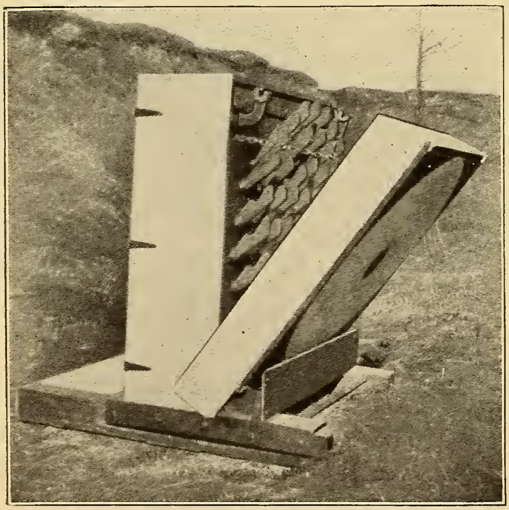


FIG. 2. CONTACT HAMMERS IN BACK OF TARGET.

Operation of the target is quite simple. The face of the target is a steel plate, thick enough not to be pierced by the bullets. Back of this plate are arranged a great number of hammers hung from hinges so that they rest against the plate when it is in position. These hammers are shown plainly in Fig. 2. A bullet striking the plate at any point will drive back the hammer that is alloted to that particular area. As the hammer flies back it closes for an instant an electric circuit connected to one of the annunciator drops on the annunciator board at the firing station.

The annunciator drops are similar to the annunciators on a telephone switchboard, and operate in the same way. In a telephone system, when you take your receiver from the hook an electric circuit is closed to the telephone exchange and releases a drop which indicates to the operator the number of your line. (In the later switchboards it lights a lamp.) In the same manner, when one of the hammers on the target is driven back it closes a circuit which releases a drop on the annunciator, indicating the point on the target where the bullet struck.

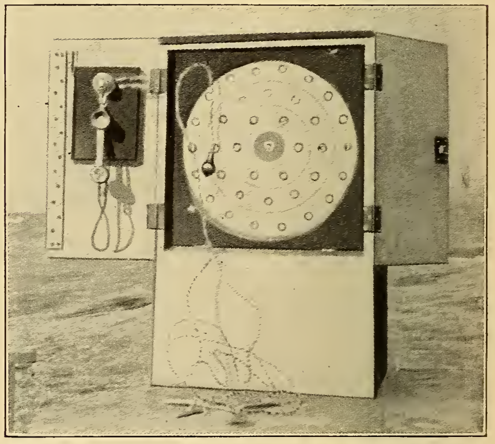


FIG. 3. ANNUNCIATOR AT FIRING STATION.

Each hammer is so hung on the back of the target that it is returned by its own weight to its original position after it has been driven back by a bullet, so that the target is automatically restored to the operating position after each shot.

A telephone line is also connected between the two stations so that communication may be held with a man behind the target if desired.

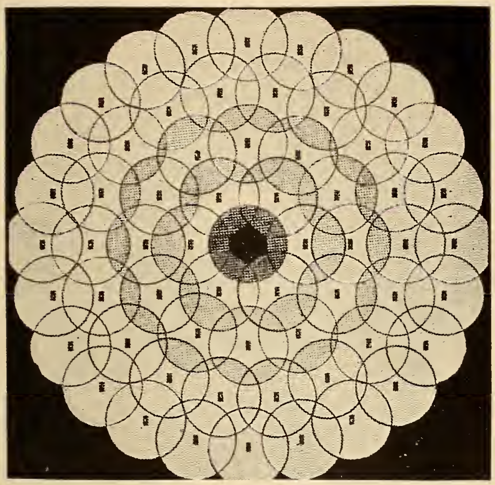


FIG. 4. BLACK SPOTS SHOW POSITION OF HAMMERS ON BACK OF TARGET.

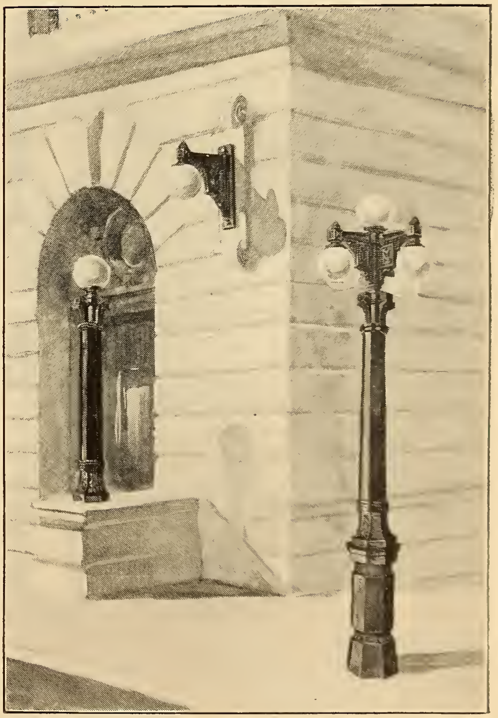
Fig. 4 is a diagram which represents by the black spots the positions of the various hammers on the back of the target. The circles around these spots represent the area controlled by each. It will be noted that the circles overlap, so that there is no area on the target which could be struck and not give an indication at the annunciator board. Under certain conditions two of the annunciator drops may fall but the indication always shows the circle on the target within which the bullet struck.

ELECTRICITY IN THE HIMALAYAS.

One of the largest and most important water power schemes that has yet been projected in the continent of Asia is that which is now approaching completion in the State of Kashmir, whereby 20,000 electrical horse power will be available for lighting, power and other purposes within a circle of about 160 square miles. The big power house is practically completed and a current of 60,000 volts is being delivered. It will be used for a wide variety of purposes, for illumination and traction, and for driving mills. Among other things it will be used in the State silk factory for the generation of heat in 3,000 filature basins where the silk is reeled from the cocoons.

ARTISTIC STREET LAMP DESIGN.

A prize competition for the design of a street lamp post, bracket and pedestal was held recently by the Chicago Architectural Club. Prizes to the amount of $200 were given by the Commonwealth Edison Company and James B. Clow & Sons of Chicago. Specifications upon which the competition was carried out called for a design with 75 to 100 candlepower in incandescent lamps, and having not less than two or more than four bracket arms. The prize winning design



ARTISTIC ARC LAMP DESIGN.

shown herewith is the idea of Mr. C. H. Hammond, and is at once artistic and practical. The same idea is worked out in the post, pedestal and bracket. The post embodies the essentials of both the bracket and pedestal, with the addition of a substantial base. The design is intended to be worked out in cast iron.

ELEMENTARY ELECTRICITY.

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

CHAPTER II.—VARIETIES OF ELECTRIC CIRCUITS.

Such an apparent complexity is presented, when a great number of electric circuits are brought together in any limited space, that, to those just beginning the study of electricity, it seems almost hopeless to endeavor to trace them through their separate paths. There seems to be neither rhyme nor reason for the way they are at times connected to neighboring wires, while at other times they pass them by as if entirely ignoring their existence.

Though at first sight it seems that there are infinite varieties of circuits, yet, generally speaking, direct current circuits can be divided into two great classes, namely:

(1). Series circuits.

(2). Multiple or parallel circuits.

Strictly speaking, there is a still broader classification that includes circuits of all kinds, whether direct or alternating, namely: Simple electric circuits, and compound electric circuits. Simple electric circuits consist in a combination of a single source with a single electro-receptive device, while compound electric circuits consist in the combination of more than a single electric source, or more than a single electro-receptive device, or both. Since, however, we are now endeavoring to point out some way in which the apparent complexity of compound electric circuits may be notably decreased, we will confine our attention to the classification of compound direct current circuits just given, i. e., series circuits, and multiple or parallel circuits.

SERIES CIRCUITS.

In a series circuit one or more electric sources have their poles so connected with a number of electro-receptive devices that the current passes successively through each of these devices from the first device to the last. The manner in which this is done will be readily understood from inspection of Fig. 7, which represents a single electric source or dynamo (D), connected in a series circuit with 10 arc lamps.

Within certain limits, practically any number of electro-receptive devices can be connected in series with a single electric source, or with a number of electric sources combined so as to act as a single source. In practice the principal consideration that limits the number of such devices is whether the machine or source is able to produce an electromotive force (E. M. F.) that is able to cause the electricity to pass through all the devices that are placed in the circuit. In the case of a dynamo the increased electromotive force can, within certain limits, be obtained by increasing the speed of the dynamo. When this limit has been reached a further increase of electromotive force can only be obtained by so combining two separate dynamos or sources, as to cause them to act as a single electric source of higher electro-

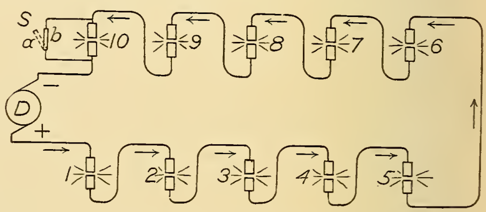


FIG. 7. DYNAMO AND 10 ARC LAMPS IN SERIES CIRCUIT.

motive force. To do this it is necessary to connect them with each other in series.

As we shall see in subsequent articles the proper operation of any electro-receptive device requires a certain electric pressure or electromotive force, in order that a certain amount of electricity per second or a certain electric current, shall pass through the device. It is evident that in the series circuit, since the same current strength passes through all the different devices in the circuit, no matter how many devices have been introduced into or removed from it, the current strength must be the same in all parts of the circuit. For this reason a series circuit is sometimes called a constant-current circuit.

Since in the series circuit the electro-receptive devices are placed one after another, the electric resistance of a series circuit necessarily increases with each device added, and decreases with each device removed from the circuit, for the total resistance of a series circuit is equal to the sum of its separate resistances. In such a circuit, therefore, the electromotive force of the source must vary in order to cause the necessary current to pass through each of the devices, the necessary E. M. F. increasing as additional devices are introduced into the circuit, and decreasing as some of the devices are cut out or removed from it. For this reason a series circuit is sometimes known as a circuit of variable electromotive force.

In many electro-receptive devices, such as arc lamps, different effects are produced according to the direction in which the electric current is passed through the device. It is evident, therefore, that care must be taken to see that the current passes through a circuit in the right direction.

In the case of arc lamps, the light is produced by the passage of an electric current between two carbon rods, one of which is generally placed vertically to the other. It is found that the carbon out from which the current flows, or the positive carbon, has a much higher temperature than the negative carbon, or that into which the current returns after having passed through the circuit. Since the amount of light emitted by an incandescent or heated body rapidly increases with its temperature, the light thrown off from the positive carbon of an arc lamp is greater in amount than the light produced by the negative carbon. If, therefore, arc lamps are to be employed for illumining the space below them, it is necessary to make their upper carbons the positive carbons.

Since in the series arc circuit the electro-receptive devices are inserted in breaks in the circuit, the circuit wires can change their direction to any desired extent, the only condition that must be fulfilled being that the wire which passes out of the lower carbon of the last device placed in the circuit, must be connected with the negative pole of the source. This fulfills the prime requirement of the electric circuit, i. e., that the electricity produced by the source, after it has left its positive pole and has passed through all the separate receptive devices, must have a path provided by which it may return to the negative pole of the source.

In order to prevent all the remaining lamps from being extinguished on the extinguishing of any particular lamp, it is only necessary to move a switch, either automatically or by hand, and thus provide a by-path through which the current can flow past either the faulty lamp, or the lamp which has been purposely removed from the circuit.

The means employed for cutting out or introducing any arc lamp into a series circuit is a switch such as is represented

FIG. 8. ENCLOSED ARC LAMP WITH SWITCH.

in Fig. 7, at S, as connected with the lamp No. 10. When this switch is turned so as to leave a space between the blades (a) and (b), the current passes between the two carbons and the lamp burns. When, however, the switch is turned so as to bring the contact (a) and (b) together, lamp No. 10 will be extinguished, because so much of the current passes through the low resistance path offered by the switch blades, that the amount of current passing between the carbons will be insufficient to produce an arc.

In Fig. 7, only a single switch is represented. Each lamp, however, must be provided with a switch.

In practice this lamp switch is provided with a handle or lever that projects from the top of the lamp, as represented in Fig. 8 at (S). This switch can be opened or closed from the floor by means of a pole without lowering the lamp.

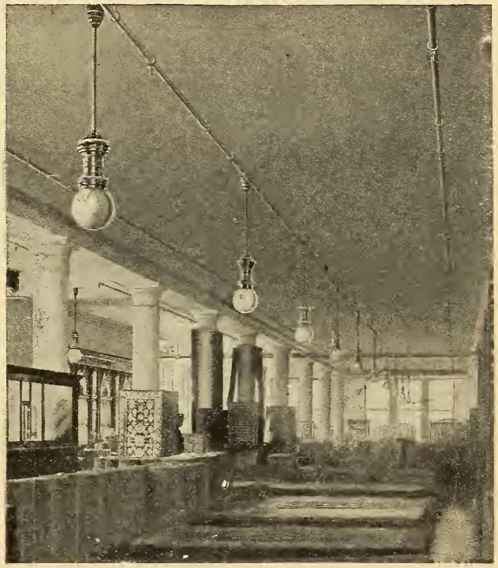


FIG. 9. ARC LAMPS WITH EQUAL SPACING.

It will be observed that in Fig. 7, the different lamps in the circuit are represented as being placed at equal distances apart. Where arc lamps are employed for the illumination of interiors, as represented in Fig. 9, the spacing between the successive lamps is constant. The same thing is true where arc lamps are employed for the illumination of streets or roadways, the lamps for this purpose being placed generally at the intersection of the cross streets. When, however, as is frequently the case, the current employed for the lighting of small stores, requiring three or four lamps only, is taken directly from the street service circuit, the distance between the lamps is greatly decreased. In other cases, where a few lamps only are required in a building, a few blocks away from the main service circuit, a loop of the circuit conductor carries the current to that particular spot and then leads it back again to the main street. In such cases there may be a comparatively great length of circuit wire in which no lamps whatever are placed.

Either electric sources, or electro-receptive devices can readily be connected together in a series circuit. When a number of electric sources are connected in series, the electromotive force furnished by the combined source, will be equal to the sum of the electromotive forces of the separate sources. If, for

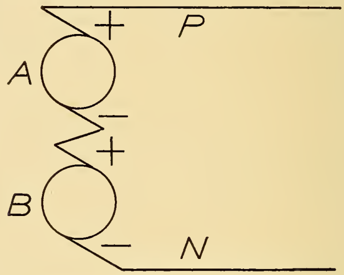


FIG. 10. DYNAMOS CONNECTED IN SERIES.

example, two dynamos, (A) and (B) are connected as shown in Fig. 10, they will be connected in series. To do this it is only necessary to connect the negative pole or brush of one of the dynamos (A), with the positive brush of the other dynamo (B), thus leaving the free posi-

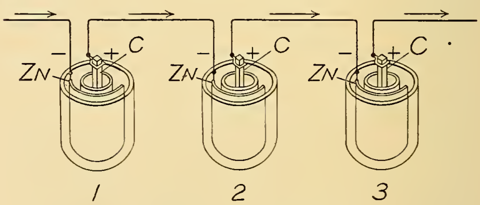


FIG. 11. THREE LE CLANCHE CELLS CONNECTED IN SINGLE BATTERY CIRCUIT.

tive terminal of the dynamo (A), for connection with the end (P) of the series conductor, and the negative terminal of the dynamo (B) for connection to the other end (N) of the conductor. It is possible in this way to connect any number of dynamos in a series circuit. In all such cases, however, the opposite poles of the intermediate dynamos are connected together, leaving the free poles of the end dynamos as the poles or terminals of the series-connected battery of dynamos. The name battery is generally applied to such a combination of a number of separate sources as will permit

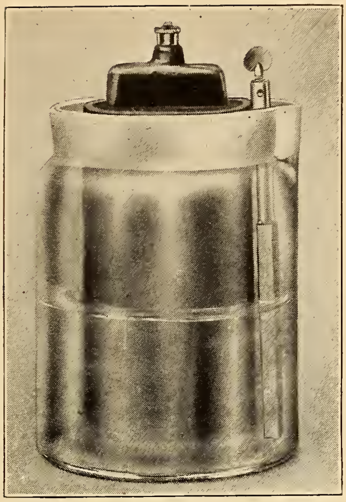


FIG. 12. LE CLANCHE OR SINGLE FLUID CELL.

them to act as a single source.

All kinds of electric sources are capable of being connected together in series, so as to produce a greater electromotive force than any of the separate sources can produce alone. Take, for example, three LeClanche cells represented in Fig. 11. In order to connect them in a series battery it is only necessary to proceed as in the case of the dynamo-electric-machine, and connect their opposite poles or terminals in the manner indicated.

As is well known the LeClanche cell forms what is sometimes known as a single fluid cell that is, a cell in which the two elements are excited by a single liquid. As shown in Fig. 12, the elements consist of zinc and carbon. The carbon element consists of a plate of hard carbon placed inside a porous cell or cylinder of unglazed earthenware that is tightly packed with a mixture of black oxide of manganese and finely broken gas-retort carbon, so as to bring the mixture with pressure against the sides of the carbon plate. Both the zinc rod and the porous cell are immersed in a solution of sal-ammoniac and water. As will be seen from an inspection of Fig. 11, in order to connect these cells in series, the carbon or positive pole of cell No. 1, is connected with the zinc or negative pole of cell No. 2, while the carbon of cell No. 2, is connected with the zinc or negative pole of cell No. 3, thus leaving two free poles, i. e., the zinc or negative pole of cell No. 1, and the carbon or positive pole of cell No. 3, as the negative and positive poles respectively of the battery. In this case, as in the case of the battery of dynamos represented in Fig. 10, the electromotive force of the three series-connected cells is equal to three times the electromotive force of any of the separate cells.

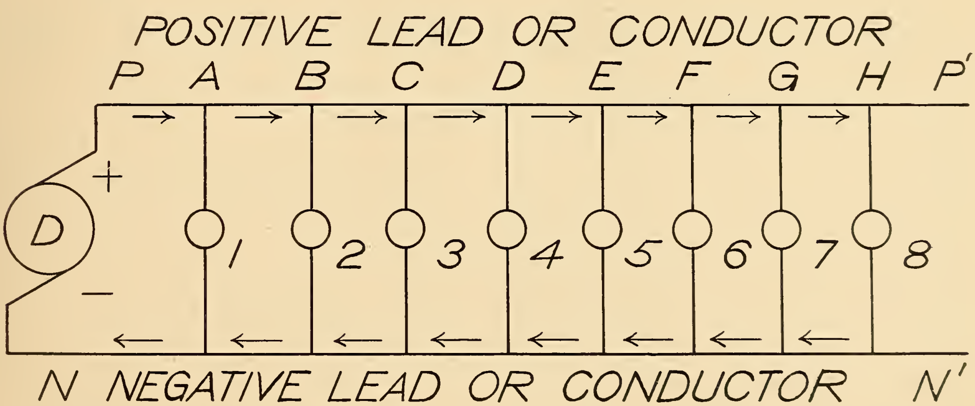


FIG. 13. MULTIPLE OR PARALLEL CONNECTION OF EIGHT LAMPS.

MULTIPLE OR PARALLEL CIRCUITS.

In a multiple or parallel circuit, a number of separate electric sources, or separate electro-receptive devices, or both, have all their positive poles connected to a single positive conductor, and all their negative poles similarly connected to a single negative conductor. In multiple or parallel circuits the conductors are generally known as leads. The lead connected with the positive pole of the source is called the positive lead, and that connected with the negative pole, the negative lead. Since the amount of electricity that passes per second, or the current strength that passes through the conductors that connect the lamps with the leads, is much less than the current strength passing through the leads, the wires in these separate conductors are made much thinner than in the leads.

Fig. 13 represents the multiple or parallel connection of eight separate incandescent electric lamps to the dynamo (D). Here the positive poles of all the lamps are connected with the positive lead or conductor (P P′), and the negative poles with the negative lead or conductor (N N′). It will be observed that there is no direct connection of the far ends (P′) and (N′) of the positive and negative leads, as would be done in the case of a series circuit. The two conductors (P P′) and N N′) are kept separate and distinct as positive and negative conductors or leads respectively, and are connected with each other only through the receptive devices, in this case the incandescent lamps. The path taken by the current from the dynamo through the separate lamps, back again to the dynamo is clearly indicated by the arrows. For example, in the case of lamp No. 1, the current leaving the dynamo (D) at its positive pole, passes through lamp No. 1, and then returns to the source at its negative pole.

But it will be observed that the current from the dynamo branches at (A), a part only passing through the lamp No. 1, the remainder continuing on through the positive lead between the lamps Nos. 1, 2, 3, 4, 5, 6, 7, and 8. A branching of the circuit takes place at each additional place where the other lamps are introduced into the circuit, as, for example, at (B), where a portion of the current passes through lamp No. 2, at (C), where another portion passes through lamp No. 3, and so on successively.

Now a certain quantity of electricity per second, or a certain current strength, is necessary for the proper operation of an incandescent electric lamp, just as it is for the operation of any other electro-receptive device. The same current strength must therefore pass through each of the thinner conductors that connect the lamps with the positive and negative leads. In order that this may be the case, it is necessary that there shall be the same difference of potential or electromotive force on all parts of the positive and negative leads. Now, while there is necessarily what is called a drop of potential in the leads, or a decrease in the electromotive force, as the distance from the source increases, yet, if the leads are made of fairly thick, heavy conductors, as is generally the case, this drop of potential, or difference of electromotive force is nearly constant. The multiple or parallel circuit, therefore, provides means for so branching an electric current through a number of separate electro-receptive devices as to cause the same current strength to pass through all the separate devices. Such a circuit is called a multiple circuit because it provides for a number of multiple circuits between the positive and negative leads respectively, in a practically parallel direction.

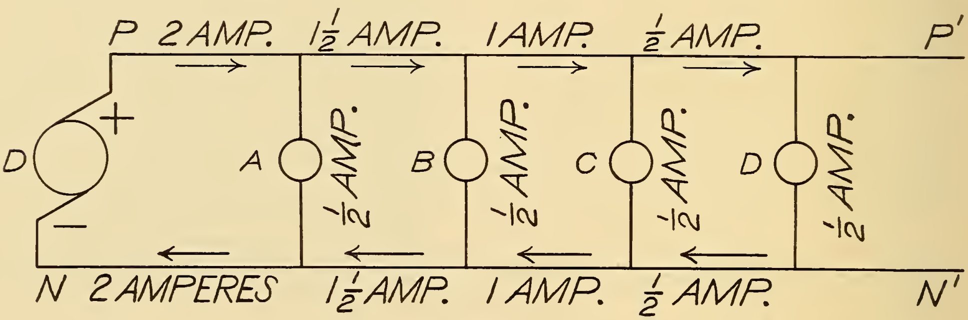


FIG. 14. DIVISION OF CURRENT IN PARALLEL CIRCUIT.

A multiple or parallel circuit is sometimes called a constant-potential circuit because it necessarily maintains a practically constant difference of potential, or electromotive force, between all parts of the positive and negative leads.

It will be seen that the series and multiple circuits differ from one another in this respect. A series circuit is called a constant-current because the current strength that passes in any particular part of the circuit is necessarily the same. The multiple or parallel circuit is called a constant-potential circuit because the potential between the leads is maintained constant, while the current strength in different parts of the lead necessarily varies.

Those beginning the study of electricity sometimes find it difficult to understand that in the multiple or parallel circuits, the current strength necessarily varies in different parts of the leads or main conductors. It is true that the circuits of the thinner wires containing the

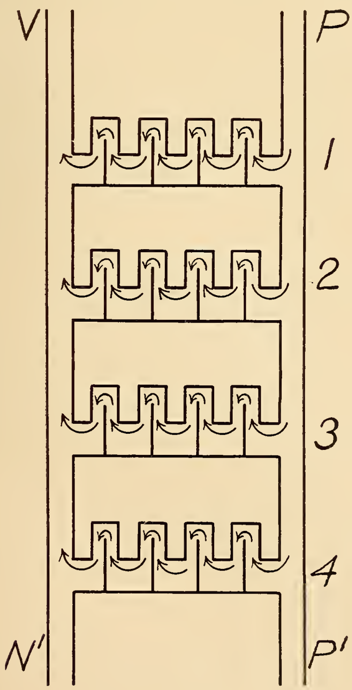


FIG. 15. STEAM RADIATOR SYSTEM IS A FORM OF PARALLEL CIRCUIT.

lamps and connecting portions of the positive and negative leads, have currents of constant strength passing through them. This fact sometimes leads students to regard the multiple or parallel circuit as also forming a constant-current circuit. A little thought, however, will remove this difficulty, and as the matter is an important one, we will explain it at somewhat greater length.

Suppose that four separate incandescent electric lamps, (A), (B), (C) and (D), are connected in multiple or parallel circuit, as represented in Fig. 14, and that each of these lamps requires for its proper operation a current strength of half an ampere. Suppose, moreover, that the difference of potential or electromotive force between the positive and negative leads is sufficient to force a current of half an ampere through each of the lamps. Consequently, a constant current of half an ampere will pass through each of the lamps. It is because the currents are constant in these circuits that the mistake is sometimes made of regarding this species of circuit as a constant-current circuit.

As is well known, incandescent lamps are provided with switches in the shape of keys by which they can be readily connected or disconnected from the leads or mains. Suppose, now, in Fig. 14, that the lamp (D) is turned on by the closing of its circuit, while the lamps (A), (B) and (C) have their circuits left open. Under these circumstances, a current of half an ampere will flow from the dynamo (D), through the positive lead (P P′) and, after passing through the lamp (D), will return through the negative lead (N N′) re-entering the dynamo at its negative pole. All parts of the leads would therefore have the same current strength of half an ampere passing through them.

Now suppose that in addition to the lamp (D), having a current passing through it, the switch or key of the lamp (C) is closed, thus permitting a current of half an ampere to pass through it. Since this additional current of half an ampere is drawn from the dynamo (D), it is evident that all portions of the positive and negative leads or mains lying between the lamp (C) and the dynamo (D) must now have a current of one ampere passing through them, since one-half an ampere is required to operate (C) and the remaining half to operate (D). There will then already be a marked difference in the current strength flowing through the leads lying between the lamp (C) and the dynamo, and those lying between the lamps (D) and (C).

In the same way, if the switch of the lamp (B) is closed, an additional half ampere of current must be provided by the source so that there now flows between the portions of the main connecting (B) and the dynamo, a current of one and a half amperes, between (B) and (C), a current of one ampere, and between (D) and (C) a current of half an ampere.

In the same way if the switch of the lamp (A) is closed, an additional half an ampere of current must be produced by the source, so that the different portions of the leads between the lamps (A), (B), (C) and (D), respectively, and the dynamo, must have, respectively, current strength of two amperes, one and a half amperes, one ampere and a half ampere as shown.

As will be seen the multiple circuit differs from the series circuit in that, instead of all the electricity flowing through one and the same path, the current divides through a number of more or less parallel paths.

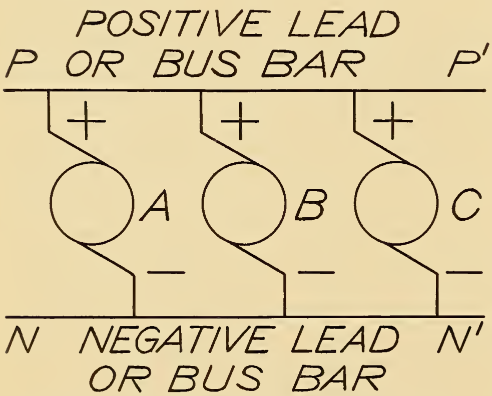


FIG. 16. DYNAMOS CONNECTED IN MULTIPLE OR PARALLEL.

Perhaps this peculiarity can be better understood by taking the analogous case of steam or hot water flowing through the hot water or steam radiators employed in systems of artificial heating. The separate radiators may be regarded as receptive devices connected in series with the source of heat so that the steam or hot water is obliged to pass successively through all the radiators placed in the circuit. Or the radiator may consist of a number of pipes that are connected in multiple as represented in Fig. 15, where the steam passing through the pipe (P P'), which may be regarded as representing the positive lead or main, divides simultaneously through the radiators (1), (2), (3) and (4), which discharge the steam in equal parallel streams into the pipe (N N'), which may be regarded as representing the negative lead.

It will be understood, that where a great number of electro-receptive devices are connected to a circuit in multiple or parallel, the amount of current the source is called on to supply will be great. In such cases it will be necessary to connect a number of separate sources in multiple or parallel, so as to permit them to act as a single battery or source. A battery of this kind is known as a multiple-connected battery, in order to distinguish it from a series-connected battery.

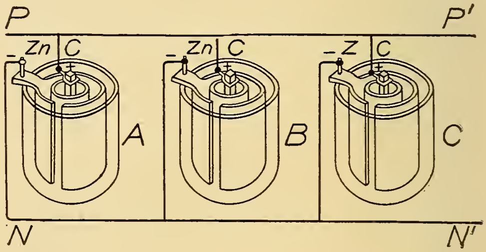


FIG. 17. GROVE CELLS CONNECTED IN MULTIPLE OR PARALLEL.

The connection of three separate dynamos in multiple to leads or conductors (P P') and (N N') is represented in Fig. 16. Here, as will be seen, all the positive poles or brushes of the three dynamos (A), (B) and (D), are separately connected to the positive lead (P P'), and all the negative brushes are similarly connected to the negative lead (N N'). In this case, supposing the dynamos of the same size, each of the leads will have three times as great a current poured into it as it would if connected to a single machine only. The leads required for this purpose must be large and heavy in order to carry the large current. Such leads are generally known as bus bars, a contraction for omnibus, the Latin word for "all," because they receive all the current of the dynamos that are connected to them.

Other electric sources besides dynamos can be connected in multiple or parallel. For example, in Fig. 17, three Grove voltaic cells are represented as connected in parallel with the positive and negative leads or mains (P P′) and (N N′). Here, as before, all the positive terminals of the separate cells are connected to the positive lead and the negative terminals to the negative lead.

In the Grove voltaic cell, the voltaic elements consist of zinc and carbon, that are immersed in sulphuric and nitric acids, respectively. The zinc forms the positive pole or terminal of the cell, and the carbon, the negative pole or terminal. It is only necessary, therefore, to connect all the carbon or positive poles to the positive conductor (P P′) and all the zinc or negative poles or terminals, to the negative conductor (N N′). Then the conductors (P P′) and (N N′) form the free positive and negative conductors of the multiple-connected battery. As in the case of the multiple-connected battery of dynamos, the electromotive force of the battery of the three multiple-connected cells will be no greater than the E. M. F. of any of the separate cells. The amount of current, however, supplied by the battery to the leads, will be three times as great as that which any of the separate cells is capable of supplying.

(To be continued.)

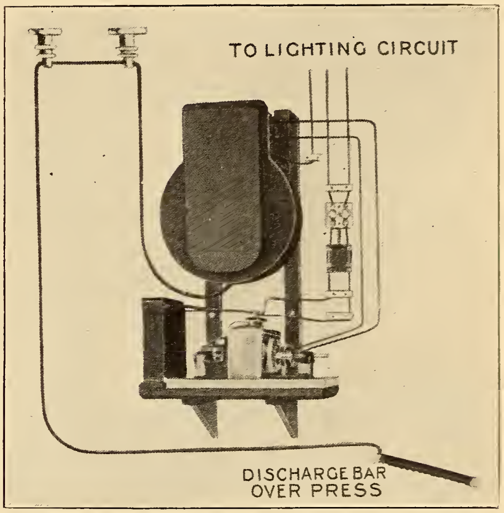
ELECTRIC DENTAL APPLIANCES.

The modern dentist often does all his work by electricity, from the lighting and heating of his offices to the making of plates and sets of teeth. He has, moreover, his own switchboard, by means of which he can turn the current on or off this or that particular instrument or process. He heats his water in a small glass tumbler by electricity, he sterilizes his instruments, heats his furnace, does his annealing, all by the same agency. The following is a list of instruments and conveniences used by the dentist and operated by electricity: Engine lathe, drill, sterilizer, annealer, magnifying lamp, furnace, water heater, pyrometer, atomizer, gold annealer, hot air syringe, mouth lamp, root canal drier, bleacher point, spatula, antrum lamp, reducer, etc.

ELECTRIC NEUTRALIZER FOR PRINTING PRESSES.

A serious trouble often encountered in the operation of printing presses is the sticking of the paper to the cylinder or fly-sticks, due to static electricity accumulating on the sheet. The phenomenon is similar to that noted when a comb is drawn through the hair and made to pick up small scraps of paper. This trouble becomes serious under certain atmospheric conditions and makes the work of the pressman slow and tedious.

A very simple device, known as the Chapman neutralizer, is now extensively



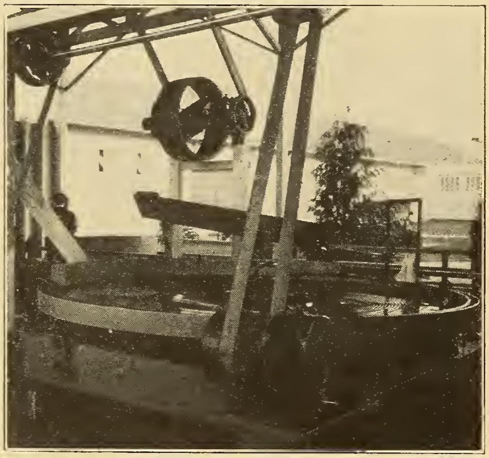
used to overcome this difficulty. It literally fights electricity with electricity. It works on the principle that any static charge, such, for instance, as that produced on the paper, will select from a neighboring discharge of alternating current, electricity of the right kind and amount to exactly neutralize itself. The Chapman neutralizer, therefore, is simply a form of transformer which takes the ordinary lighting current and transforms it to alternating current at about 8,000 volts pressure. This current is carried to a bar on the press, placed horizontally over the paper and very close to it. The bar is provided with small metal teeth, and from these teeth an electrical discharge takes place over the surface of the paper, neutralizing the static electricity which has been generated there.

EXTRACTING GOLD FROM SAND.

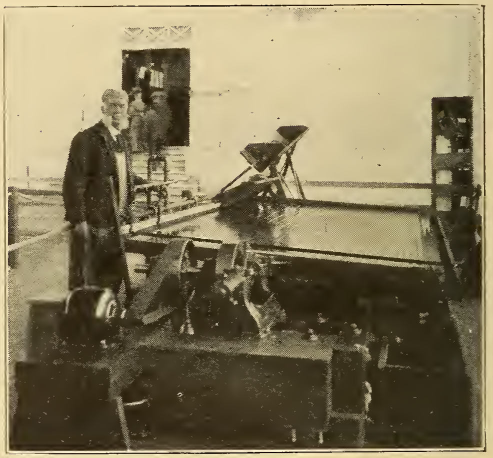
One of the most interesting lines of experimental work undertaken during recent years by the United States Government is that having for its object the extraction of gold and other valuable minerals from sand, heretofore regarded as valueless. Electrically operated plants designed to point the way to a utilization of this new source of wealth have been in operation at Portland, Ore., where the so-called black sands of the Pacific coast have been experimented with, and in North Carolina, where similar deposits on the Atlantic coast have been subjected to treatment.

The sand from which it is desired to extract the gold, platinum and other precious mineral particles is, upon arrival at the concentrating plant, placed in challenge feeders. From these it is elevated by a belt elevator and delivered to a screen after which it passes to a vertical revolving mixing distributor, from which it is piped to the different concentrators.

The concentrators, each of which is operated by motors of from one-half to two horsepower, constitute the most interesting features of the machinery equipment. Various forms of concentrators have been introduced in this new field, but all possess in common the main essential feature of a shaking table fitted with corrugations or grooves perhaps an eighth of an inch deep. The sand passes over this quivering table under the influence of a steady flow of water. The mineral particles settle in the grooves and owing to the shaking motion travel along the grooves to a prepared receptacle at the point of discharge, while the lighter waste material is washed off the table by the continuous flood of water. After the pulp is dried it is passed through a magnetic separator where the magnetic elements are extracted. A drying furnace is also provided for drying the concentrates as they come from the various concentrators. This new plan for harvesting the earth's riches will, if it proves as successful as is now expected, enable the profitable manipulation of many mineral deposits in all parts of the country which could not heretofore be made to yield a profit by dredging or any other process.



REVOLVING GOLD EXTRACTOR.



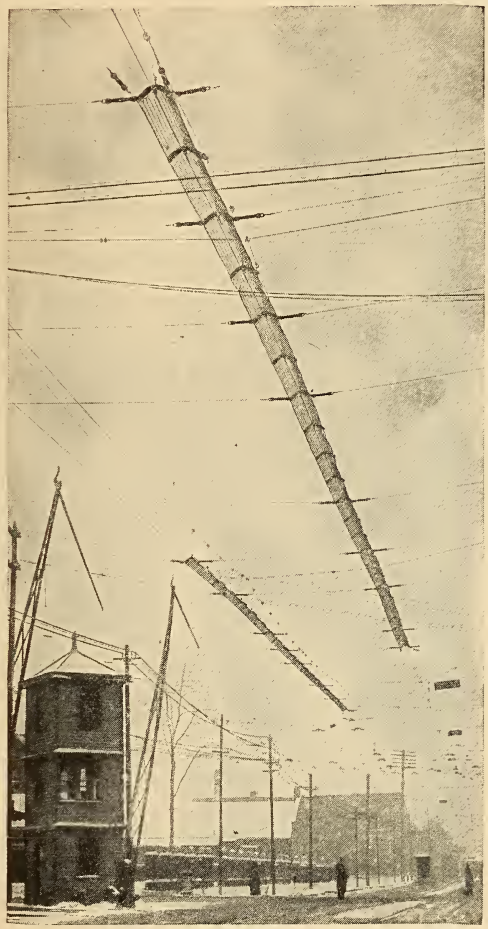
ELECTRICALLY OPERATED GOLD EXTRACTOR.

LARGE DAM CONTEMPLATED.

The highest dam anywhere in the western country will be erected across the Missouri river a few miles from Wolf Creek, Montana, on the site of the power plant of the Capitol City Power Company. M. H. Gerry, Jr., is general manager. The dam will be 117 feet high, built of concrete and steel, and will back the water up a distance of 18 miles. The plant making use of the power from this dam will generate 30,000 horsepower of electricity.

TROLLEY GUARD FOR RAILROAD CROSSINGS.

It is not pleasant to think what the consequence would be if a trolley car were to become stalled on a railroad crossing. Yet such accidents have been known to happen. In going over the rough crossings the trolley wheel is apt



TROLLEY GUARD FOR RAILROAD CROSSINGS.

to be jolted from the wire and the car left on the steam tracks "dead," unless a guard of some kind is provided to keep the trolley wheel in contact with the source of current.

Various types of trolley guards have been devised, a new one, possessing many advantages being the National railroad trolley guard. This guard consists of a wire mesh trough which is hung in an inverted position over the trolley wire and fastened with suitably insulated guys. The trough is made of galvanized iron, aluminum or copper wire. The whole trough is in electrical connection with the trolley and is therefore charged with electricity. Should the trolley wheel accidentally leave the wire it will follow along the under side of the trough and keep the motors supplied with current until the car is safely over the track.

The trough being made of wire mesh prevents the accumulation of snow and also offers no resistance to the upward rush of the locomotive exhaust as in the case of a trough of solid construction.

A CITY ELECTRICAL.

Every school boy knows that Chicago is not yet a hundred years old, in name even, and has an actual corporate existence as a city of barely 70 years. Not everyone, however, realizes Chicago's still more wonderful development in certain particular lines. The electric light has only been before the public as a public utility for some 30 years, yet Chicago bids fair before very long to be the greatest electrical center of all the world. A few figures tell in part the story.

Last year over 323,000,000 kilowatt hours of electric current were supplied the Chicago public. Compare this with London with its population of 6,000,-000. Last year according to the government report the so-called "World's Metropolis" was supplied with but 213,000,000 kilowatt hours. The electric light was first introduced over there at the same time that it was in Chicago, and it would seem that the advantage would be all with the older city. But Chicago moves swiftly and London somewhat ponderously.

In a year or two Chicago will have the low rate of seven cents per unit or kilowatt hour, which it is said will be the cheapest rate in the world, showing a profit to the producers of the electricity as well. There may be apparently cheaper rates given by certain municipal plants, but consumers eventually pay more than the difference in taxes. And Chicago is developing in every way electrically—new electric lines year by year and new electric amusement parks. It is in popular demand this wonderful electricity.

NATURE OF A LIGHTNING DISCHARGE.

With the best appliances ever constructed by man an electric spark or discharge can only be made to jump through the air a distance of five to ten feet; and this with apparatus that will develop hundreds of thousands of volts. What then must be the enormous electrical pressure or voltage that will cause a lightning flash to leap from cloud to cloud or cloud to earth? No one knows. But it is certainly up in the millions of volts —too great for the mind to conceive.

The views shown herewith, the two lower ones secured through the courtesy

of the General Electric Company, are from excellent photographs of actual lightning discharges. It is interesting to study the peculiar forms of these discharges. They seem to follow no definite law. Some follow a comparatively straight path; others branch out into fantastic forms.

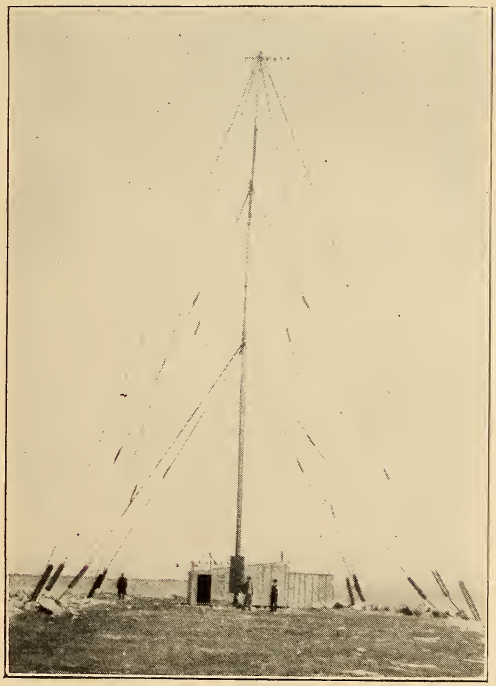
Atmospheric electricity is known to be a form of static electricity. Static electricity is the kind which is generated by friction. Most people have tried the experiment of rubbing their feet rapidly over a carpet and then holding the finger near a gas jet. The spark which jumps from the finger and passes to earth through the gas pipe is a static discharge similar to lightning. It is believed that the clouds, as they move swiftly through the air, become charged with this frictional or static electricity to such an extent that the enormous resistance of the air is broken down and the lightning flash as it leaps from the cloud to the earth is the readjustment of the unbalanced electrical forces.

ELECTRICITY ON THE FARM.

The Department of Agriculture has sent an expert to South Dakota to aid a co-operative association formed to construct an electrical generating plant for the purpose of furnishing light, heat and power for the farmers for miles around. The farmers are very enthusiastic over the proposition and the department experts, while more cautious in their statements, predict that the success of the proposed venture will ultimately work a revolution in farm life.

THE ALDEN WIRELESS TELEPHONE.

Now that the wireless telegraph has become a commercial success inventors are turning their attention to wireless telephony, and already systems have been constructed with varying degrees of success. Among the wireless telephone inventors is Mr. Charles E. Alden of Cottage City, Mass., a suburb of Boston. Mr. Alden, by the way, is a direct descendant of the famous John Alden of Puritan days.



AERIAL FOR ALDEN WIRELESS TELEPHONE.

The Alden system of wireless telephony is said to be based upon a principle closely allied to that of the Marconi wireless telegraph, although the details of the construction have not as yet been given out. Like the wireless telegraph, the apparatus requires aerial wires. One of the pictures shows an aerial of Mr. Alden's experimental system and the other shows the inventor with his apparatus. Conversations are said to be carried on perfectly over distances up to two miles.

MR. ALDEN AND HIS WIRELESS TELEPHONE.

ELECTRICITY TO CURE DRUNKENNESS

In an address delivered recently before the Frances E. Willard union of the W. C. T. U. in New York, Andrew McConnel of Washington, D. C., explained that through an appreciation of the possibilities of human electricity, bodily ills may be reached by a proper understanding and direction of vital force. In his view the organs of the body generate an electric current, which may be stored and used as a stimulant to renew strength and vitality. In the case of the drunkard, Mr. McConnell explained that the efficiency of the body had fallen below par and this artificial means had been employed to revivify. The desire for drink could be obviated by proper training in the value of carefully stored human electricity.

ELECTRICAL ILLUMINATION OF NIAGARA FALLS

It has been said that man's audacity established a new record when the attempt was made to improve upon nature by increasing the beauties of Niagara Falls. However that may be, it is a fact that during dark nights the splendors of Niagara are hidden from sight, and that by the aid of electric searchlights this has been overcome, and beautiful effects obtained which rival the daylight scene.

Plans and specifications were submitted some months ago for a permanent equipment of searchlights for illuminating the falls at night. The cost of an installation as contemplated would, however, be too great to assume without knowing beforehand what the effect would be. So a temporary equipment was put in last September for trial, with which the beautiful effects shown in the accompanying illustrations were secured. These views were obtained through the courtesy of the General Electric Review.

ILLUMINATION OF THE FALLS FROM THE CANADIAN SIDE.

ELECTRIC AURORA DIVERGED.

Three batteries of electric searchlights were placed at advantageous points.

Battery No. 1 comprised 11 30-inch and 10 18-inch projectors installed on a platform 250 feet long, located in the Gorge at a point midway between the American and Horseshoe Falls, 20 feet above the water's edge, and approximately 1,200 feet from the center of Goat Island.

Battery No. 2 consisted of four 30-inch projectors placed on what is known as the "spillway" of the Ontario Power Company, approximately 3,500 feet from the American Falls.

Battery No. 3 was made up of 11 18-inch projectors located in Victoria Park about 1,500 feet from the center of the American Falls.

So satisfactory was the temporary equipment that a permanent equipment

BATTERY OF SEARCHLIGHTS.

aggregating 2,000,000 candlepower will be installed.

Mr. W. D'A. Ryan, the illuminating engineer who planned the installation, is of the opinion that the most beautiful effects were obtained by the use of white light. On this point, however, there appeared to be considerable difference of opinion. There is no question that the introduction of soft clear colors through suitable screens did not detract from the beauty of the falls, but lent a pleasing variety of effects, which appeared to be greatly admired and appreciated by the thousands of people who thronged the parks on both sides of the river every evening. An additional variation was introduced by noiselessly exploding loose

A BEAUTY SPOT ILLUMINATED.

giant powder in front of the main battery of searchlights. This formed a blanket of pure white smoke, appearing as a cloud into which the colors were introduced. The sunset effects thereby produced in the water were beautiful beyond description.

EXTRAORDINARY GROWTH OF ELECTRIC RAILWAYS.

Secretary B. V. Swenson of the American Street and Interurban Railway Association gives some interesting figures in a pamphlet recently issued in the interests of the association. In the year 1907, approximately 1,200 street and interurban railway companies, operating in the United States, carried nearly 8,000,000,000 passengers. These companies operate, in round numbers, an aggregate of 90,000 cars over an aggregate of 40,000 miles of track. The total capital invested in these electric railways amounts to approximately $4,000,000,000.

WIRELESS TELEGRAPHY MADE SIMPLE.

BY V. H. LAUGHTER.

PART II.

WIRELESS TELEGRAPH TRANSMITTERS.

THE simplest means for sending out the signals in wireless telegraphy is the plan originally used by Marconi, described in Part I. The sending end as explained consists of a spark coil with the secondary terminals leading to the spark balls, or oscillators, which in

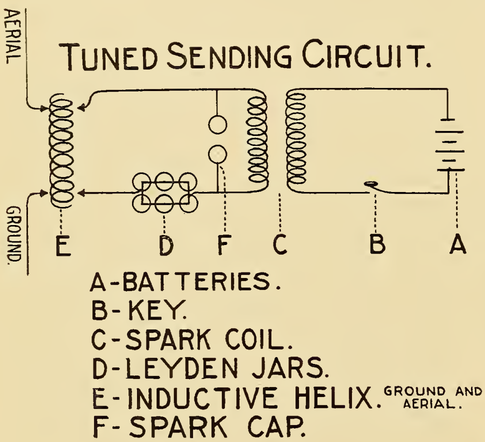


FIG. 6.

turn lead to the earthed terminal and aerial wire. When the high frequency current breaks down the resistance of the air gap separating the spark balls, the wave motion is set up which produces a like wave motion in the ether and is picked up by a suitable receiving end. Such a means for transmitting is excellent for experimental work, yet when the distance becomes greater and the conditions require a set that will work without outside influences, a more complicated tranmitter is required.

The main objection to the open circuit system described in Part I is that the emitted wave is of short duration, that is, the damping effect of the open circuit is very great and the maximum power of the coil cannot be secured, as a certain amount of the energy may be lost in charging an aerial not in unison or "tune" with the coil supplying the energy.

In commercial wireless work, and for long distance experimenting, means are provided whereby the sending and receiving ends are placed in tune with one another. This may not be clear to all and can best be explained by the action of the tuning fork. When a tuning fork is set in vibration and brought near a second tuning fork of the same size, the second one will take up the vibration as well. If the sizes be different, however, the vibration will not be taken up by the latter, due to the difference in the period and frequency of the wave, which affects the receiving fork best when the two are of the same size.

The above conditions are supposed to be present in the operation of a wireless

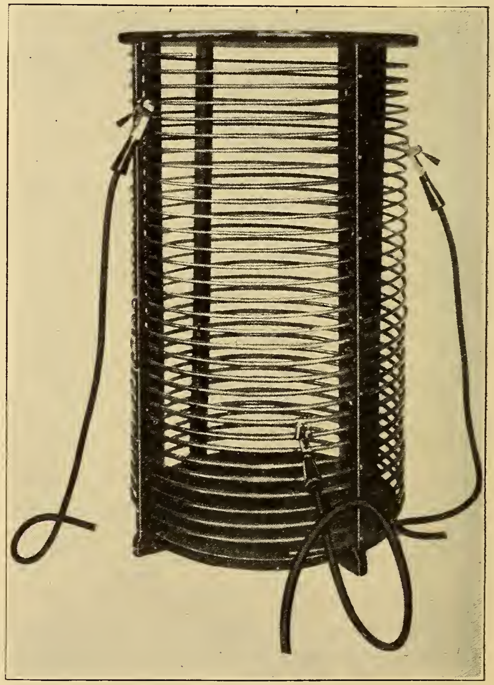


FIG. 7. TUNING COIL.

set. When two closed-circuit sets are tuned with one another a wave of a certain vibration is set up at the sending end, which produces the maximum results at the receiving end when both are tuned to the same wave length.

The tuning of the sending end is accomplished by bridging a number of Leyden jars in series with an inductive wound resistance coil around the spark gap as shown in Fig. 6.

It may be well at this point to explain the operation of a Leyden jar and also

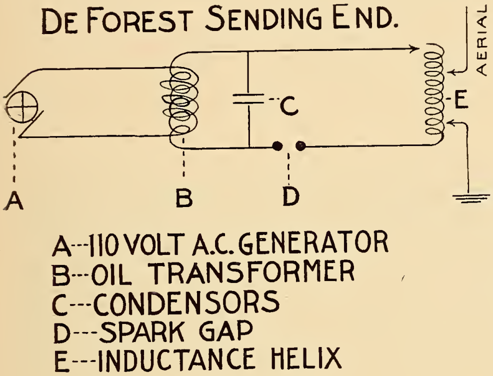


FIG. 8.

what is meant by an inductive resistance. A Leyden jar consists of a glass jar having a coating of tin foil on the inside and another on the outside, each coating extending only part way up the side of the jar. If the outside coating of tin foil be discharged. In the wireless set the high frequency current charges the Leyden jars, which discharge across the spark gap with a crash, sending out a wave of much longer duration than the open circuit set described in Part I. This charging and discharging of the Leyden jars occurs at every swing of the vibrator, resulting in a hot, fat spark that is especially desirable for wireless work. The Leyden jars used should be four of the one quart size, so connected that different numbers could be thrown in the circuit, as the capacity will vary with the different sets.

An inductive resistance is simply a coil of wire wound in the form of a spiral. Direct current will pass through this wire spiral impeded only by the natural resistance of the wire, which is comparatively small. When alternating current is passed through such a coil, however, the rapid alternations of the current set up little waves of magnetism around the wire, which oppose the flow of current and exert a dampening effect, which, added to the natural resistance, makes it very hard for alternating current to pass through the coil or helix.

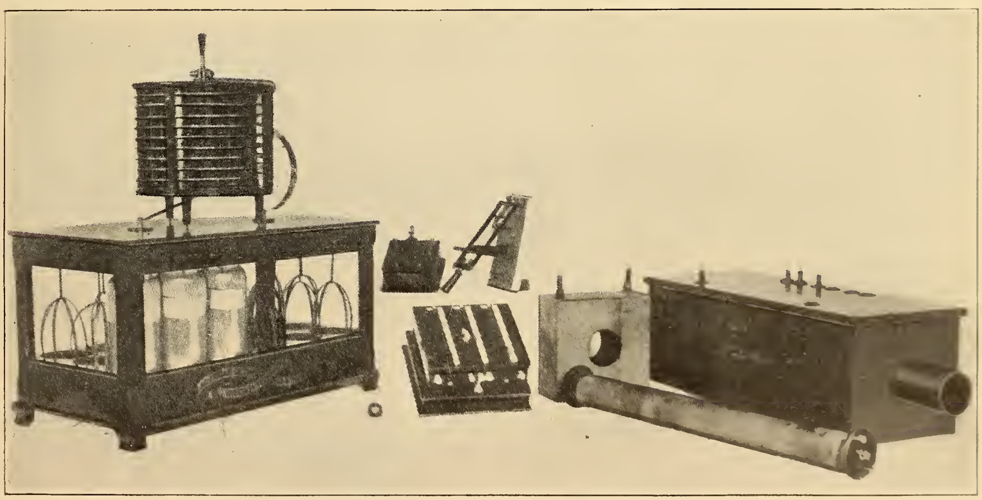


FIG. 9. DE FOREST SENDING SYSTEM.

connected with one terminal of a source of electricity and the inside coating connected to the other terminal, the jar will absorb a certain charge, which it holds stored up until the two coatings of tin foil are electrically connected, when the jar is

The arrangement of the Leyden jars (D) and the inductive coil or helix (E) is shown in Fig. 6, and constitutes the tuning apparatus of a sending station. The tuning coil or helix is composed of 10 turns of copper wire wound on a hard rubber frame 10 inches high and eight inches in diameter as shown in Fig. 7. The lead from the spark gap (see Fig. 6) to the tuning coil is made of flexible

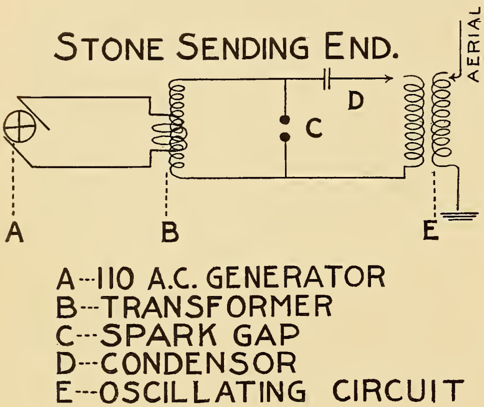


FIG. 10.

conducting cord with clamp connection soldered to the end so that the inductance of the circuit may be varied instantly by coupling on to the different windings at any point, as shown in Fig. 7. The wire used in winding the tuning coil

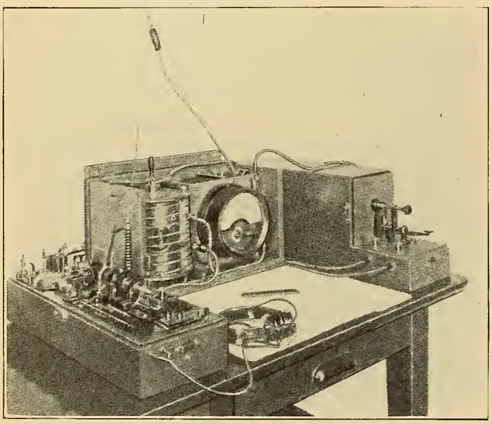


FIG. 11. MASSIE SYSTEM COMPLETE.

should be of the same size as used in the aerial wire. The method of tuning the sending and receiving end will be taken up in a later chapter.

The DeForest system, as well those of the principal other companies, has replaced the spark coil with an oil transformer which is energized from an alternating current generator, the Leyden jars being connected directly across the spark gap as in the circuit just described. The oil transformer consists of the primary of a few turns of heavy wire inside of which is placed a greater number of turns of smaller wire comprising the secondary and immersed in oil. The arrangement is shown in Fig. 8.

The DeForest sending system complete is shown in Fig. 9.

There are quite a number of systems in use, all of which have their special features and points of advantage. Under

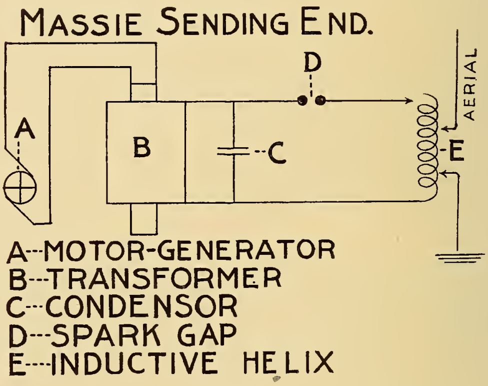


FIG. 12.

this heading may come the Stone, Massie, Fessenden, DeForest and several others of importance. The Slaby-Arco system, which is of German manufacture, is also employed in the U. S. Navy as well as the others mentioned above.

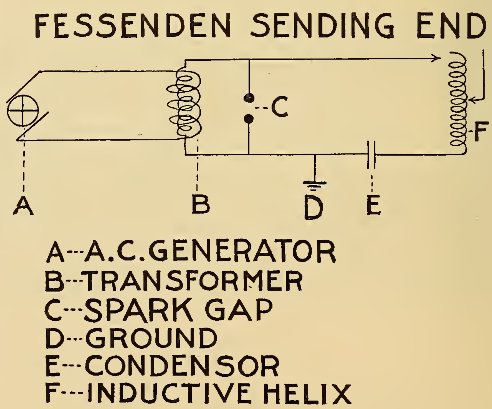


FIG. 13.

Inventors of the Stone system have devoted quite a lot of attention to the perfection of non-interference systems and have done creditable work along this line. The diagram of the Stone sending end is shown in Fig. 10 and differs from the plan of the tuned set in Fig. 6 by using what is known as the inductively connected circuit, which is provided with a second transformer set, with secondary leading to the aerial. At the sending end of the Massie sets the current is usually supplied by means of a motor-generator to the transformer, which in turn charges the aerial wire. In Fig. 11 is shown the complete set. To the right is the transformer, in the center the hot wire ammeter which is used in measuring the wave length, next come the inductance helix, spark gap and condensor. The condensors used in place of Leyden jars are of the glass plate kind, consisting of thin glass plates covered with tin foil having a very low capacity. To the extreme left is shown the complete receiving set. Fig. 12 is a diagram of the connections of the Massie sending end.

To Prof. Fessenden is given credit for being inventor of the electrolytic detector, which is one of the most sensitive receiving devices known for use in wireless telegraphy. He has done other noteworthy work as well, but particularly with receiving ends. The operation and construction of the detector will be taken up in a later issue. The plan of the Fessenden sending end is shown in Fig. 13 and consists of the transformer (B), which charges the oscillating circuit, the spark gap (C), condensor (E), inductance helix and aerial (F), and ground (D).

As will be noted the ground, instead of being connected onto the lower part of the inductance coil, as in usual cases, is placed behind the condensor (C). In Fig. 14 is shown the disposition and arrangement of the various parts of the apparatus.

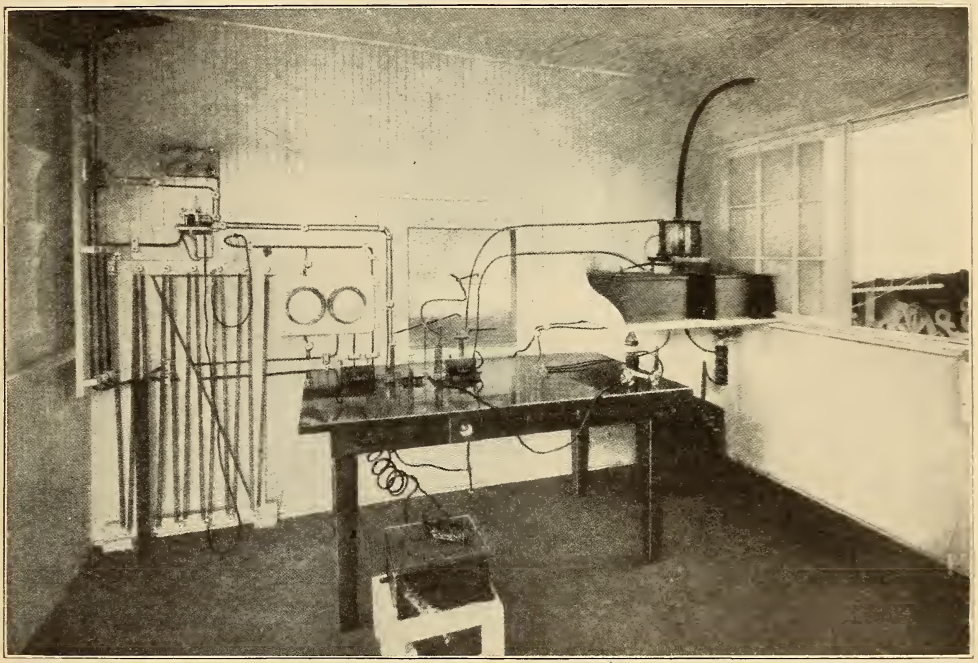


FIG. 14. FESSENDEN WIRELESS SYSTEM.

The Slaby-Arco system is nearly similar to the Fessenden, the difference lying in the placing of the condensor and ground. The inventors claim some special theoretical points for this system which need not be taken up here. In operation the Slaby-Arco system is the same as the others given, and need not be repeated.

(To be continued.)

ELECTRIC "TUBES" OF LIGHT.

Daylight is hard to imitate by any form of artificial lighting. But the new Moore light furnishes a very close approximation. Tubes of light are so much different from points of light, characteristic of all other forms of illumination, with the exception of the mercury vapor lamp, that considerable wonder is excited when they are seen for the first time.

The Moore light consists of a clear glass tube about two inches in diameter, and long enough to extend all the way around a room or over the area to be lighted. This tube is filled with carbonic acid gas. On connecting a suitable electric current to the two ends of this tube, artificial daylight results, because the light seems to come from everywhere. All objects under the tubes, no matter how delicate their peculiar shades of color may be, appear exactly as they do under natural light. When nitrogen gas is substituted for carbonic acid gas the color changes from a pure white to a golden sunset hue.

FIG. 1. STORE LIGHTED WITH MOORE TUBES.

Fig. 1 shows the interior of the ribbon department of a store lighted by the white Moore light. Colors are matched under this light at night and on dark days with the same accuracy as in daylight.

Fig. 2 will give a careful investigator an idea of how the system operates. First will be noted the transformer, which produces the special form of electricity that is essential. This is the large device in the center of the frame. Second, the feed valve will be seen to the right. This is necessary to feed the gas to the tube, since the electricity by slow degrees eats up the gas through which it has to flow in order to produce the light, and it is necessary to provide means to replenish this small quantity of gas. The tube breathes in a fresh quantity of gas in a manner almost identical to that in which a mud turtle takes a breath of air. When air alone is fed to a Moore tube it becomes an electric "air" light.

There are many other interesting features in connection with this light. For example, all of the electrical apparatus is contained in the terminal box, as shown in Fig. 2, which is closed and fastened with a lead seal. The tube cannot, therefore, set fire to anything, because it is always cool, that is, about the temperature of the hand, and as no shock is felt

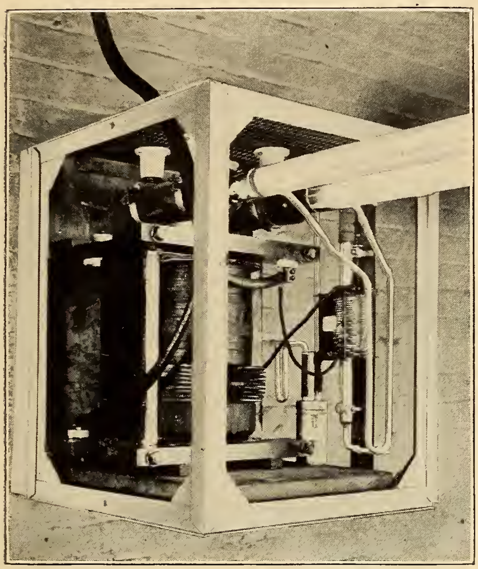


FIG. 2. TERMINAL BOX FOR MOORE TUBES.

in touching the tube it is a very safe method of lighting.

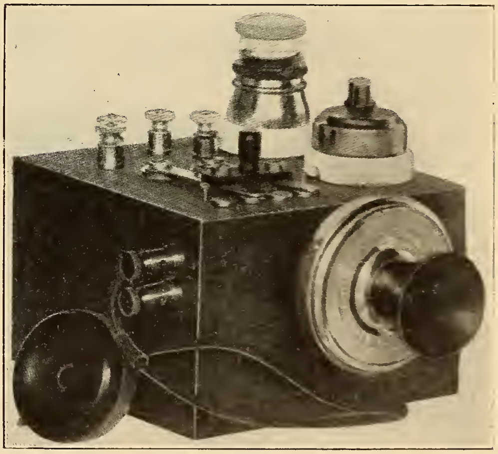
Electricity applied to a tube filled with gas at ordinary atmospheric pressure can be made to give no light, but if the gas within the tube is only about one-millionth as dense as ordinary air then the electricity will flow with comparative ease and incidentally produce this remarkable light. Therefore, a vacuum pump is required in the construction of one of these tubes, which rarifies the gas so that it will become a good conductor.

Of course it is not practical to transport a lamp 200 feet or more in length. The tubes are, therefore, sent out in sections about eight feet long, and at the present time these sections are joined together on the premises where the light is desired, by fusing or melting together the ends of two tubes. In this way a tube of any length is put together. It might be said, therefore, that a new trade has been born—glass plumbing.

JOERIN SINGING ARC LAMP.

One of the strangest, and to the novice the most mysterious applications of electricity is the singing arc. Imagine an arc lamp that sings, talks and whistles. Yet an ordinary arc lamp may be made to do these things. To those familiar with electricity the process is simple. A telephone transmitter is connected with the arc lamp and the vibrations of the voice when speaking into the transmitter are made to vary the resistance of the arc lamp circuit, and as a consequence vibrations are set up in the flame of the arc. These vibrations or flickerings are wonderfully rapid and set up corresponding sound vibrations in the air, which are in accord with the voice vibrations sent into the transmitter. In this manner the arc is made to sing and talk.

Many noted scientists have experimented with the singing arc but no extensive application was made, however, until recently, when Mr. Arthur E. Joerin of Chicago developed a simple equipment for using the singing arc as a



device for entertainments. A picture of the Joerin apparatus is shown herewith.

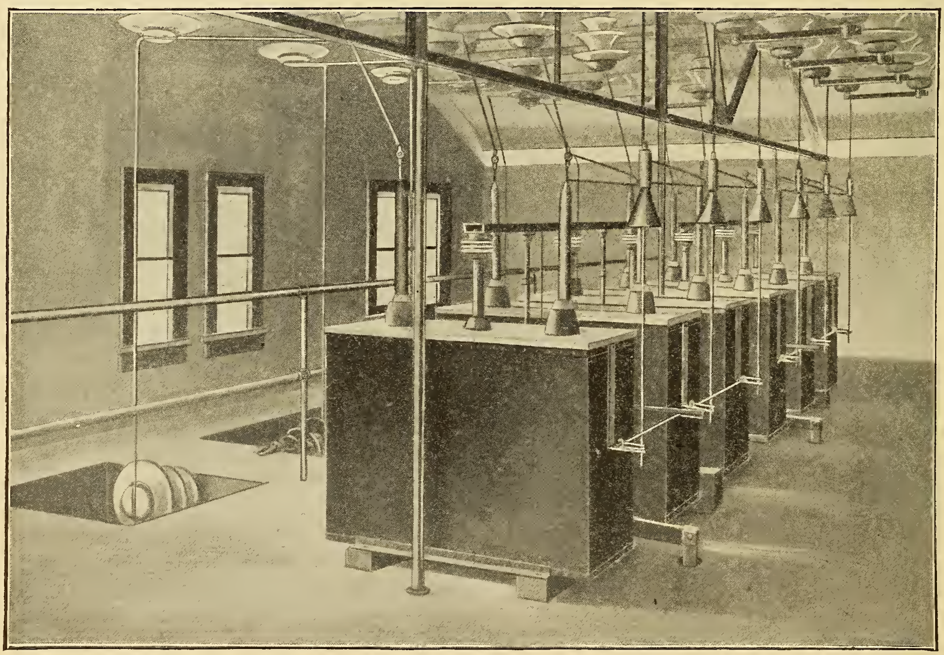
By inserting this outfit in the inducing circuit of a medium sized dynamo, which feeds a number of arc lamps, say in an amusement park, it will be found that all the arc lamps will whistle, sing, reproduce dances and military marches surprisingly loud, providing the arrangement be properly carried out. We thus have before us the interesting possibility of future evening strolls through the park, enlivened by strains of music emanating from the singing arcs.

HANDLING 75,000 VOLT CURRENT.

The Edison Electric Company of Los Angeles, Cal., stands in the front rank in this country in the development of electrical energy for power and lighting purposes, its total output being nearly 60,000 horsepower. The company generates power by both steam and water power plants located in different sections of southern California, but all are connected by transmission lines with the main distributing station at Los Angeles, which makes the total amount of power generated available in that city at any time, if required.

One of the most interesting plants in the entire system is the water power station located on the Kern River, about 125 miles from Los Angeles, in the Sierra Madre Mountains. Here power is generated by water from the melting snows in the high mountains and transmitted to Los Angeles and other cities where it is used for lighting and power purposes and for running trolley cars. This power is transmitted at the tremendous pressure of 75,000 volts, over six heavy copper cables carried on immense insulators which are placed on steel towers instead of the old style wood poles.

One of the greatest difficulties in the transmission of power at this pressure is the turning on or off of the power at the various stations along the line and providing an apparatus for automatically cutting it off in case of trouble. In these stations power is taken from the main transmission line through transformers which reduce the pressure from 75,000 volts down to 500 volts for trolley cars or 110 volts for lighting purposes. Circuit breakers, which are simply automatic switches, are used in these stations for turning the power on or off, the automatic feature being designed to instantly cut off the power in case of trouble, which if left on for a few seconds only might cause thousands of dollars' worth of damage in burning out expensive transformers or other apparatus.



75,000 VOLT OIL SWITCHES.

The great necessity for a circuit breaking device for such high voltages resulted in the development of Kelman's automatic oil circuit breakers, which are now installed in all stations on the Edison Electric Company's lines, and which are doing the work required of them in an entirely satisfactory manner.

The switch blades which open or close the circuit, thus turning off or on the power, are placed in large iron tanks, as shown in the picture, which are filled with oil, it being necessary to use the oil in order to prevent the destructive "arc" which would result if the circuit was opened in the air. This arc or flash would be of the same nature as that which is often noticed at the trolley wheel of a car, as it spins along on the trolley wire, but whereas in the case of the car it means only a harmless flashing, in the case of turning off a large amount of power at 75,000 volts, this arc or flash might be anywhere from 10 to 20 or 30 feet long or even more. Such a flash would be intensely hot and would be very apt to result in a destructive fire.

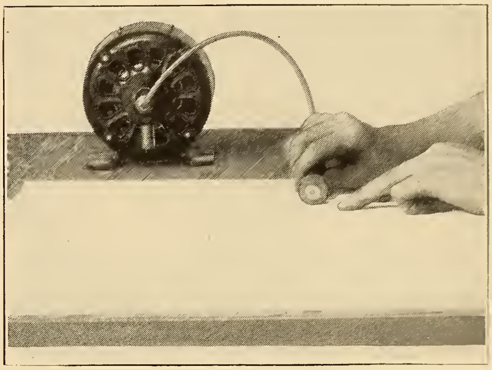
It may seem strange that oil, being of an inflammable nature, is used in the tanks instead of water. But water is a conductor of electricity and the fluid used to "drown out" the arc must be a non-conductor. Oil is a non-conductor. The mechanical arrangement of the blades, combined with the great weight of oil, is such as to practically prevent the formation of an arc, or in other words, the arc is actually "drowned out" before it is formed, on the theory that prevention is better than cure.

QUEBEC'S ELECTRIC ILLUMINATIONS.

Quebec, oldest city of Canada, is to have a great celebration in August. The three-hundredth anniversay of the town is to be commemorated by fetes and illuminations. American, British and French warships to the number of 24 or more will be there to help, and they will be illuminated by electricity each night. Special electrical illuminations are being arranged for the heights of the citadel and the upper town, including the famous Frontenac hotel, and they are expected to surpass any of the kind ever before seen. It is expected that the Prince of Wales will be there from England and will lay the foundation stone of a great "Peace statue" to be erected on the Plains of Abraham, marking the final union of French and English Canadians.

MOTOR DRIVEN ERASER FOR DRAUGHTSMEN.

A new application of the electric motor is for the operation of an eraser. The device is adapted for use in draughting rooms and is superior to the hand eraser as it is said to make absolutely clean



erasures, owing to the high speed at which the eraser wheel revolves.

The eraser wheel is driven with a flexible shaft by a small Westinghouse induction motor, which is easily moved from table to table in the draughting room. The motor is provided with a flexible cord and plug for attachment to the incandescent lamp socket which is usually provided at each draughtsman's table.

THE KILOWATT MADE EASY.

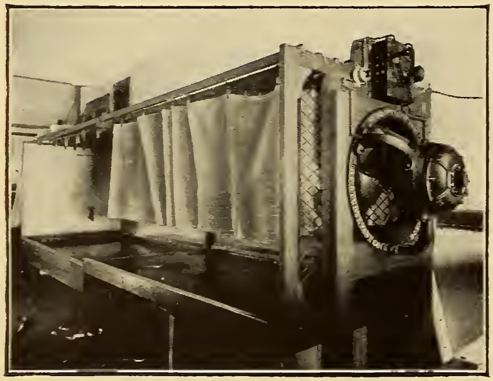
When the Commonwealth Edison Company's rate ordinance was before the city council of Chicago a short time ago, one of the city fathers in opposing a motion to postpone the passage of the ordinance remarked that "it didn't matter if the aldermen waited a year they wouldn't know the difference between a kilowatt and a mutton chop even at the end of that time." For their benefit and that of the public at large here is the kilowatt made easy.

Measurement of electrical power is expressed in watts, the same as mechanical power is measured in horsepower. The watt is, therefore, the rate at which work is done by electric current. 746

watts represent one horsepower. This unit is too small, however, to measure large quantities of current; it runs up into too many figures. So another unit is used for commercial purposes—the kilowatt. This equals 1,000 watts. The kilowatt, however, only measures the *rate* of work. To express the actual amount of work done the time element must come in, that is, we must know how long the current is flowing. A current of one kilowatt flowing for one hour will do a certain amount of work. If it flows for two hours it will do twice as much work, and so on. An arbitrary unit of work has been chosen, therefore, for commercial purposes. It is the kilowatt hour. This represents the work of 1,000 watts, or one kilowatt, flowing for one hour. It is a little more than a horsepower hour. Electric light and power companies, consequently, charge a given sum for a kilowatt hour.

ELECTRIC FAN DRIES BLUE PRINTS.

A quick way to dry blue prints or photographic prints is by the use of an electrically operated propeller fan as shown in the picture herewith. The fan is mounted in one end of a long frame, in which the blue prints are hung up

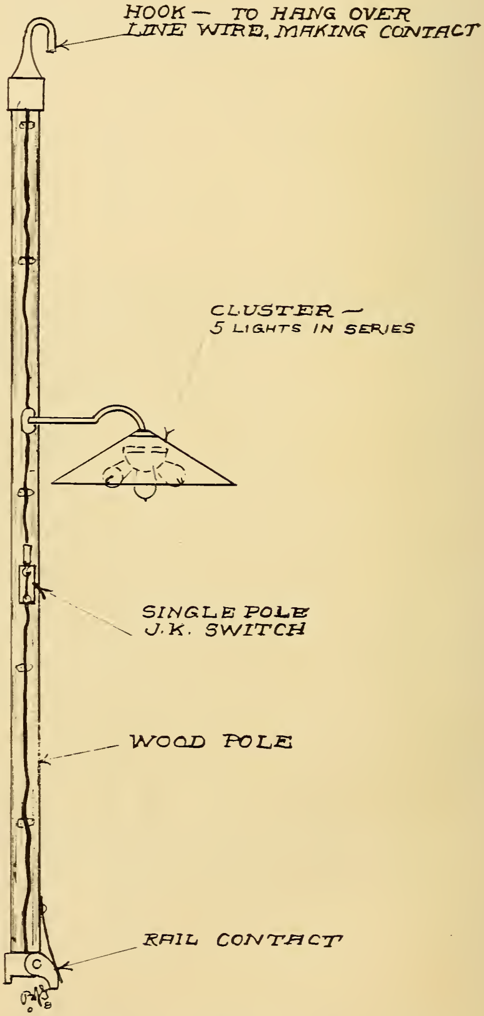


FAN FOR DRYING BLUE PRINTS.

ready to dry. It would ordinarily require several hours for the prints to dry out by themselves, but with the aid of the Sturtevant propeller fan the air may be circulated around the prints so rapidly that they will be dried in a small fraction of that time. As shown in the picture the fan is mounted in a circular opening in the end of the frame. The motor is attached directly to the shaft of the fan.

EMERGENCY STREET RAILWAY LIGHT.

The illustration clearly describes a unique emergency lighting apparatus used by a repairing crew with a large street railway company where a strong



EMERGENCY STREET RAILWAY LIGHT.

light was sometimes wanted along the track after dark.

The construction is very simple. A wooden pole with a length equal to the average height of the trolley wire is provided at the top with an iron hook and at the bottom with a shoe for clasping the rail. At a height of about seven feet is an iron bracket supporting a five-light series cluster with an enameled steel reflector. Below this is a single pole jack-knife switch. Insulated wire is run down the pole and attached to it by cleats.

To operate, merely hang the hook over the trolley wire and spring the lower shoe over the rail. Throw on the switch and circuit is completed, giving a strong light where required.

A TELEGRAPH THAT PRINTS.

A revolution in the receiving and the sending of telegraph messages is taking place throughout the United States. This new era in the telegraph business is due to the Barclay printing telegraph system, an invention which is but little known outside of the big telegraph offices. Wherever many messages are received and sent daily these machines are being installed, and at present nearly all the large cities transact much of their business through these machines. New York has already installed 28 machines and Chicago about as many. These machines are capable of handling from 75 to 100 messages per hour at the hands of young girl operators whose services can be secured for $10 per week and less, for no knowledge of the telegraph business is required.

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FIG. 1. PUNCHING TAPE FOR PRINTING TELEGRAPH.

The messages are first "punched" or spelled out in the Morse characters on an endless tape by a special form of typewriter, as shown in Fig. 1. The tape is then fed into the sending machine, as shown in Fig. 2, where a wheel guides it along its course. The holes in the tape allow electrical contact to be made, which sends impulses over the wire in the same manner that they are sent by an ordinary operator's key, only much faster.

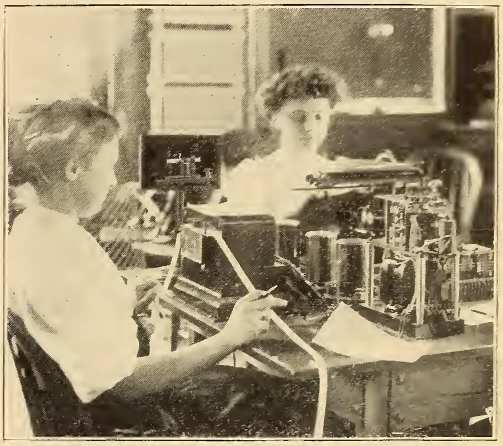

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FIG. 2. FEEDING TAPE THROUGH TRANSMITTER.

At the receiving end of the wire an electrically operated typewriter takes the message and prints it in letters instead of dots and dashes. This is done automatically and no operator is required at the receiving end.

The advantage of the system is obvious.

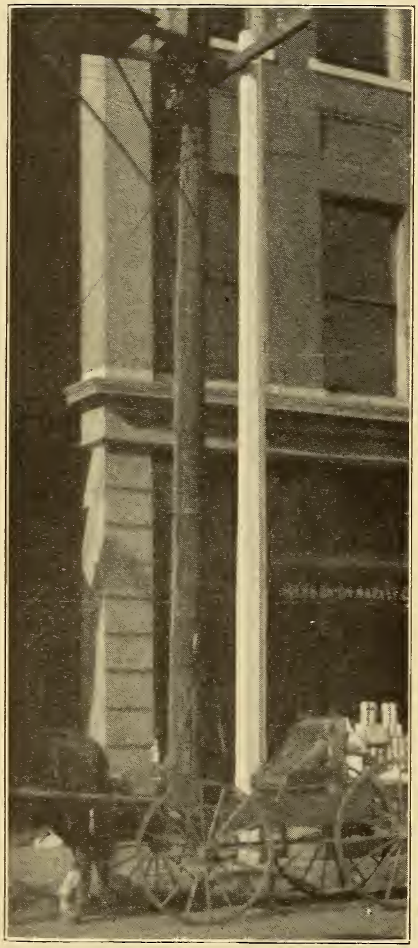
One wire will transmit messages as fast as three or four girls can perforate the tapes on the perforating machines, and they can do this as fast as they could write the words on an ordinary typewriter. As mentioned above, no operator is required at the receiving end, which is another advantage. The machines also work duplex the same as an ordinary telegraph instrument, that is, two messages may be sent over the same wire at the same time.

LIGHTS ENOUGH TO ENCIRCLE THF GLOBE.

If the connected commercial load of the Commonwealth Edison Company of Chicago, equivalent to 3,817,115 16-candlepower lamps, were strung out in a single line of lights, 35 feet apart, they would completely encircle the earth.

CONCRETE TELEPHONE POLE.

The new reinforced concrete pole for stringing telegraph and telephone wires, invented by Mr. T. H. Tidnam, manager of the Oklahoma Gas & Electric Co., of Oklahoma City, Okla., promises to be a great success in its field of application. This pole is constructed of a steel skele-



A STRIKING COMPARISON.

ton, over which the concrete is poured. Being hollow inside, it is light of weight without sacrificing strength, making it suitable for any requirement of permanency. It is constructed not only to withstand the elements, but to be an æsthetic improvement on the ungainly and unstable wooden pole. The cost of this pole is no more than that of the common pole now in use. The accompanying illustration gives a comparison between the old wooden pole and the new reinforced concrete pole, and is evidence of the improved appearance and durability of the latter.

PRINTING TELEGRAPH AT THE U. S. CAPITOL.

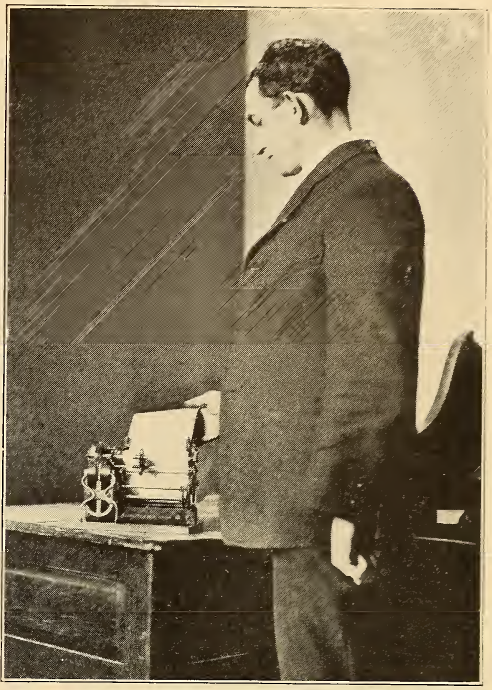
There has recently been installed at the United States Capitol at Washington a printing telegraph that is unique in its function and highly interesting as pointing out a new field for this device. For some years past there has been felt an urgent need for some means of communication other than the telephone to annihilate the distances in Uncle Sam's big building, and the demand became more insistent with the approach to completion of the new office buildings for the members of the United States Senate and House of Representatives, annex structures, each located one-third of a mile from the Capitol.

The officials of the national legislature were desirous of securing some means of electrical communication that would automatically transmit to all portions of the Capitol and the new annexes a continuous record of all that transpires in the legislative halls of Congress. Thus senators or representatives at work in their private offices at some distance from the seat of lawmaking can keep momentarily in touch with the proceedings of Congress and hurry to the legislative chamber when any matter in which they are interested is called up for consideration.

Claims of various communicative systems were investigated and finally the superintendent of the Capitol decided upon the installation of a printing telegraph system. Technically, the printing telegraph that has been placed in operation in Washington is not different from similar apparatus that has come into use in other spheres since the perfecting of the invention a few years ago. The equipment consists primarily of a sending station, the conspicuous feature of which is a keyboard similar to the keyboard of an ordinary typewriter, save that the keys are larger and arranged in a double circle. Before this keyboard sits an operator who pounds out on this keyboard the words and sentences of the bulletins of current proceedings in Congress handed to him by the journal clerks or official reporters of that body.

A network of wires connect this central sending station with receiving stations in various parts of the Capitol building and the annex. At all these receiving stations there are recorded simultaneously and automatically duplicates of the message typed at the receiving station as above explained. Each bulletin is printed letter by letter on paper about the width of ordinary note paper which unwinds from a roll at the back of the machine. From time to time the printed portion of the unwinding sheet is clipped off and bound with its predecessors in a form that makes the successive bulletins readily accessible. Thus a congressman arriving at his office late in the day can, by consulting the file at a receiving station, quickly familiarize himself with all that has transpired during the day.

The primary purpose of the installation, it may be explained, is to afford an "intelligence system" for congressmen scattered through the Capitol and its adjacent buildings, but it is proposed ultimately to establish receiving stations at the White House, the executive departments and other government buildings in Washington so that members of Congress, even though they be several miles distant from Capitol Hill, may keep almost constantly in touch with what is transpiring at the legislative headquarters.



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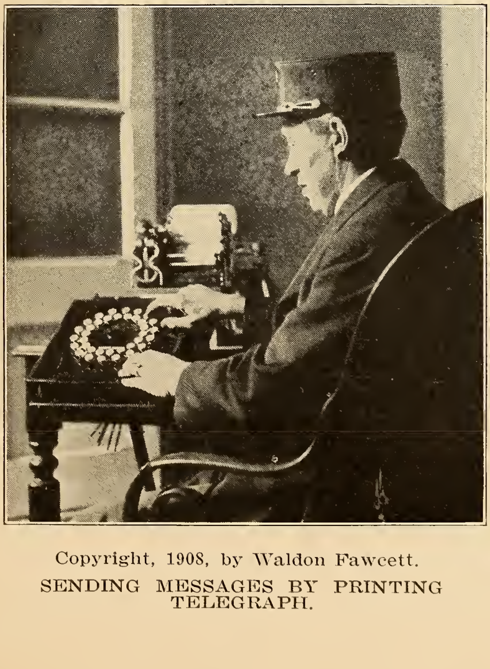
READING MESSAGES FROM PRINTING TELEGRAPH.



Copyright, 1908, by Waldon Fawcett.
SENDING MESSAGES BY PRINTING TELEGRAPH.

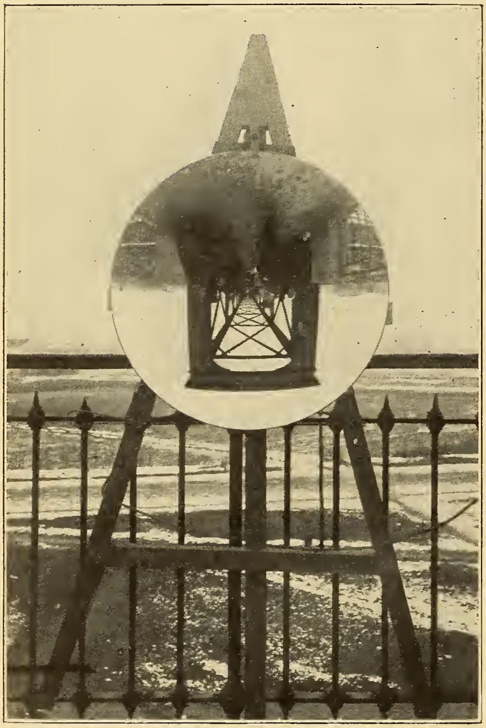
Of course, absolute accuracy is essential in the dispatch of bulletins recording congressional procedure and including the chronicling of ballotings on legislative measures. As an aid to this the operator at the sending station of the printing telegraph has the benefit of a "dummy" receiving station located adjacent to the sending instrument. At this dummy all bulletins are printed exactly as they are at all the regular receiving stations and thus the operator by keeping one eye on this checking device can correct any error that has been made in the transmission of a bulletin.

In making electrical apparatus it is often necessary to make a hole in glass. This may be done by surrounding the portion to be penetrated with wax and etching out the enclosed space with hydrofluoric acid.

REFINEMENTS OF THE MODERN SEARCHLIGHT.

Searchlights of the present day are exclusively electrical, a focusing arc lamp of great power being used and the light being concentrated by a parabolic mirror. The reflected beam of light diverges at a very small angle, so as to allow objects to be studied at great distances.

In order that the penetrating power be great and an arc lamp of focusing type using a moderate current in amperes be effective it is necessary to have lenses and reflectors of the most accurate and perfect curves. The use of the parabolic mirror in searchlight service is to produce effective lighting at great distances, and this is done by providing a beam of light of practically parallel rays, which can be concentrated on any object it is desired to study on land or water.



LOOKING INTO A SEARCHLIGHT REFLECTOR.

The illustration herewith is taken from a photographic image looking directly into an Italian parabolic mirror with an aberration of between 1/15 and 1/5 inch. This view shows very clearly the accuracy with which the mirror is constructed, the objects showing in their true relative sizes. Such a mirror will project rays of light from the arc which are almost exactly parallel.

LIFTING TONS BY A MAGNET.

Imagine a giant magnet able to pick up and carry tons of iron or steel as easily as a toy magnet will pick up a nail. Imagine this magnet to be attached to a traveling crane, so that it may be raised and lowered and moved from place to place. A conception may then be had of one of the very important labor-saving applications of electricity. Such magnets are now made on a commercial basis and are coming into general use for a number of purposes, such as the handling of pig and scrap iron, metal plates, tubes, rails, steel plates, etc.

The great advantages of the lifting magnet are that no chains or tackles are required to attach it to the load and that it is able to lift a large number of small pieces at one time, which would otherwise be tedious and awkward to handle. A further advantage of lifting magnets, and one that has led to their installation in many foundries and blast furnaces, is found in the fact that metal too hot to be touched with the fingers can be handled with a magnet as easily as cold metal.

In the accompanying illustration, Fig. 1, a lifting magnet is shown hoisting a 5,500-pound "skull" of iron. This magnet is of the Milwaukee type, made by the Cutler-Hammer Clutch Company.

The anatomy of a lifting magnet is comparatively simple. The largest single piece is the body casting. This is usually a circular casting of iron or steel, hollowed on the inside to receive the magnetizing coil, and corrugated on the outside in order to secure the greatest possible surface area for heat radiation. Fig. 2 is a diagram, partially in cross-section, which shows very clearly the construction of the magnet. The magnetizing coil is shown lying in the recess in the body casting. It will be seen that the body casting amounts virtually to a great number of horseshoe magnets set

FIG. 1. LIFTING MAGNET RAISING 5,500-POUND "SKULL" OF IRON.

side by side and arranged in the form of a circle, the magnetizing coil being wound in the opening which would be formed by the open space between the legs of all these magnets.

The object of the magnetizing coil is to increase the strength of the magnet. An ordinary magnet is able to lift iron or steel objects by virtue of what is called residual magnetism, which is present in all magnetic metal. If, however, a coil of wire be wound around the magnet and a current of electricity passed through the coil, the strength of the magnet is increased according to the number of turns of wire and the strength of the current flowing in the wire. When the current is shut off from the wire, however, the strength of the magnet immediately falls back to its residual value. It is owing to this fact that the lifting magnet is made a practicable labor saving device.

In operating the magnet the current is first shut off from the magnetzing coil and the magnet is lowered into contact with the object to be lifted. Current is then admitted to the magnetizing coil and the strength of the magnet is instantly increased hundreds and even thousands of times and the load may be lifted. When the load has been transported to the desired place the current is shut off from the magnetizing coil, the magnet lets go and the load is safely deposited.

A 50-inch magnet under actual test has been known to unload a gondola car containing 109,350 pounds of pig iron in two hours and five minutes. The average weight of metal moved, per lift, was 789 pounds. The current required to energize the magnet was 30 amperes at 220 volts. The cost of current consumed by the magnet during the period required to unload the 54 tons of pig iron was less than 25 cents. This was accomplished by one man—the crane operator.

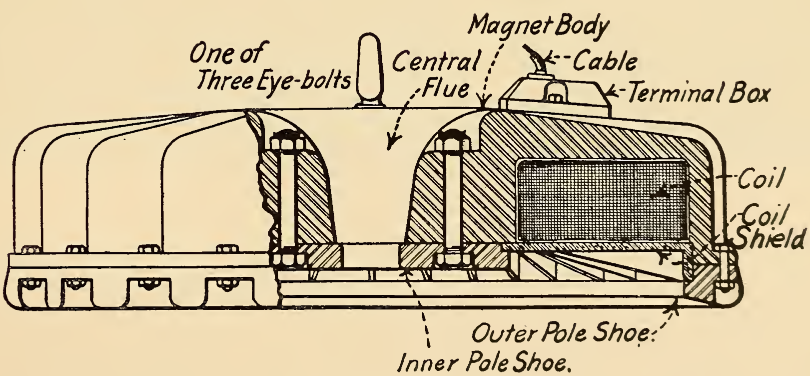


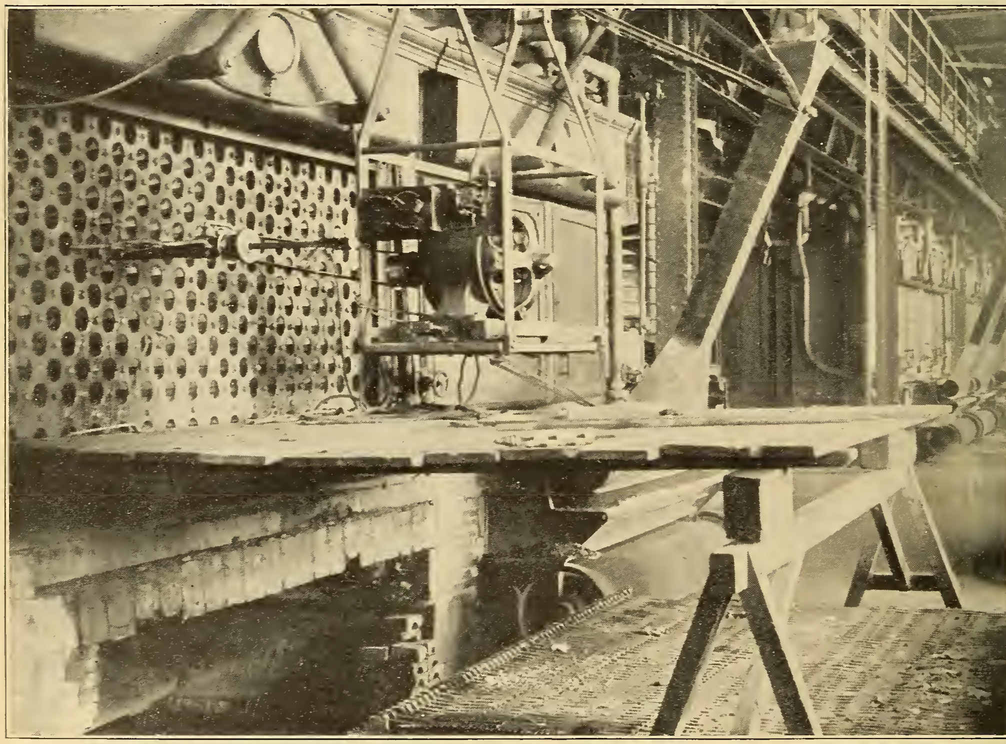
FIG. 2. DIAGRAM SHOWING CONSTRUCTION OF LIFTING MAGNET.

MOTOR DRIVEN BOILER TUBE CLEANER.

Scale encrusted boiler tubes are not only extremely uneconomical in their operation but they are a source of actual danger. All ordinary feed-water contains scale-forming elements, which, either alone or with oils or grease from the engine, are precipitated on every surface with which the water comes in contact in the boiler. Water, in passing through the earth, dissolves many substances and carries others in suspension. Bi-carbonate of lime (quicklime) and sulphate of lime (plaster paris) are generally the most troublesome. The bi-carbonate changes to carbonate at about 200 degrees F. and is precipitated. It forms a soft scale, which with grease or oil becomes dense and adheres to the tubes and plates. The sulphate forms a hard scale which is much more difficult to remove.

Earthy and organic matter are also precipitated when the feed water reaches boiling temperature and often add greatly to the amount of scale. Other scale forming substances are the salts of iron and magnesium. The inner surface of the boiler is soon covered with a crust, which, if neglected, increases until the tubes of water tube boilers, for instance, are completely filled.

If the deposit of scale in the boiler tubes cannot be prevented by adding chemicals to the feed water, mechanical means must be resorted to in order to clean the tubes. Mechanical cleaners of various types have been devised to bore their way through the tubes and remove the scale. This work cannot well be done by hand as considerable power is required. The electric motor has been found applicable to this work. In case there are a large number of boilers in line, an ideal arrangement is to use an overhead track with a carriage for the motor. This scheme is shown in the illustration herewith, which is a view in one of the power plants of the St. Louis Transit Company. The tube cleaner in this case is of the Weinland type and is



CLEANING BOILER TUBES BY ELECTRIC POWER.

driven by a belt from the motor. As the successive tubes are cleaned the motor is moved back and forth on its carriage.

ELECTRIC MOTORS IN THE CEMENT INDUSTRY.

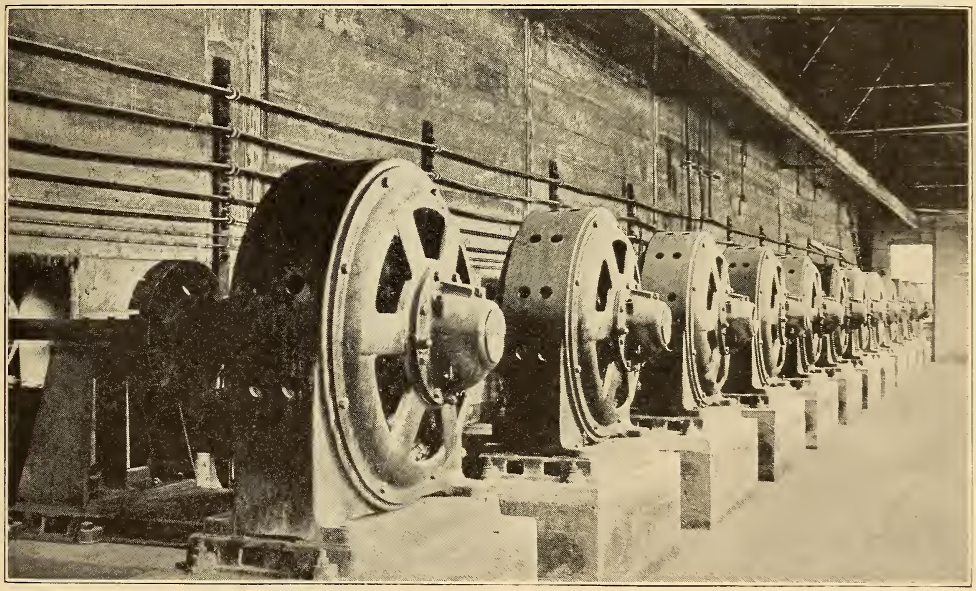
The marvelous increase in the consumption of cement within the last 10 years has brought forth a new industry of great magnitude. Cement in the form of concrete or reinforced concrete is being employed in almost every form of building construction. Great skyscrapers in the larger cities, chimneys, machinery foundations, dwellings and churches, bridges, etc., are among the many structures made from concrete. It is said that last year over 50,000,000 barrels of Portland cement was manufactured.

With this great development and increased output of cement every effort has been made to utilize modern labor-saving devices, and electric power has been employed to great advantage in economically operating the up-to-date machinery in cement manufacturing plants.

The accompanying illustration shows 12 motors at plant No. 4 of the Universal Portland Cement Company at Buffington, Ind. With the motors arranged in this way it will be seen that only one gear reduction is necessary, and the concrete wall separates the motors from the mills, securing an unusually clean motor room.

At this plant there are 140 motors in use, having a total output of 5,740 horsepower, while at plant No. 5 of the same company, at Pittsburg, there are 148 motors having a total output 3,533 horsepower.

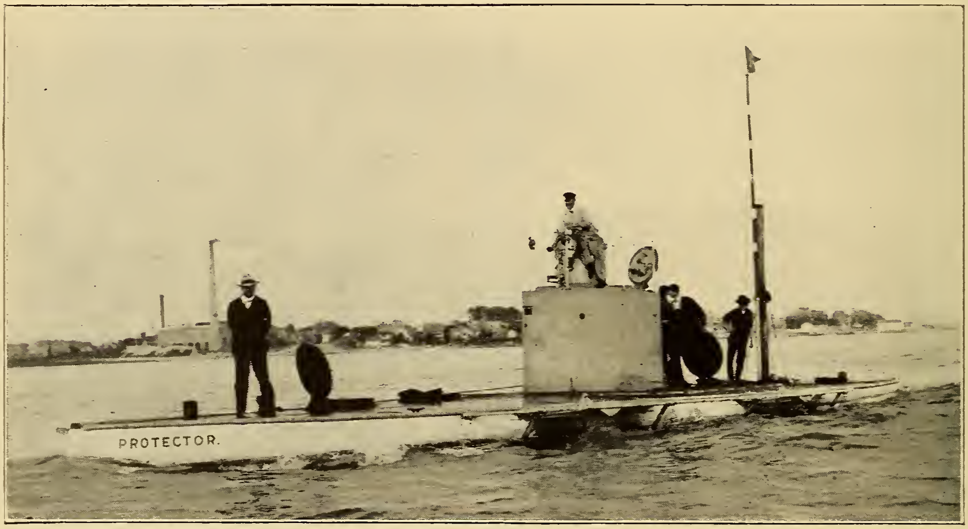
It may be stated that in the manufacture of Portland cement the essential elements are alumina, silica and lime. These elements are finely ground, mixed in the right proportion (approximately 8 per cent, 21 per cent and 62 per cent of these three ingredients, respectively, and 9 per cent impurities impossible to eliminate commercially), and roasted at about 2,800° F., when they are again ground. There are many raw materials in which the necessary ingredients are found. The right proportion is generally obtained by combining two materials, in one of which lime predominates, and in the other silica and alumina. The materials used in this country include cement rock and limestone, also limestone and shale, or clay and marl. Blast furnace slag and limestone are also used as well as caustic soda waste and clay.



ELECTRIC MOTORS DRIVING CEMENT MACHINERY.

UNCLE SAM'S NEW SUBMARINE.

The question of relative merit in the types of submarine torpedo boats designed by the leading American inventors bids fair to be settled before long. The recent action of the Secretary of the Navy means that the Lake type of underwater fighter—the invention of Simon Lake—shall have representation in the Navy as well as the Holland. The principal point of difference between the Holland design and the Lake boat is that the latter submerges on a level keel, whereas the former dives to the bottom.



LAKE TYPE SUBMARINE BOAT "PROTECTOR."

The motive power of the new or Lake type of submarine consists of a double installation of gas engines and electric motors—one motor and one engine being connected to each of the twin shafts. The gas engines are for use only when the vessel is navigating at the surface. All submarine work is performed with electrical energy from a storage battery. For regular underwater propulsion the standard type of Lake boat has on each shaft a six-pole, shunt-wound, Diehl motor, the motor being thrown in by a friction clutch. When merely the engines are being used to drive the boat the armature of the motor revolves freely with lifted brushes and serves the purpose of a fly-wheel. Each motor has a rated capacity of 37½ kilowatts at 125 volts when driven at 300 revolutions a minute, a range of electromotive force of from 80 to 160 volts and a current capacity of 300 amperes at full load, with a momentary capacity of 450 amperes. There are 60 cells of the well-known Gould type of storage battery, with spun plates of the Plante pattern. It is estimated that at full speed the batteries will give a cruising radius of 20 knots, whereas at an economical speed this will reach 30 knots. For the purpose of speedy dashes in attack or escape the motors and engines can be coupled together on the driving shafts thus giving a combined propulsive power on the two screws of 350 horsepower.

ELECTRICITY IN ITS INFANCY.

Electricians say rightly enough that they have just started in to make this the electrical century and also to make everything electrical. Why not? The United States leads in everything that relates to electricity and here are some figures.

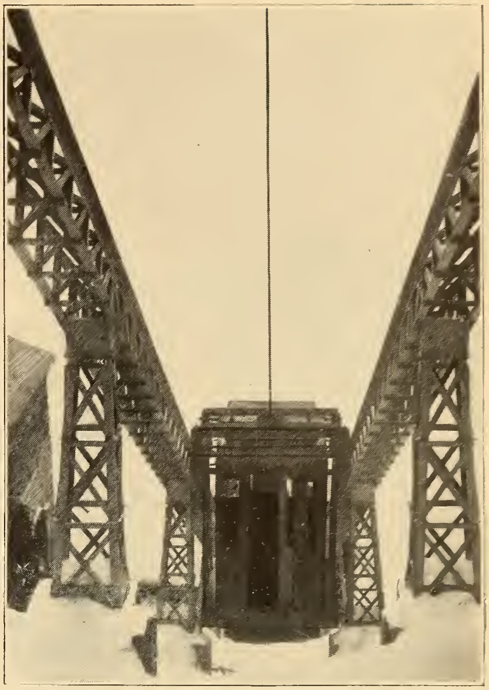
The Census Office reports that though gas had nearly 75 years the start of electricity, yet electricity as an illuminant is now easily in the first place. Yet gas as matter of fact has not lost in the amount consumed by the introduction of electricity. It is simply that electric lighting has forged away ahead of it. There are now about 4,000 electric light central stations in the country as against 877 gas plants. Last year the gas plants earned an income of $75,000,000 as compared with $85,000,000 earned by the central stations. Gas last year employed 22,400 men and the electric light 23,300. The cost of construction and equipment of both was relatively the same, $500,-000,000. But in addition to these central stations there are over 50,000 small or large isolated plants scattered over the country. There are 1,000 in New York City alone.

In all there are perhaps 40,000,000 incandescent lights burning nightly over the country and over 800,000 arc lights. The use of electricity in New York State in the last ten years has increased over 2,000 per cent for lighting alone, and the use of power from central stations has increased 1,200 per cent in the same period.

NOVEL ELECTRIC ELEVATOR.

At St. Moritz, Switzerland, there is a hotel overlooking the lake, and which is located on the side of the mountain at a point inaccessible from the thoroughfare below. For the benefit of the occupants of the hotel a unique incline electric elevator has been installed. The accompanying illustrations show this peculiar elevator, the construction of which is somewhat similar to that of an incline cable railway.

ELECTRIC ELEVATOR ON MOUNTAIN SIDE.



MASSIVE SUPPORTS OF ELECTRIC ELEVATOR.

Steel towers are used for supporting the curved rails, which are mounted on a light steel lattice work. The total height is about 92 feet and the total length of travel about 132 feet as measured on the curved track. Six passengers may be carried at a time, the working load of the car being 1,000 pounds and the speed about 150 feet a minute as the maximum.

The car is operated by a winding drum operated by an electric motor. It is said to be practically proof against accident. A safety catch is provided on the trolley which carries the car, and in case one of the winding ropes should slacken or break, the guides attached to the track are strongly gripped, locking the car securely. In order to still further guard the safety of this incline elevator, there is a speed regulating device arranged so that the same pair of gripping checks or cams are actuated, and if the car reaches too high a speed these checks operate instantly and stop the car.

ELECTRIC HARDENING OF STEEL.

There are said to be about 60 different methods of hardening steel, each of which has its advocates, and no one of which is suited for all sizes and shapes of articles or for all kinds of steel. One way which has not come into general use is hardening by electricity, and the process is described by Garnier in Le Genie Civil. The process is simple and the appliances necessary neither complicated nor costly; neither is any great amount of previous experience in this particular manner of hardening required. The tool to be hardened is put in electric connection with the positive pole of a battery or other source of current. In similar connection with the negative pole there is a cast iron tank full of carbonate of potash dissolved in water. The current is regulated by a rheostat. The tool is plunged to the desired depth in the solution, just as for hardening in the usual manner. The current is then switched on and the tool heated to the same degree as would be required in the ordinary hardening. When the proper temperature has been reached and held for the desired time the current is switched off and the tool left in the bath, which latter, by the simple act of switching off the current, is at once converted into a hardening bath.

Another method, which permits of hardening places on the surface of pieces where the dripping process would not accomplish the desired object, is local heating with the electric arc. Here the tool or other article is laid on a copper block, and heated with an ordinary arc carbon held in a safety holder. The electric connections with holder and block being made, the carbon pole is touched to the piece to be locally hardened. Of course the heating is both intense and local. The work piece is at once plunged in the ordinary bath, and when one place is hardened the next may be heated and so on.

The electric current may also be used to draw the temper of a hollow object. Instead of using a red hot iron to plunge in the bore a cold rod is employed, which is used as a resistance in the circuit of a secondary current of about two volts tension. The temperature of the iron rod gradually rises, and when the work piece has reached the desired color the current is shut off. This method is said to produce less liability to cracking than the old-fashioned way of drawing the temper with a hot rod. It is particularly recommended for large hollow mills The great advantage consists in the perfect regulation possible by means of a rheostat, and in the possibility of getting exactly the same temperature every time for similar objects, once the right heat and color are attained.

SENDING PICTURES BY ELECTRICITY.

BY FOREE BAIN.

TO transmit a picture or reproduce its counterpart electrically over a wire seems, at first glance, to be marvelous. It is all very simple, however, when you know how, and some remarkable results have been obtained in this direction by laboratory experiments.

Assume, for the sake of explanation, that we have two glass cylinders located at points remote from each other, that is, at opposite ends of a wire, and that these cylinders are adapted to be rotated by electric motors, or otherwise, at the same number of revolutions per minute. We place both cylinders within light-tight stationary cylinders as shown in the accompanying illustration, within which the glass cylinders may be rotated and at the same time reciprocated laterally or vertically. Around the transmitting cylinder is wrapped a developed photographic film of the picture or image to be reproduced at the receiving or remote end of the line. Around the rotatable cylinder at the receiving end is wrapped an undeveloped sensative photographic film. At the proper point a small aperture is provided through each of the enveloping light excluding cylinders.

Within the glass cylinder of the transmitter is placed a selenium cell to receive the reflected rays of light coming through the very small aperture made in the light-excluding cylinder. The illustration shows the cylinder raised slightly from the cell. A very strong light, such as an electric arc or incandescent lamp is provided for the transmitting and for the receiving instrument.

In both, the light is focused by proper lenses to project a powerful but sharp beam of light through the small orifice made in the exterior stationary cylinder.

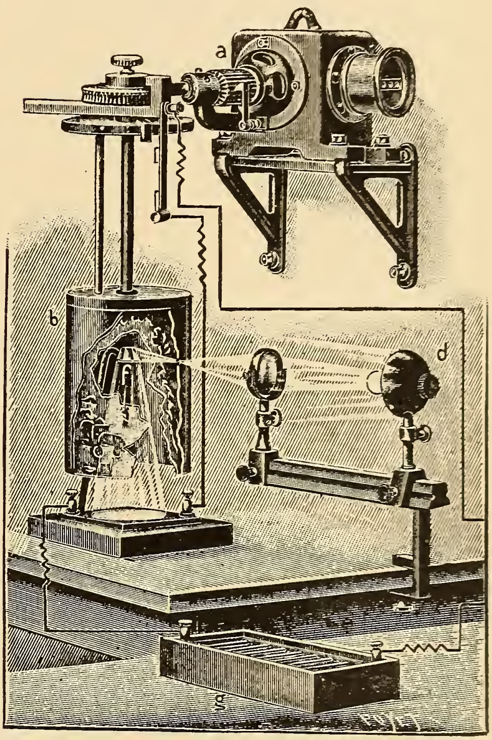
It may be well to state that selenium is a material resembling sulphur in some respects which permits the passage of electricity through it in proportion to the intensity of the light that falls upon its surface. In other words, its electrical resistance varies greatly as the light varies. When exposed to light the resistance is very much less, and the electric current passing through the circuit containing a selenium cell will be correspondingly greater than when the cell is not subjected to the light.

A selenium cell usually consists of two small wires wound around a small piece of non-conducting material, such as hard rubber, and having the fused selenium poured around the wires to electrically join them.

Assume that the two glass cylinders are revolving at the sending and receiving ends at uniform speed, and also that the cylinders have a lateral movement, like the reproducer on a cylinder graphophone By this means all of the surface of the cylinder carrying the film will eventually pass before the orifices in the respective light-excluding stationary cylinders

The developed photograph film around the rotating cylinder of the transmitting instrument is transparent, but the silver deposit, representing the picture is more or less opaque When the transmitting cylinder is revolved and gradually moved vertically, the lights and shadows of the picture are in turn brought in front of the beam of light and the intensity of the light when it reaches the selenium cell is thereby modified accordingly As the beam of light falls upon the selenium cell, its intensity is varied by the lights and shadows of the photograph negative as they in turn pass before it. The strength of the current transmitted to the distant receiving instrument is accordingly varied as the resistance of the selenium cell is varied by the intensity of the light falling upon it.

Suppose now, that an electric incandescent lamp be included in the circuit, through which the varying current is transmitted at the receiving end, and that a beam of light therefrom be focused so as to fall upon the sensitive film of the revolving, receiving cylinder. The light from this lamp will vary according to the strength of the current flowing, and the decomposition effected on the deposit of this film will vary in extent with the intensity of the light, so that when the film has been developed it will be practically a duplicate of the developed film used at the transmitting or sending end. From this developed film photographs may be printed.



ELECTRIC PICTURE TRANSMITTER.

In the year 1883 the writer developed and patented a system by means of which photographs can be reproduced at a distant receiving end upon an engraved block by an engraving tool operated by electromagnets. From this block the original picture may be printed by placing the block in an ordinary printing press.

Sponge fishing by submarine boat has been tried with success. A submarine for this purpose is made to hold two men. An electric searchlight is fixed in front to illuminate the bottom of the sea.

ELECTRICITY IN MEDICINE.

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

PART II.

Having in our introductory chapter considered the general principles which underlie the science of electricity, it now behooves us to become familiar with the construction and the uses of the various instruments or apparatus which are employed in the application of electrical energy in medicine. The best known, but not by any means most easily understood, instrument is the so-called Faradic induction coil, which produces the well-known interrupted current with which every person is familiar who has ever handled a common toy battery.

The Faradic coil (physician's induction coil) consists of an iron core, made of a bundle of iron wire or a solid piece of iron, which is covered with some insulating material such as paraffin paper. Around this core a course of wire is wound called the primary coil. This is also covered with insulating material. Then follows a winding of finer wire, the secondary coil. Thus we have a core, a primary coil and secondary coil entirely separated from one another by insulation.

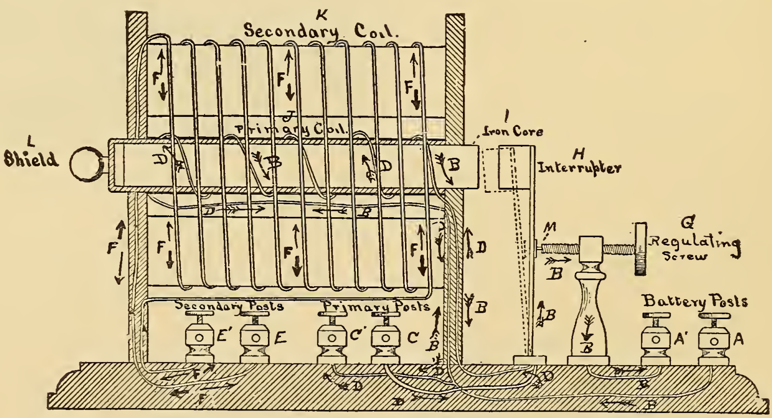


FIG. 1. CONSTRUCTION OF A PHYSICIAN'S INDUCTION COIL.

Look at the diagram (Fig. 1) and follow the course of the wires which start at the two posts (A) and (A′). These two posts represent the two elements (positive and negative) of the battery generating and furnishing the current. The current is constant (galvanic). The wire from (A) is connected with one of the primary binding posts (C′). Before it gets there, however, it will be seen to split into distinct wires, one of which is seen to ascend and form the primary coil (D and B) winding around the core. For the present do not notice the direction in which the arrows point. This will be made clearer later on. After winding around the helix it returns and connects with the circuit-breaker, which is the vibrator or interrupting hammer. Looking at the diagram you notice at the extreme right a battery post (A), then another battery post (A′), then a post upon which the regulating screw (G) is mounted, and finally the circuit-breaker. This circuit-breaker is a sort of a hammer (H), mounted on top of a spring which is in contact with the regulating screw at (M). This end of the regulating screw is a platinum point. The spring of the circuit-breaker may move forward (see diagram in broken lines), causing a gap at (M) and breaking the circuit at that point. If the spring moves back, contact will be perfect at (M), and the circuit, therefore, complete. The hammer is placed opposite one end of the helix, touching it when the spring carries the hammer forward. When there is contact at (M), there is a gap between helix and hammer. When there is contact between core and hammer there is a gap at (M).

The battery post (A′) is connected with the post upon which the regulating screw is mounted. The primary binding post (C) connects with the circuit-breaker. The primary binding posts (C and C′) hold the wires that go to the patient.

Let us follow the complete circuit. From (A) to the primary coil and to (C′), then to the circuit-breaker, then to (C). When contact at (M) is complete, the circuit at that point is perfect. The only gap or break in the circuit is between the two binding posts at (C′) and (C). This break is filled by the patient's body.

When the battery is generating electricity, the current will pass through the primary wire which winds around the helix. The latter is magnetized while the current passes. The magnetic helix will attract the hammer of the circuit-breaker and cause a break at (M). The moment this break occurs, the circuit is broken, the current stops, the helix ceases to be magnetic and the hammer is let go and springs back to its original position, which means that contact at (M) is again made and the circuit of the current re-established. The helix again becomes magnetic, the hammer is again attracted towards the helix and away from the platinum point at (M). It is a continuous make and break of the circuit.

The secondary coil (F) is not connected with the battery. Being placed in the magnetic field of the primary coil it gets its current by induction from the primary coil. Its only attachments are to its own binding posts (E and E′) between which the patient's body is interposed. The make and break of the circuit in the secondary coil corresponds in every particular to the make and break in the primary circuit. Being an induced current its direction or polarity is constantly changing.

Most coils are provided with what is called a shield (L) which can be pulled out, thereby exposing more and more of the helix and increasing the amount of electricity involved in the magnetization of the core.

The make and break of a circuit gives rise to some characteristic physical effects. Every interruption of the current means a reversal of its direction or polarity. Thus we see that the faradic current is an alternating current. Since the alternations are comparatively slow, we may speak of interrupted currents of this kind as being currents of low frequency. The frequency of an alternating current, as we have seen in our first lesson, expresses the speed of alternation.

When the current is actively in evidence, magnetization of the helix takes place. This means that the helix is surrounded by lines of magnetic radiation. Thus we see that the waves of magnetism radiate in the same space which is the scene of action of the electrical radiation in the primary and secondary coil. There is a necessary cutting or intersection of magnetic waves by the convolution of the primary and secondary windings of wire. The more convolutions of wire, the greater the number of intersections of magnetic waves. This is of importance because upon the number of intersections of magnetic and electrical lines of energy depends the increase in the electromotive force (voltage) of the current.

Thus we see that the faradic current is characterized by alternation of polarity, the frequency of alternation being comparatively low, and by an increase in the electromotive force, the increase depending on the number of turns in the primary or secondary wire. The fact that the direction of the current is reversed whenever an interruption of the circuit occurs is illustrated in our diagram by the position of the arrows (see position of arrows indicating opposite directions of current flow in the same circuit at B and D).

For the purpose of applying galvanic (constant) currents or faradic (interrupted) currents the modern physician usually equips himself with a switchboard upon which the different devices for the regulation of electrical energy are mounted. This switchboard is connected with the cells that produce the electrical energy, or is connected with the lighting circuit from the street. In the latter case it is wired in series with an incandescent light consuming a certain quantity of electricity. In this way the amount of electrical energy supplied to the switchboard is definitely limited and controlled. The switchboard may be laid on a table or placed on the wall or mounted in a more or less elaborate roller cabinet.

The parts of an ordinary galvanic-faradic switchboard are: (1) the induction coil; (2) the milli-amperemeter: (3) the rheostat; (4) the rheotome. All these terms have been explained in our first lesson. In addition to the parts mentioned there are switches to control the primary and secondary faradic current. the galvanic current, the milli-amperemeter and the rheotome. The rheostat is usually in the circuit of whatever current is used. Two binding posts for the patient complete the equipment of the switchboard. Some faradic coils have two circuit-breakers, one at each end of the helix, for very rapid or only ordinarily fast interruption. The appearance of the ordinary switchboard is shown in Fig. 2.

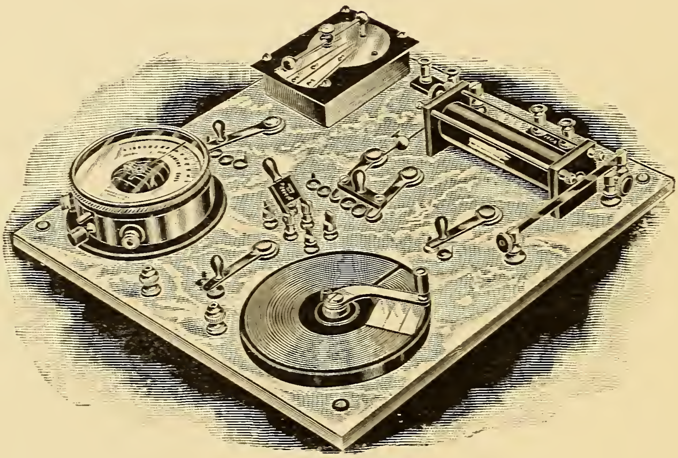


FIG. 2. PHYSICIAN'S SWITCHBOARD.

The instrument in the upper right hand corner is the (faradic) induction coil, that in the upper left hand corner is the rheotome, consisting of a clockwork which allows the current to pass only at certain intervals. The length of the interval is controlled by the pendulum on the face of the instrument and also by the switch which in our illustration is shown below the instrument, between the rheotome and the milli-amperemeter in the lower left hand corner. The milli-amperemeter measures the quantity of current passing. There are many types of this instrument. The best known and most frequently employed type is shown in Fig. 3.

The rheostat is shown in the lower right hand corner of the switchboard. The manner of wiring is indicated by Fig. 4.

The "series lamp" controls the amount of current which is admitted to the switchboard. One wire (from N to NN) goes directly to the patient. The other supplies the rheostat, which represents resistance, and is increased or de-

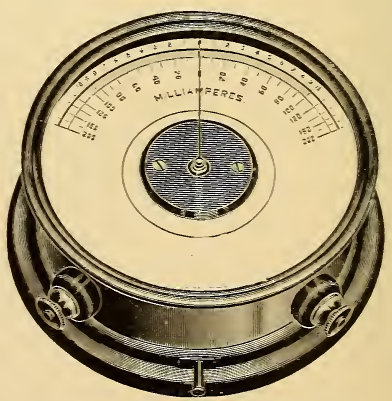


FIG. 3. MILLI-AMPEREMETER.

creased by the handle. Both wires supply a lamp which takes up as much electricity as will pass through the rheostat. It is in a shunt circuit. Sometimes this lamp

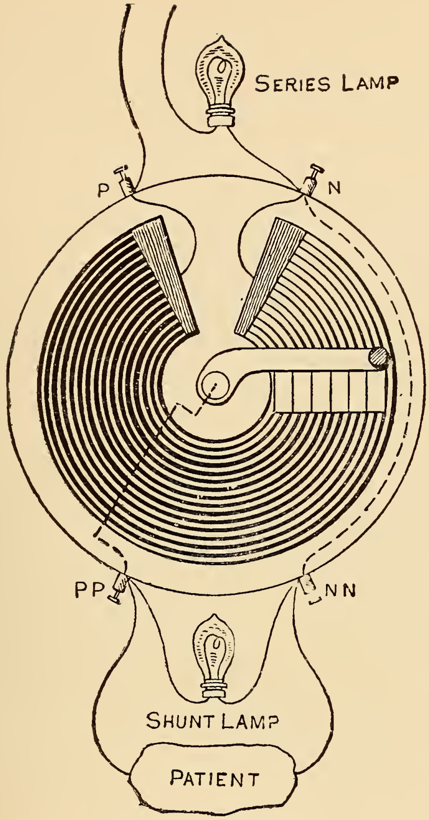


FIG. 4. RHEOSTAT.

current, on the size of the primary wire, on the number of turns in the primary coil and on the length and thickness of the helix.

In discussing the physics of the faradic coil we had occasion to speak of magnetism or rather magnetization produced by electricity. Magnetism and electricity are closely related to each other and, in the light of modern scientific thought, perhaps different manifestations of the same elementary force. Magnetism is being used as a remedial agent in a variety of ways. Let us, before concluding our second lesson, consider a few salient points in connection with it.

There are two kinds of magnets, nat-

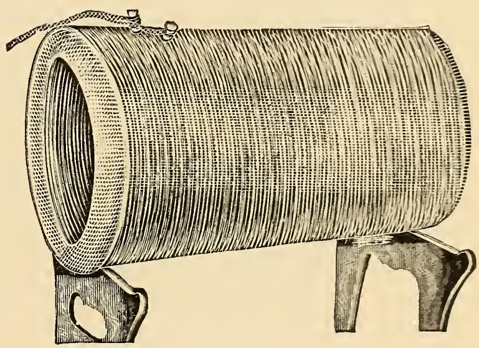


FIG. 5. BENNETT COIL.

is wired in series with the patient by being placed either between (PP) and patient or (NN) and patient.

The rheostat controls the galvanic as well as the faradic current. It controls

ural magnets, those which naturally and constantly possess the property of magnetism, and artificial magnets, those in which the magnetic property is produced artificially, e. g., by electricity in the

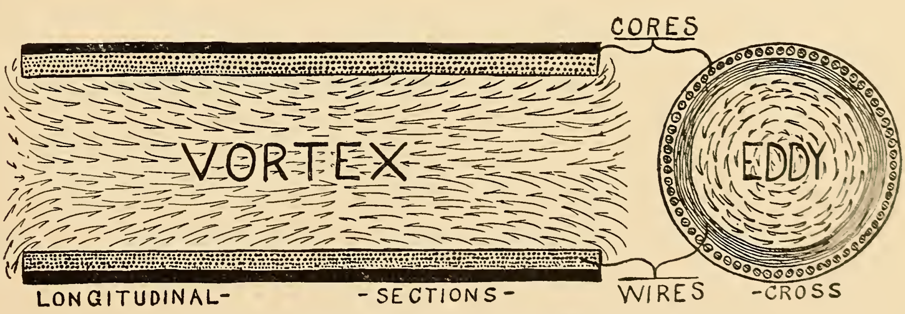


FIG. 6. CONSTRUCTION OF BENNETT COIL.

the galvanic current absolutely and exclusively. The faradic current has other controlling factors upon which it depends, to-wit: in its induced form it depends on the strength of the primary

helix of an induction coil. The magnetic field is the sphere of influence surrounding a magnet. The employment of magnetism in medicine depends on the peculiar effects which have been noticed after a living animal body has been placed in a magnetic field for a variable length of time.

The instruments used are named after two Americans who have been foremost in the elaboration of this subject, Dr. H. C. Bennett of Lima, Ohio, and C. Bachelet, a physicist in New York.

The construction of the Bennett instrument is shown in Figs. 5 and 6.

The body of the instrument consists of a heavy pasteboard drum over which a great quantity of insulated wire is wound. This coil is covered or surrounded by a tubular battery of compound electromagnets. The construction is shown in longitudinal and transverse section. The inside space (vortex, eddy) receives the part to be treated, e. g., arm or leg. The instrument is placed in the circuit of an alternating current, preferably 110 volts and 60 cycles.

The Bachelet instrument is simpler, consisting of a flat box ten inches square and about two inches thick. It contains several powerful electromagnets. The instrument represents a set of two or more magnetic generators which are placed in the desired position with reference to the patient. Fig. 7 shows the double instrument attached to the lighting circuit and on both sides of the chair occupied by the patient who literally surrounded by a flood of magnetic waves.

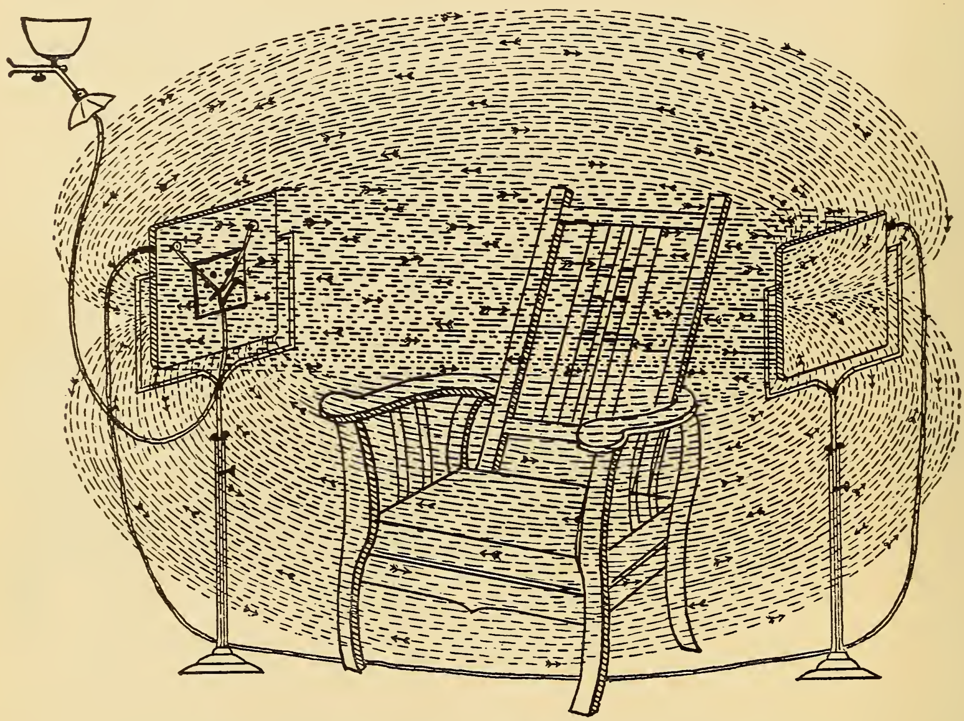


FIG. 7. BACHELET ELECTROMAGNETIC APPARATUS.

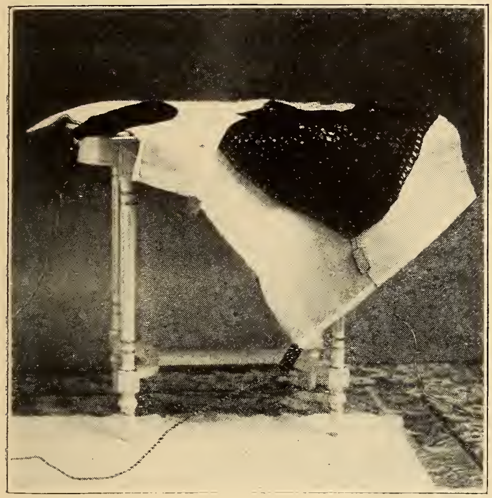
(To be continued.)

ELECTRICALLY HEATED FABRICS.

Early in the development of electric science a curious phenomenon was discovered, which is known as the thermophile effect. It was found that when two different metals were joined together, and a current of electricity sent through them, heat was generated at the junction. A modern application of the thermophile takes the form of electrically heated fabrics. These fabrics are loosely woven and small wires made up of alternate sections of different metals are interwoven through the fabric. When current is sent through the wires the junctions are heated.

Applications of the thermophile are

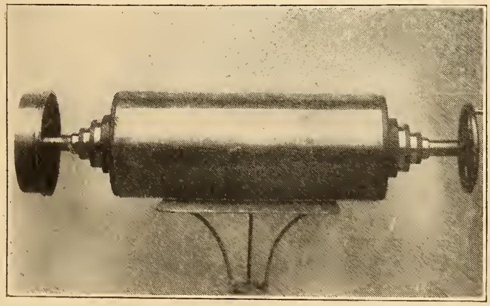
numerous, and they are used to a considerable extent, especially in Europe, for foot warmers in railway coaches and carriages. Perhaps their widest application is in medical practice, where they are used for warming operating tables during long operations; also in compresses, gloves, knee caps, leggings, etc., for applying heat locally to different parts of the body. It is stated that the



ELECTRICALLY HEATED FABRIC.

electric thermophile is beneficial not only by the intensity of its heat, but also by the sweating which results. The effects may be prolonged or modified as the circumstances and the results to be obtained require.

The thermophile may also be used to advantage on drying rollers for fabrics



ELECTRICAL DRYING ROLLER.

in paper works, bleaching houses or dying works. These rolls are surrounded by an appropriate electric thermophile fabric either alone, or more often, covered with thin metal plate. The current is conveyed to the fabric by rubbing contacts on the axle, and the temperature necessary at any moment can be regulated. The losses of steam through turning joints and the stains caused by condensation waters are avoided, and above all, the mass of these cylinders and their great thickness can be reduced to the minimum without danger of bursting, which is frequent and dangerous in steam heated rolls.

BOOK REVIEW.

CONVERSATIONS OF ELECTRICITY, PART I. By Joseph G. Branch. Chicago, New York: Rand, McNally & Co. 1908. 282 pages with 105 illustrations. Price $2.00.

Although the working theories of electricity have been developed to a high degree of perfection, the vast majority of people are almost totally unfamiliar with its most elementary principles. This is partly due to the fact that the study of electricity by the novice is approached with timidity, and most people are imbued with the idea that it is a science difficult to understand. In order to teach the elementary principles of this great agent of mankind, in a way which shall overcome the erroneous impression that these principles are difficult to comprehend, the author has selected the question and answer method as more confidential and more in sympathy with his readers. From cover to cover of the book, one who peruses its pages will find the very questions which he has been asking in his own mind concerning the theory and practical application of electricity, and which he has so often put aside thinking that none but the technically educated would be able to comprehend the answers. Each and every one of these questions is answered in simple and lucid language, without the use of mathematics. In short, it is a book which will give the ordinary reader, who is not interested in the finer technical details, a broad and useful understanding of the principles and applications of this great force: knowledge which he owes it to himself to secure in view of the important part which electricity now plays in the affairs of daily life.

THINGS TO KNOW ABOUT ELECTRIC CURRENT.

In many cases wires carrying electric current are not dangerous to the person who accidentally comes in contact with them. But the safe plan to follow is never to touch an exposed wire, no matter if you feel certain that it is not carrying a dangerous voltage. You can never tell when it may be crossed with a high-voltage wire and is therefore charged above the normal. Some interesting observations regarding the effects of electric shocks are given in Cassier's Magzine from which the following extracts are taken:

"Touch one side of a circuit lightly with the finger while making contact with the other side either through a ground or by actually touching it; the sensation is similar to receiving a violent blow in the chest; a small burn that is deep, but not painful, will be found on the finger where contact was made. Make a better contact, as by touching the circuit with a piece of metal held firmly in the hand, and the blow will be strong enough to knock the experimenter down. It is probable that no burn will result, as the current has a large surface through which to enter the hand; in rare cases the person may become unconscious for a short time. Grasp the wire firmly in the hand, and for a time at least it will be impossible to release it. Serious burns are made where the wire touches the hand, and unless the victim succeeds in wrenching himself free, or help is quickly rendered, the result is liable to prove fatal. The last case is of very rare occurrence; it is pretty sure to obtain considerable space in the daily papers when it actually does occur, while in many of the reports seen the victim may exclaim, with Mark Twain, 'Accounts of my death greatly exaggerated.' On the other hand, people are knocked down by the current every day. It is rather peculiar that the 500 volt shock will, in the majority of cases, kill a horse.

"Trolley current is a 500-volt circuit, with the exception of perhaps half a dozen lines recently installed, which go to 1,000 or over; and the statements above apply to the trolley as well as to motors. As the return circuit is through the rails, the circuit is always grounded. It is well to remember, in case of a falling trolley wire, that standing upon a dry board will give full protection; that while sitting in a car there is no danger of shock from a broken wire or other cause if one does not touch metal or wet wood; raising the feet from the floor that may be wet or dirty will do as an additional precaution. If one wishes to remove a wire to avoid shock or for other reasons it may be done with safety while standing upon a dry, clean board and removing the wire with a piece of dry board not large enough to stand on, or with several thicknesses of dry paper (a newspaper), or, in case of emergency, a bundle of dry clothing.

A KITE TELEPHONE.

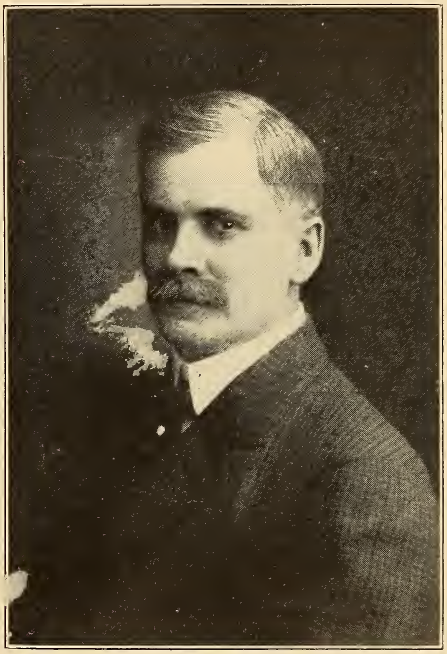
An interesting combination of a kite and special telephone set to be used for war purposes is proposed by Edward E. Harbert of Chicago. The principal feature of the invention consists of an egg-shaped telephone case, having on one side a glass tube with electrical connections at the top end and in the sides, and a quantity of mercury in the lower portion. The large end of the case is weighted. A transmitter and receiver, on a complete metallic circuit, are inclosed in the case, which can easily be opened. The case is suspended, large end up, from a light double wire running over a pulley which is attached to the kite line close to the kite. Large box kites are used of sufficient strength and size to support the apparatus as well as their own necessarily heavy flying line.

The big box kite is sent up in the air by the party which is approaching the beleaguered spot and to it are paid off from reels the kite string and the telephone wires. At intervals the secondary kites are sent up. When careful calculation shows the kite is directly over the spot to be reached the kite line reel is checked and the telephone reel is allowed to run, lowering the egg-shaped case from the pulley to the ground. When it strikes on any surface it tips upon its side because of its shape and the mercury in the glass tube runs down to the top, making connection between the two electric terminals and establishing a circuit which immediately rings a bell at the sending station. The operator then knows that the apparatus is on the ground and cuts out the bell circuit.

ELECTRICAL MEN OF THE TIMES.

BION J. ARNOLD.

It is interesting to follow the life of a genius, the more so if he be a young man whose future holds promise of new and greater things. That Bion J. Arnold is a genius none can deny—a genius not of the kind who devotes his time to the pursuit of the elusive but whose energies are given to the solving of problems effecting the every-day life of his fellow men.



Mr. Arnold was born at Casnovia, Mich., Aug. 14, 1861. His parents soon after moved to Ashland, Neb., where his early education was obtained. Later he studied at the University of Nebraska and finally entered Hillsdale College (Michigan), where he received the degrees of Bachelor of Science in 1884, Master of Science in 1887 and Doctor of Philosophy in 1889. He also took one year of post-graduate work in Cornell University.

At an early age young Arnold evinced a marked liking for mechanics, and while a mere boy was a better machinist than many men who have spent their lives at the work. Cherished among his keepsakes is a model locomotive, complete in every detail, which now occupies a prominent place in his big Chicago office. This locomotive was built by him when he was only 18 years of age, and from cow-catcher to tender the details of its construction are evidence of remarkable mechanical accuracy.

Electricity, as it began to make headway in the industrial world, became to him of intense interest, and this became his chosen field, especially in the lines of electric traction and electric lighting. To enumerate, even, the many achievements which have won for him the honored place he now holds in the profession would make a long story. It will suffice to say that he was made delegate to the International Electrical Congress in Paris in 1900; was president of the American Institute of Electrical Engineers, 1903 to 1904; vice-president and chairman of the executive committee of of the International Electrical Congress at St. Louis, 1904, and president of the Western Society of Engineers, 1906-1907. These are the highest offices that could be bestowed upon him by the electrical fraternity.

As a mark of the faith of the people in Mr. Arnold's ability as an engineer, he has been retained by the city of Chicago as chairman of the board of supervising engineers who have charge of the rehabilitation of the Chicago traction lines under the new ordinance, being the chief engineer of this work, which is one of great complexity. He was also one of the board of engineers having charge of the electrification of the New York Central lines in and near New York city, and has recently made an exhaustive report on the subway signal system of the Interborough Rapid Transit Company.

Himself a brilliant example of concentrated energy and thorough education, Mr. Arnold's own advice to boys and young men is to get the best theoretical training possible, but at the same time to learn to use tools like a skilled mechanic. Such an engineer is the one who will be sought as long as problems remain to be solved in the engineering world.

ELECTRICITY IN THE HOUSEHOLD

MORE COMFORT IN THE HOME.

BY ELIZABETH H. CALLAHAN.

"How can I solve this servant problem," said a delicate little woman to me one day. "I cannot afford to pay the wages they ask, neither am I able to stand by a hot stove and get overheated. Our family is small, but there is just so much cooking that must be done." "Why not try cooking by electricity," I asked. "Oh, I know nothing about electricity and am afraid that is a dream of the future." Then I hastened to assure this little woman that cooking by electricity is no dream but a very pleasant reality, and showed her how simple, safe, helpful and clean it is. I might go on indefinitely describing the merits of cooking with electricity.

We are all familiar with the coal and gas range. They both have their good points, but they also both have their dirt and heat. How much better it is to have a clean oak table that never needs to be blackened, only wiped with a damp cloth when necessary. We have at the back of this table a switchboard on which are fastened the cords that are attached to the cooking devices when they are in use. The neat, shining utensils appeal to the careful housewife, and this table becomes her pride and pleasure.

The complete outfit consists of cereal cooker or steamer, griddle, broiler, coffee percolator, water heater, plate warmer, frying pans, and best of all, an oven. No more headache on baking day. On a warm day in summer the kitchen is as cool as the parlor, for electricity does the work assigned to it and cooks the food within the utensil. It does not throw out the heat to make the air of the kitchen heavy, and this alone proves it by far the most healthful method of cooking. No more matches for the small boy of the house to make a blaze or gas burners for him to turn on. Electricity is the "safe fire" to have in the house with children. The housewife no longer dreads the hour for preparing dinner. Any of these devices may be ready for use within a few moments after attaching the plug at the side of the utensil. Simple, you say. Why a child could cook with electricity, and indeed it seems like child's play after using a coal range.

Let me describe a few of these utensils. The cereal cooker or steamer is a combination which may also be used as a water heater or double boiler. When steam is used a small quantity of water is sufficient, and the heater uses less current and requires less time for cooking. It is made of sheet aluminum.

The coffee percolator is also made of sheet aluminum and is an ornament to any breakfast or dinner table. This method of making coffee extracts the flavor from the coffee bean without the harmful ingredients. There is no alcohol to spill on the table and make a disagreeable odor. Simply connect the cord to the chandelier above the table and within a few moments a delicious cup of coffee is ready to be served.

The plate warmer or stove is made of cast iron and has a flat top on which any ordinary sauce pan may be placed. We all know that griddle cakes should be served hot and if the family likes cakes, one member must be in the kitchen baking. Why not bring the electric griddle, place it on the dining table, attach the cord and serve the cakes hot without breaking the family circle?

The broiler is especially fine for steak and chops, as there is no danger of burning, and the heat may be regulated as desired. All these devices are indestructible and with ordinary care will outlast any other cooking utensil and always look bright and shining. The meals can be prepared in half the time—no more cross hostesses because the fire won't burn. Only a happy, cheerful housewife, who sits down to a quickly prepared meal without the worried look she used to wear.

Do we use electricity only in the kitchen, you ask? Oh no! In every room in the house we have some means of comfort procured through the agency of electricity.

In the laundry we have a big change from the oven heated room of days gone by. The electric iron makes ironing a pleasure. No more weary steps to and from a hot stove. The iron is attached to a receptacle convenient to the ironing board and we can iron all day without leaving the board once. The peculiar shape of the iron makes it possible to iron the corners and ruffles as you never thought you could with the old style fire heated iron. If the day is warm, take the ironing board out on the back porch, extend the cord through the window and iron in the cool air. In speaking of the laundry, we must not forget the motor to run the washing machine. Just attach the small motor to the machine and you will find where the washing used to take the whole morning, in less than an hour it will be hanging on the line.

A KITCHEN WHERE ELECTRICITY REIGNS.

In the dining room we have the chafing dish which has become a household necessity. Many a dainty meal can be prepared by the hostess when she does not wish to go into the kitchen for the after-theater or Sunday night supper. It is also just the thing for the young folks, who may wish to make candy at a time when it is not convenient for them to be in the kitchen. The chafing dish may be carried up stairs if necessary where the invalid member of the family must take his or her meals. Served in this manner they are sure to be hot and appetizing.

I have in mind a young boy who had the misfortune to break his leg and was confined to his room for some weeks. The electric chafing dish was his greatest amusement. He prepared many of his meals, having a chafing dish table with everything convenient to his hand. He gave many a delightful "spread" to his friends, and his family blessed the chafing dish for saving them many a trying hour.

IT'S COZY BY THE LUMINOUS RADIATOR.

And what has electricity done for the sick folks? The heating pad takes the place of the hot water bottle that usually breaks at the time it is most needed, or leaks, causing the patient to take cold. The heating pad may be regulated to give three degrees of heat by a switch which the invalid can easily turn, and we all know the comfort and almost immediate relief from pain which comes from the application of heat.

For the bath room we have the hot water heater for the man of the house to heat water for shaving or mother to heat baby's milk at night.

If the weather is cool we can turn on the luminous radiator, and the chill is almost immediately taken off the room. In the luminous radiator we have a splendid substitute for the old fashioned fire place, although nothing can ever take its place even if some houses have the misfortune to be built without one. Then young folks, who love a romantic spot, turn out all the lights and turn on the luminous radiator. It lights with a cheerful glow and throws out sufficient heat to make a chilly room comfortable in the spring and fall when it is not cold enough to operate the furnace.

Why need we have our backs aching because we have run a sewing machine all day? If electricity did our washing, why not our sewing. Let the motor run the machine and the seamstress need only guide the seam and rest her weary limbs. If she wishes to press a seam all she need to do is to connect the small iron to a convenient lamp socket and press her seams without going into the kitchen and wasting her time waiting for an iron to heat or often for the fire to come up.

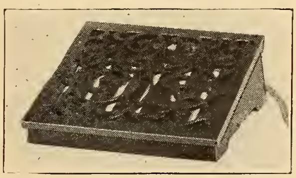
It takes but a few moments when our friends drop in of an afternoon to turn on the switch by the side of the tea table in the parlor and attach the cord to the side of the kettle. In a few moments the tea kettle is singing merrily and we have a nice hot cup of tea to refresh our friends.

Do the men who go to the offices where the electric fan makes a delightful breeze ever think of buying one for their wives to cool them as they go about their necessary duties? Could anything be pleasanter on a hot day than to sit in a room when an electric fan is running? We almost forget that it is warm and look around for a wrap, wondering meanwhile how we ever were able to do our work before electricity did it for us.

ELECTRIC FOOT WARMER.

Improper distribution of heat, floor draughts and temperature difference between the floor and higher levels, all combine to produce cold feet, and, as a consequence, an uncomfortable condition generally. How nice it is, then, to produce a little heat just where it is wanted. The Simplex foot warmer will do this and at the same time act as an admirable foot rest. The frame is made of cast iron, finished in black japan. The heating coils are located within the frame, where they cannot be injured. A suitable cord and plug are provided for attachment to the nearest electric light socket.

The warmer is made in two styles. One style has a solid top, designed for a mild foot warmer for continuous use, without making the feet unduly warm. It is just hot enough not to burn leather, and the current required is less than for an average 16 candlepower lamp. The other style is made with a "register" top, and arranged for three degrees of heat.



When on low heat it fills the demand for a mild foot warmer, and on a high heat it is quite effective for a local heater under the desk, or some similar location.

UNIQUE LIBRARY ILLUMINATION.

Reading, at all times a pleasure, becomes more than ever enjoyable amid luxurious surroundings such as are pictured in the accompanying illustration. Of all the furnishings, the feature to first attract the attention is the candelabra of electric incandescent lamps with its umbrella-like reflector or canopy which casts the rays downward. The lamp globes are frosted, so that the glare does not become objectionably strong. The various corners and nooks in the library are also illuminated by individual bracket lamps. The photo from which the cut was reproduced shows an interior view of one of Chicago's most beautiful homes, and is an example of the artistic and practicable application of electricity to library lighting.

Photo by Gerlach.
UNIQUE LIBRARY ILLUMINATION.

A REVELATION.

It is morning in the electrical house, a touch of a button lights the face of a tiny clock on the dresser and the master of the house can see that it is time to get up. The weight of a finger on another button lights the room; another button pressed and the electric luminous radiator sends its cheering heat out into the room.

In the bathroom the water for the morning bath is heated as fast as it can be drawn, by the instantaneous water heater. The luminous radiator quickly heats the room. The electric shaving mug prepares the suds for the morning shave and the electric vibrating machine is ready to administer the invigorating massage.

With the mistress of the electrical house there is no waiting for sleepy eyed servants; no poking at slow burning fires; no carrying and handling of coal and ashes. While she is dressing she touches a button, and the invisible fires in the electric kitchen are started and by the time she appears in the kitchen the cereal is cooking and the tea kettle boiling away. In a few minutes the breakfast is prepared in the electric stove and the day is fairly begun.—Everbest Magazine.

THE NEW SERVANT GIRL.

BY MRS. G. A. FLEMING.

There's a new servant girl on the market, come and buy. She's the sort that you can own body and soul. "She's great," so great that you have to take her in sections. When once she becomes attached to you, she will never leave you, for while she is always engaged, yet she never gets married. She is not a "peach" but a current. She won't tolerate even a wink from the good man of the house, consequently, the "family jars" all contain sugar where she is. She never gossips, never gets homesick, never is impertinent and is cleanly, quiet, and every ready for duty.

She's the modern girl that knows how to do things. Its only a pleasure to watch her whirl out a batch of clothes in the washing machine, change a little belt and run them through the wringer. Then she irons the flat work on a family mangle, and smooths the fancy pieces with a hand iron.

With her portable vacuum cleaning machinery she can clean a room in short order. She simply runs the dirt collector, which is on the end of a long rubber tube, over the rugs, mattresses, portiers, walls, etc., and the suction forces the dirt and dust through the tube into the dust pan in the cabinet, which also contains the works.

It's perfectly wonderful! but she knows how to manufacture ice. She turns the kitchen refrigerator into a miniature ice factory and freezes a coating of ice all over on the inside of its different compartments between the outer case and the inner linings. No ice man's dirty tracks up the back steps for her.

Her baking and cooking are something to be remembered, nothing burnt on one side and raw on the other, since the temperature in the range can be regulated to any degree. She can run the ice cream freezer or the sewing machine all day and not get tired. Behold! She is also the dish washer, and to her you can trust your daintiest china, without fear of injury. She delights and educates the children by turning their toy wind-mills and merry-go-rounds.

She has at her command numerous little machines that are very useful; one to polish the silverware, one for warming the plates, one for lighting "his cigar," one for heating the lady's curling iron, one for drying the lady's hair after a shampoo, one for heating the water in "his" shaving mug, one to warm the milk for baby, a heating pad that keeps a steady heat and never leaks because its never filled, an alarm clock and a burglar alarm, any one of which will continue ringing until "throttled." A silver toned chime announces the fact that breakfast, dinner, or supper is ready. Won't these glad tidings cheer the weary housewife? She also has medical contrivance at her command for increasing vital activity. By these appliances she can relieve pain, cure the sick, and make the old seem younger.

She can play the piano better than Paderewski, himself. The stereopticon she can run beautifully and never make a mistake in slipping scenes along. On a cold winter's night she will meet you at the door with a bright welcome and a warm reception. With her fans and sprayers going, the atmosphere of her house is as pure and invigorating as the mountain air.

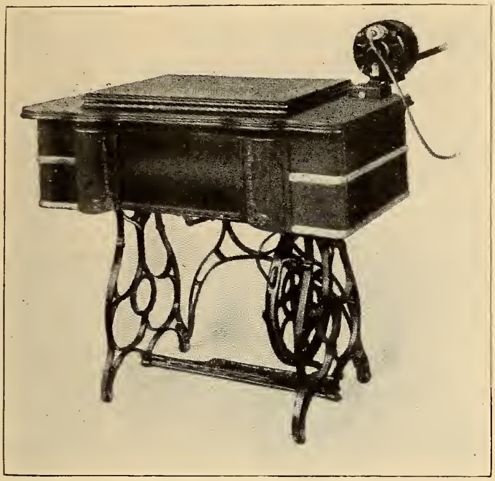
This matchless maiden has switches in her hair, fire in her eye, wheels in her head, volts in her throat, rubber in her neck, speed in her feet and healing in her hands. Her favorite amusement is looping the loops. Her lineage is aristocratic, dating back to Benjamin Franklin. She is extremely fond of her relations, and woe to the party that gets between her and her connections. Despite her culture and refinement if she is not properly treated, she will shock you.

Take her and trust her and she will bring you comfort, safety and happiness. What! Never met her? How unfortunate! Come and be introduced to "Miss Electricity."

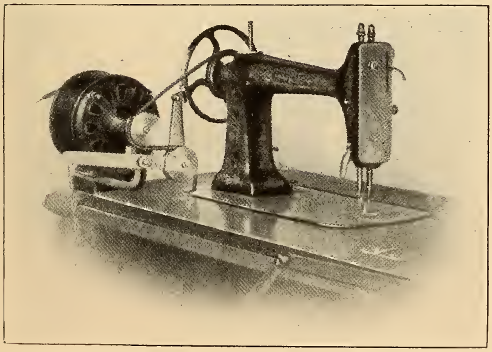
A MOTOR FOR THE SEWING MACHINE.

Application of a motor to the sewing machine is highly appreciated in any household where a considerable amount of sewing is done. Motors for this purpose are now manufactured which are equally satisfactory for drop-head or stationary-head sewing machines.

In the Westinghouse type of sewing machine motor, shown in the two illustrations, the motor is mounted on the top of the table and runs at a constant speed. The speed of the needle is regulated by increasing or decreasing the belt tension. A special brake and belt tightener arm is attached by a chain to the foot pedal, which should be disconnected from the large balance wheel. Pressure on the pedal releases the brake, tightens the belt and starts the machine. Perfect regulation of the speed is obtained after a few minutes' practice. In fact the needle may be stopped with greater promptness than when running from the foot pedal, and the usual control over the speed is readily learned.



MOTOR APPLIED TO DROP-HEAD SEWING MACHINE.

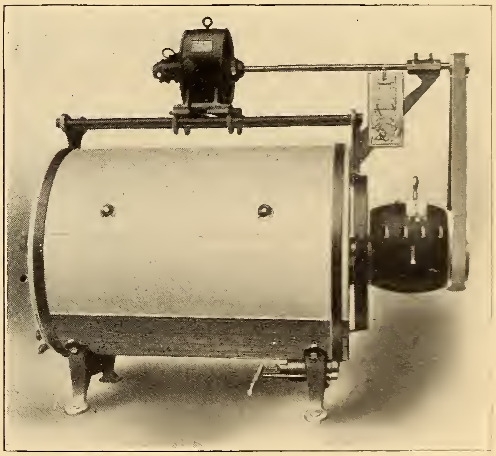


MOTOR APPLIED TO STATIONARY-HEAD SEWING MACHINE.

AN ELECTRIC LAUNDRY WASHER.

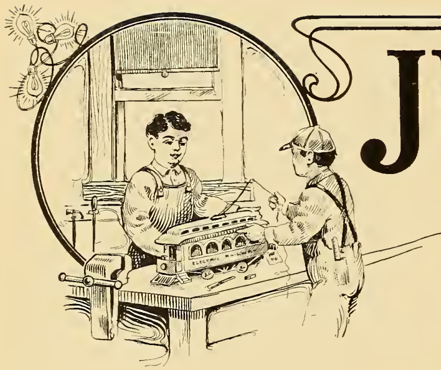
Modern conveniences for doing housework go a long way toward solving the problem of securing and retaining domestic help. One of the great stumbling blocks has always been the laundry work. but a neat electrically driven washer, similar to the one shown in the illustration, is much less apt to strike dismay to the heart of a prospective servant than is the old-fashioned wash tub.

No particular knowledge of electricity is necessary in the operation of the machine. Simply moving the little controller handle from left to right starts the motor, which maintains the proper speed until the current is shut off.



ELECTRIC LAUNDRY WASHER.

An automatic mechanism reverses the direction of rotation exactly the same as in a hand-driven machine, and the inside cylinder of the washer makes equal revolutions in each direction. The small electric motor is shown in the cut as operating the washer by a belt. These motors are, however, arranged in some types to drive the machine by means of enclosed gearing, thus doing away with the belt, and absolutely preventing oil or dirt from reaching the clothes.



JUNIOR SECTION

HOW RALPH PHOTOGRAPHED THE THIEF.

MR. HARRIS came home one night looking worried. As he sat down at the supper table he remarked: "Mother, there is something wrong at the store, and for the life of me I can't make it out."

Ralph Harris, who was a sturdy, well-set-up boy of 15, pricked up his ears at this, but said nothing.

"Some one is stealing copper wire from the rear store room," continued Mr. Harris, "they don't take a great deal at a time, perhaps only one coil, but it has been going on for several weeks quite regularly and something has got to be done about it. Copper wire is worth nearly 15 cents a pound, and I have already lost a great deal more than I can afford."

Nothing more was said at the time, but during supper and for a long time after he went to bed, Ralph was thinking.

"It must be some one who has a key to the store and also to the back store-room," said Ralph to himself. "It looks to me as if it was one of the men who works for father, and who thinks that by taking a little at a time he will not excite suspicion." I wonder how I can catch him in the act."

Suddenly a happy thought came to Ralph. Why not photograph the thief? But how could it be done?

Ralph was an enthusiastic amateur photographer and owned a good outfit. He was also familiar with the general principles of electricity and often rigged up electrical devices for his own amusement, for his father's store was a general electrical supply establishment and he had materials at hand. So it did not take him long to devise a plan to detect the thief. He explained it the next morning to his father.

"Father," said Ralph, "I want you to let me set up my camera in the store-room to-day and be ready to catch that thief, whoever he is, right in the act."

"How are you going to photograph him at night," said Mr. Harris?" who secretly had a great deal of confidence in Ralph's brightness and ability.

"This is the way I will do it," said Ralph. "I will set up my camera in the store-room, and focused on the door. Over it I will place a box tilted up on one edge and held by a prop which will be pulled from under the box by a string attached to the door. After it is dark in the store-room, I will open the shutter of the camera and leave it. If any one opens the door the action will set off my flash light powder and also pull the prop from under the box. The box will fall down over the camera and keep the light out of it, when daylight comes, until I can come and close the camera shutter."

"Very good," said Mr. Harris. "But how will you flash the powder while you are safely at home in bed?"

"Simple enough," said Ralph—"electricity. On the floor at a point where the door will be when it is about one quarter open I will nail a little strip of tin, and from the tin I will run a wire to one terminal of one of those little induction coils we sell at the store, and which are used for the little shocking outfits. On the door I will nail another strip of tin so it will just brush over the strip on the floor when the door is opened. From the tin on the door I will run a wire to the other terminal of the induction coil. I will also connect a dry battery with the coil, as it would be connected if we used the induction coil as a 'shocker.' Then I will put the two little metal handles of the induction coils which you take hold of when you want to get a shock from the coil, very close together in my dish of flash-light powder—not quite touching, but less than a sixteenth of an inch apart. When the door is opened the connection will be made for an instant by the two metal strips and a spark will jump from one handle to the other, lighting the powder. The camera will be pointed at the opening in the door, the exposure will be made and the box will tumble over the camera covering it safely."

CAUGHT IN THE ACT.

"It look as if it might work," said Mr. Harris, "and you can try it."

So Ralph worked secretly in the storeroom that day and set up the camera and made the electrical connections as described. After dark that evening he opened the shutter of the camera. But next morning nothing had happened, and the box was still up over the camera and a plate was spoiled by the daylight.

On the second night something happened, however. In the morning when Ralph went to look at his camera trap he found the door open and the box was down over the camera. Very carefully he covered the box and camera with a black cloth and carried them to his dark room and developed the plate. The picture with this story shows how well he succeeded. The thief entering the door was one of his father's employes and who had never been suspected of dishonesty. When the flashlight was exploded he evidently became frightened and left the store in a hurry. He was never seen again in the town, for he evidently suspected that he would be found out.

All the same, there were no more robberies and Ralph got the credit for discovering the thief.

THE MOTORMAN'S WATCHDOG.

Probably a good many of our youthful readers have stood on the front platform of a street car and have been frightened by a loud noise up on the roof of the platform. You may remember that the motorman then shuts off his controller, reaches up and knocks a handle on a box, and then starts his car again. You have probably wondered what that box contains and why it "explodes."

The box with its contents is called a circuit breaker and it is put there to prevent the motorman from starting his car too quickly. If he were able to start the car instantly, and the circuit breaker were not there, the coils of wire in the motors would probably become red hot and damage the motors.

The circuit breaker consists of a switch and some coils of wire wound around an iron core. When the car is started too quickly the iron core becomes magnetized by the electric current in the coils, strongly enough to knock out the switch. The current is then cut off from the motors and the motorman must turn his controller back and close the switch before he can again start his car.

A HOME-MADE BATTERY.

The common dry battery and the Leclanché or sal ammoniac cell are not well suited for running an electric motor for any length of time, but should be used only for ringing door bells and similar things. A very good cell for motor work can be constructed as follows:

Take an ordinary glass tumbler and cut a square piece of wood large enough to cover the glass as shown in Fig. 1. Obtain four pieces of electric light carbon and if there is any copper on them remove it all with nitric acid with the exception of a little at one end. Next stand the glass on the board, inverted, and draw the outline of the glass on the board with a pencil. Then mark the board as shown in Fig. 2, which will give you the location of the holes (c, c, c, c). These holes are to be bored just large enough to receive the carbons. The carbons should be even with the top of board and should not touch the bottom of glass. The carbons are connected by a wire which is held in place by four wood screws as shown. The

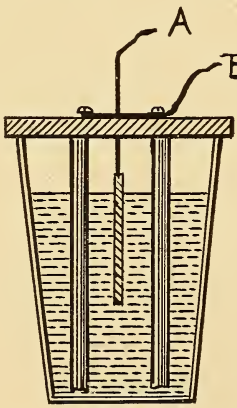


FIG. 1.

other element is zinc and you should use a plate of zinc about one-fourth of an inch thick, one inch wide and about 2½ inches long. The best way to make this zinc strip, is to melt some zinc chips or shavings in a tin cover or casing of about the right size. Then a piece of insulated copper wire should be "skinned" at the end, and the end bent into the shape of a hook. This wire should be placed in the melted zinc in such a way that when the zinc plate is cold it may be suspended by means of the wire. As shown in Fig. 1, a small hole should be bored in center of the board and the wire passed through this hole after the zinc has become cold and hard. The zinc plate must not touch the carbon rods. Wedges may be driven in hole around the wire which will make it more secure. This completes the construction of the

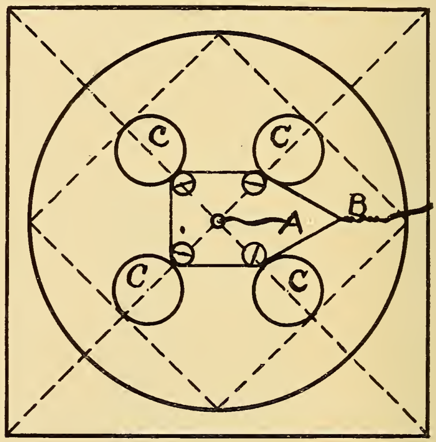


FIG. 2.

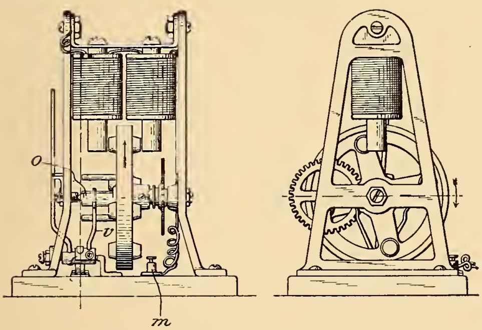
cell and we are now ready for the solution.

You will have to purchase two ounces of sulphuric acid and seven ounces of bichromate of potash. When you have obtained the above, measure out six ounces of water and add the sulphuric acid. The mixture will become quite warm and should be allowed to cool. Then dissolve the bichromate of potash in four ounces of boiling water. This solution may now be added to the acid and allowed to cool. When cold, pour enough of the solution into the tumbler to fill it within one and one half inches of the top. Next place the cover with carbons and zinc plate attached on top of the glass. The cell is now ready for use and should appear as in Fig. 1. The wires (A) and (B) are the terminals and the same connections as you would use with any other cell should be made. When not in use the cover should be removed and the elements thoroughly cleaned with hot water. The solution, when not in use, should be kept in a corked bottle.

ELECTROMAGNETIC TOY ENGINE.

Boys who have access to a fairly well equipped workshop will find that an electromagnetic engine is not hard to construct. The one illustrated in the accompanying cut is a patented device, but by studying its construction carefully some valuable ideas as to the method of procedure in constructing a similar one may be gained.

The toy consists of a main frame with two electromagnets suspended from the top. These might be two electromagnets from an ordinary doorbell. The iron cores of the magnets extend downward some distance and between them is mounted a fly wheel as seen in the cut. This fly wheel carries on each side four armature pieces of soft iron which pass



close to the cores of the magnets as the wheel revolves.

The magnet coils of the electromagnets are connected with a dry battery. Current comes from the battery to the terminal (m) up an insulated wire to the coils, through the coils to the iron frame on the other side, down the frame to the axle of the fly wheel to one of the four iron pegs (O), and through the steel spring (V) to the other terminal of the battery.

It will be seen that the coils are in circuit as long as the steel spring is against one of the four pegs, and therefore the magnets exert a strong pull on the armature mounted on the wheel which is nearest the magnet pole pieces at the time. When the steel spring leaves a peg the current is broken and the magnets exert very little pull until the next peg comes under the spring and closes the circuit again.

By arranging the circuit-making pegs on the wheel in the proper position, the electromagnets may be made to give a series of pulls, one for each armature projection as it gets near the pole pieces of the magnets. As each armature leaves the pole pieces on the other side the circuit is broken by the spring leaving the peg. The circuit is not made again till the next armature comes near the pole pieces and the next peg closes the circuit. In this manner the wheel may be made to revolve rapidly. For the sake of variety gear wheels may be added as shown in the cut.

HOW TO CONSTRUCT A SHOCKING COIL.

Parts needed for a simple shocking coil can all be made at home with the exception of the wire which will not cost over fifty cents. The coil complete consists of the following parts: Iron wire core, primary winding, secondary winding, two wood ends, and vibrator.

The iron wire core can be made from soft annealed iron wire such as is sold by all hardware stores, the size should be No. 22 or smaller. The wire is first cut in lengths of 3¼ inches, a sufficient amount being cut to form a bundle ¼-inch in diameter.

The primary winding is wound over the completed core. Two layers of No. 22 single silk-coated wire are used, being wound on continuously from end to end and leaving ¼-inch space at each end, for insertion in the wood supports. The wire should be wound on closely and evenly as possible, although any slight irregularities will not hurt in this size coil. About four layers of good strong typewriter paper are wrapped on over the primary winding and glued down with shellac glue.

The secondary winding of thin wire is composed of a large number of layers. For this we will need two ounces of No. 36 double silk coated magnet wire wound on over the primary winding continuously as in case of the primary. The winding operation can be greatly facilitated by providing a simple winding machine, the work will also be much nicer than by hand, which proves very tedious. This machine may be rigged up as the ingenuity of the experimenter may suggest. When the secondary wire has been wound the whole coil is dropped in a pot of boiling parafine wax. This is necessary or the coils would not have insulation enough from one another. It also helps to hold the secondary in shape. The boiling is continued until all bubbles cease to appear

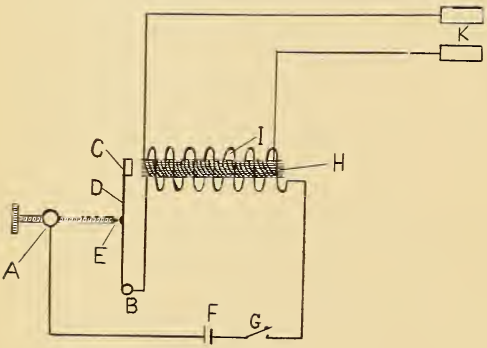


FIG. 1.

at the top, the parts can now be taken out and laid aside to dry.

The coil ends or supports can be made out of wood, hard rubber or ebonite. If wood is used it should be stained to a dead black which much resembles ebonite. The ends can be sawed round or square, the round ends, however, look much better. The size should be 1¼-inch in diameter and ¼-inch thick with a ¼-inch hole drilled in the center. The ends are now fitted on the core and should make an exact fit. The parts are now mounted on a neatly finished wood base four by six inches in area and ½-inch thick. Screws can be run from the under side which will engage the coil ends and fit tightly to the base.

Parts which go to make up the vibrator can be picked up by any boy around his shop, with the probable exception of the platinum which can be secured by breaking a burnt-out incandescent bulb and taking out the lead-in wires.

Before taking up the construction of the vibrator we had best study out the operation which is fully explained by the plan in Fig. 1. Here we have a view of the coil with the primary and secondary shown. When the key at (G) is closed the battery current flows around the core (H), through the two layers of primary wire. In flowing around this core the current changes it into a state of magnetism, and it will in this state attract iron objects such as tacks, etc. This fact is taken advantage of and a small iron disk (C) is pivoted right behind the core by a small brass spring (D) which is screwed fast to a binding post (B).

A second contact post is also provided at (A) through which the battery current completes the circuit. If the key at (G) is closed the current flows around the core through the primary winding, thereby setting up a state of magnetism which attracts the soft iron disk (C). When the disk flies forward the contacts are broken at (E). As no current then flows the magnetism ceases to exist and allows the hammer to fly back only to make connection and be attracted again. It is this rapid "make and break" of the current which will cause a smart shock to be felt by grasping the metal handles (K) leading to the secondary terminals. While there is no actual connection between the first and second windings, yet a current is set up in the secondary when the vibrator starts in operation, which is of higher voltage than that in the primary coil. This is due to what

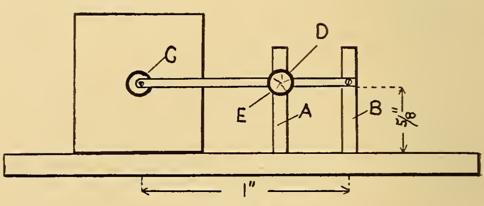


FIG. 2.

is known as inductance, and therefore the coil is often called an induction coil.

For the actual construction, the parts given below are required. A brass binding post shown at (A), Fig. 1 is required. This is one inch in height with holes threaded through the center ⅝-inch from the bottom. The soft iron disk (C) may be either round or square and ¼-inch in diameter 3/16-inch thick. This disk is soldered or screwed to a strip of thin spring brass ⅛-inch wide and one inch long. Through the opposite end of the strip a hole is drilled and the strip is screwed to the post (B) at the screw hole ⅝-inch from the bottom. A small piece of the platinum wire is hammered flat and soldered in the middle of the brass spring, this is shown at (E), Fig. 1. Through the binding post, a large thumb screw is run. In the end of this screw is placed a small platinum contact which touches the platinum as placed on the brass spring. The vibrator is now ready to be mounted which is done according to the plan as given in Fig. 2.

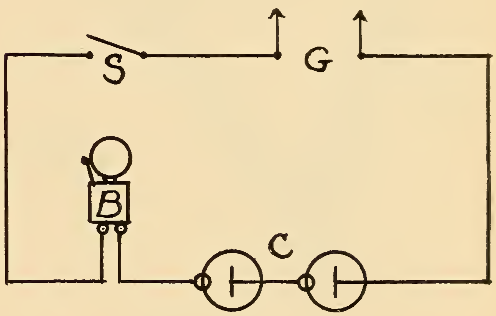
The connections are all as shown in Fig. 1, and the wires connecting the different parts may mostly be run in grooves in the bottom of the base board. To start the vibrator some little adjustment will be necessary; first screw up the thumb screw until it touches the platinum contact on the spring. If the battery is connected the vibrator should now start in operation with a buzzing noise. By turning the screw we can secure almost any desired adjustment.

ELECTRIC ALARM CLOCK.

A common alarm clock can easily be made to ring an electric bell instead of the regular alarm. The apparatus necessary to make this change consists of the following articles: An electric bell, two dry batteries, a switch, a few feet of bell wire and a little insulating tape.

The above apparatus is to be connected as in the diagram: Where (B) is the bell, (C) the dry batteries, (S) the switch, and (G) the gap in which the alarm clock is connected. This gap must be closed when the alarm is released and opened when it is not time for alarm to go off. It is therefore necessary to put an attachment on the clock which will open or close the gap as desired.

The easiest way to do this is as follows. Cut off two lengths of bell wire, each about a foot long. Wrap some insulating tape on one end of each piece. Then turn the alarm key on the back of the clock about five times, so as to wind the alarm a little. The insulated ends may then be fastened to this key, one on each side. The insulation should then be removed for a space of about five inches, starting a little way from the place where wires are fastened. The other ends of the wires must now be fastened securely to a wall or block of wood far enough away from the clock to prevent the wires from sagging and thereby coming into contact with each other. The wires should be fastened about one inch apart. To connect the clock in the circuit it is only necessary to connect a wire to each of the open points and to the bare wires on the clock. This completes the work and if you have done everything correctly the



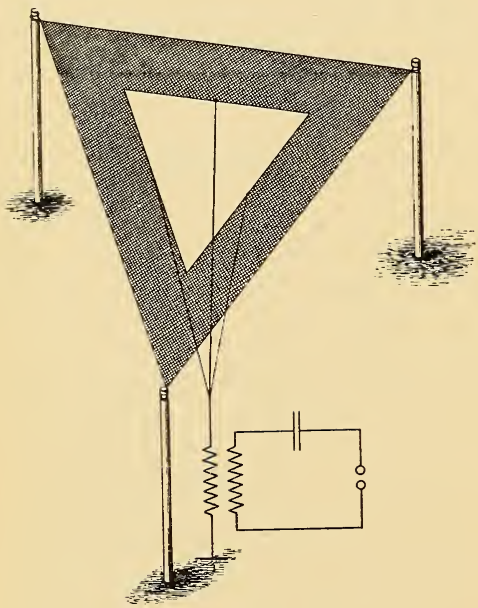
electric bell will not ring until the wires are twisted together by the alarm key, which turns around as the alarm goes off. The bell may be stopped by opening the switch, or, if you have no switch, the same thing can be done by removing a connection from the batteries or bell. When you wish to set the alarm, the key must be turned until the wires are not twisted. Then close the switch or replace any connections you may have removed.

A neat way to set up the apparatus is to make a box large enough to hold the batteries. A cover should be fastened on with hinges. The clock may be mounted on the cover and the wires fastened to the end of the box. The bell may be screwed on one side of the box and the switch on another side. The wires from the batteries may be brought out through holes in the box to make connection with the bell, switch, and clock. You will then have the apparatus in compact form.

NEW ELECTRICAL INVENTIONS.

WIRELESS TELEGRAPH ANTENNA.

The picture shown herewith is not an illustration of a kite although it has the appearance of being one. The device is the antenna for a wireless telegraph system and is the invention of Mr. Sewall Cabot of Brookline, Mass. The term antenna, as applied to wireless telegraph systems, has reference to the conductor which is used to radiate the invisible



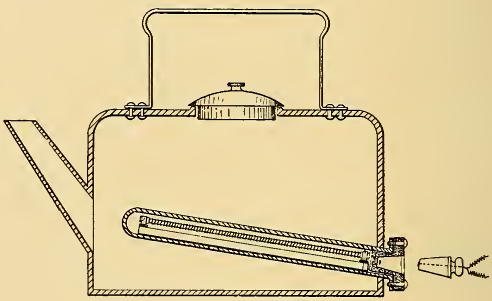
electric waves through space from the sending station and also to collect them at the receiving station. The antennæ of most wireless systems consist of one or more wires carried up vertically to a great height. In the case of Mr. Cabot's invention, however, the antenna consists of a triangular shaped wire net suspended from three poles in a plane parallel to the surface of the earth. From this net, wires are carried down to the telegraph instruments.

Wire net antennæ have been tried before this but Mr. Cabot has improved the idea by cutting out the central portion of the net, which he has found to play very little part in sending or receiving the waves. He thereby reduces the cost of construction.

ELECTRIC KETTLE.

Appreciation of the advantages of electricity for domestic purposes is by no means confined to the United States, although this country is the most lavish consumer of electric current. Here is an Australian, Mr. David Curle, of Kalgoorlie, who has patented an electric teakettle. The accompanying diagram shows the construction, which embodies an air-tight and water-tight chamber for the electric resistance coil which furnishes the heat.

The kettle is rectangular in cross section, and two heating coils are provided, only one of which is shown in the illustration. The coils extend nearly across from one side of the kettle to the other and the case in which they are contained has a large heating surface. Since the case containing the coil is entirely contained within the liquid to be heated, no heat can escape except into the liquid.



EXTRACTING METALS BY ELECTROLYSIS.

Electrolytic processes for obtaining metals from solutions are now quite commonly used. Copper, for instance, is recovered from solutions of copper sulphate by electrolysis. The copper sulphate solution is placed in a tank together with two electrodes. An electric current is then passed from one electrode to the other through the solution, and in its progress extracts the copper from the solution and deposits it on one of the plates in the metallic form. The principle is the same in an electroplating outfit.

In extracting some metals from solution of their salts, however, it is necessary to heat the solution to a high temperature, in some cases as high or higher than the melting point of the metal to be recovered. The metal would, therefore rapidly oxidize, or burn up, if it were to come in contact with the atmosphere.

The electrolytic apparatus shown in

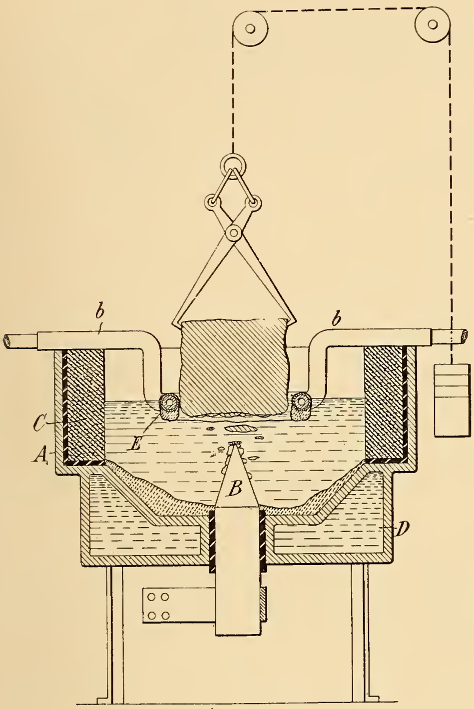


diagram will recover such metals without loss and is the invention of George O. Seward and Franz von Kügelgen of Holcombs Rock, Va.

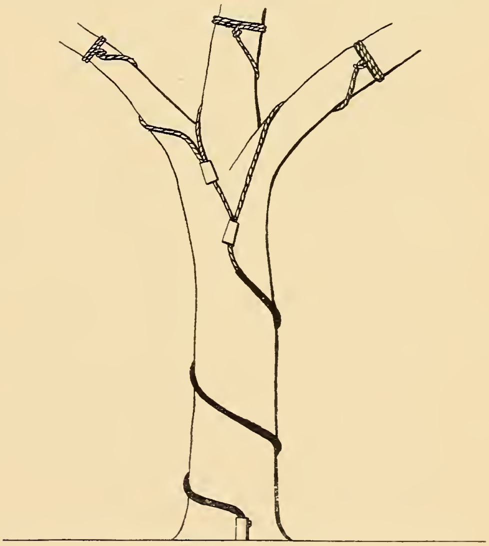
In the diagram, (A) is the tank containing the solution. One of the electrodes (B) comes up through the bottom of the tank and the other electrode (CC) is circular in form and extends around the upper part of the tank and is insulated therefrom.

Current passing through the solution, or electrolyte, as it is called, heats the latter sufficiently to keep it in the molten state. This current also separates the metal from the electrolyte, and the very small particles of metal rise and collect on the ring (E). This eventually forms a cake of the metal, which is gradually raised by the weight and pulleys as the deposit continues to collect on the under surface. It will be seen, therefore, that the deposit occurs always under the surface of the electrolyte and out of contact with the air, so that oxidation cannot take place. The tubes (bb) leading to the ring (E) have a constant circulation of cold water through them, as does also the compartment (D), so that the electrodes are kept at a comparatively low temperature.

The above process is used for extracting those metals and alloys, such as calcium, which are lighter than their molten electrolytes and which will rise and collect on the upper electrode, as shown in the illustration.

LIGHTNING PROTECTOR FOR TREES.

Mr. J. P. A. Anderson of Madrid, Ia., is the inventor of an ingenious method of protecting trees from lightning. It is obvious that the expense would be too great to permit of the broadcast use of the device, but there are many shade trees that are so highly valued that almost any pre-



cautionary steps would gladly be taken.

This unique lightning rod consists of a flexible copper rod or copper cable which is run up from the ground and branched out to the larger limbs of the tree. The branch conductors are attached to the main conductor by special clamping devices, and the ground is made by driving a heavy metal pipe into the earth and bolting the main conductor to the pipe.

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 everyone 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.

WHEN IS A CELL POLARIZED?

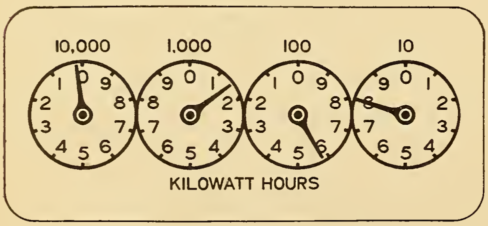
QUESTION.—What is meant when a battery cell is said to be "polarized"?—A. A. E.

Answer.—A cell is said to be polarized when so many hydrogen bubbles cling to the copper plate that the current of the cell is diminished. Hydrogen is one of the products arising from the chemical combination of the sulphuric acid (H_2SO_4) and the copper plate. It is a poor conductor of electricity and therefore insulates the surface of the plate to which the bubbles cling. The hydrogen also tends to recombine with the acid in the cell, which action gives rise to what is called counter electromotive force, that is, an electrical force opposite to that generated by the cell. This counter or "back force" weakens the current of the cell.

HOW TO READ A WATTMETER.

QUESTION.—How do you read a wattmeter and tell how much current is consumed each month?—W. H. W.

Answer.—Electricity is measured in kilowatt hours. At the top of the meter are located the four dials, as shown in the cut. The dial at the left measures the ten thousands of kilowatt hours, the second dial from the left, the thousands, the third dial the hundreds, and the fourth the tens. Now suppose that you wish to find how much current is consumed in a month, and that the dials at the beginning stand as shown in the cut.



In reading the dials it will be seen that less than 10,000 kilowatt hours are registered as the pointer on the first dial at the left stands between 0 and 1. Looking at the next dial the pointer stands between 1 and 2, so that there are over 1,000 kilowatt hours and under 2,000 registered. Looking at the third dial the pointer is between 5 and 6, so there are so far a little over 1,500 kilowatt hours registered. The amount over is registered on the tens dial, and as the pointer stands on 8 this dial reads 80. The complete reading is therefore 1,580 kilowatt hours. This is at the beginning of the month. At the end of the month read the meter again in the same manner. Suppose the reading is 2,340. The difference between the two readings is 760 kilowatt hours, the amount used during the month. The difference between any two readings of the wattmeter gives the amount of current consumed during the time elapsed between the two readings.

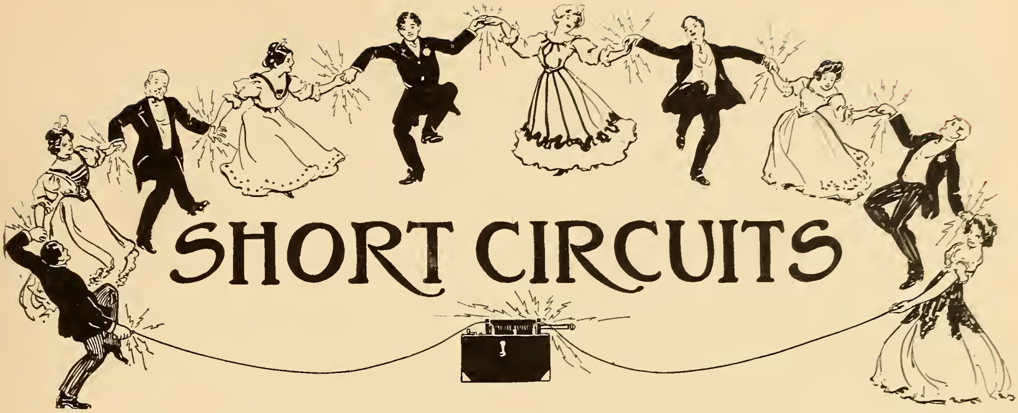
ELECTRIC HEATING.

QUESTION.—How does an electric cooking utensil, electric curling iron or other similar device derive its heat from electric current? —R. S.

Answer.—All electrically heated devices of this nature derive their heat from what are called resistance coils. These consist of coils of iron, German silver or platinoid wire small enough in cross section to present a high resistance to the electric current. As the current is forced through these coils a large amount of energy is required to do the work, which energy is dissipated in the form of heat, just as heat is generated by friction. The same effect is readily noticeable in an incandescent lamp. The filament presents a high resistance to the current and is consequently heated to incandescence.

ELECTRICAL WANTS.

Readers of Popular Electricity who are in need of any particular electrical device and do not know where it may be obtained can secure the necessary information by writing to this magazine. Such information will be gladly given at any time.



SHORT CIRCUITS

A shade bustled up to St. Peter.

"My good man," he said, "will you tell me where I must go to procure souvenir post-cards?"

And St. Peter, eyeing him sourly, told him where he could go to.—The Publisher and Retailer.

* * *

"How did you come to get mixed up in this altercation?" asked the prosecutor.

"Oi didn't come to git mixed up in it," answered Pat; "Oi come to collect a bill av foor dollars an' twinty-siven cints."—Sis Hopkin's Own Book.

* * *

On Saturday night Brown was arrested for running his automobile without the rear lights burning. Sunday he sang in a prominent church. In Monday's paper, in the police court news, it was noted that Brown was fined $5 for not having his rear lights lit, while the church notes contained a more cheerful item to the effect that Mr. Brown sang "The Lord Is My Light."

* * *

"The carriage waits without, my lord."
"Without what, gentle sir?"
"Without the left-hand running-board,
Without the French chauffeur,
Without a drop of gasoline,
Six nuts, the can of oil,
Four pinions, and the limousine,
The spark plug, and the coil,
Without the brake, the horn, the clutch,
Without the running-gear,
One cylinder—it beats the Dutch
How much there isn't here!
The car has been repaired, in fact,
And you should be right glad
To find that this much is intact
Of what your lordship had.
The garage sent it back, my lord,
In perfect shape throughout;
So you will understand, my lord,
Your carriage waits without."
—Harvard Lampoon.

* * *

A fisherman who, although a deacon in the church, sometimes allowed his imagination to carry him to extraordinary lengths in telling of the weight of the fish he had caught, was cautioned in this matter by his pastor. So he decided that on his next expedition he would include in his outfit a pair of scales and a note book, so that he could bring back conclusive proof to show the Doubting Thomases. Just before he started on his next trip there was a new arrival in the family and the fish scales were secured to weigh the new baby. To the horror of all concerned and to the utter humiliation of the deacon the infant was found to weigh 47 pounds.

Little Edna—"What is 'leisure,' mamma?"

Mamma—"It's the spare time a woman has in which she can do some other kind of work, my dear."

* * *

Lady: Mr. Conductor, could I get a shock if I put my foot on the rail?

The Conductor: Yes, mam, if you put the other foot on the trolley.

* * *

A first grade boy brought perfect spelling papers home for several weeks and then suddenly began to miss five or six out of ten.

"How's this, son?" asked his father.

"Teacher's fault," replied the boy.

"How is it the teacher's fault?"

"She moved the little boy that sat next to me."

* * *

Ambling Ike: Lady will you please give me something to eat?

Lady: What kind of work can you do?

Ambling Ike: I am a lineman for a wireless telegraph company.

* * *

Millionaire at Telephone—"Who is that talking? Central Hospital did you say? What my son taken there this afternoon, and brain fever? Oh, no, that isn't my son."

* * *

Voice at Other End—"Hello! Hello! Miss Emily? Will you marry me?"

Miss Lastchance—"Yes, yes! Who is this, please?"

* * *

In order not to expose his ignorance the schoolboy gave an ambiguous reply when asked in examination: "Which was the greater general, Cæsar or Hannibal?" The boy answered: "If we consider who Cæsar and Hannibal were and ask ourselves which of them was the greater we must unhesitatingly answer in the affirmative."

* * *

As Jones staggered home very early one morning he paused for a moment to rest his aching head against the iron frame surrounding a tree. When he decided to proceed upon another section of his journey he grasped the bars and cautiously felt his way completely around the outside of the frame. Then he was seized with a horrible feeling of despair and sank to the earth with a groan—"Locked in!"

* * *

When a woman starts an idle rumor it at once ceases to be idle.

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.

ELECTRIC RAILWAY ON THE FRENCH-GERMAN FRONTIER.