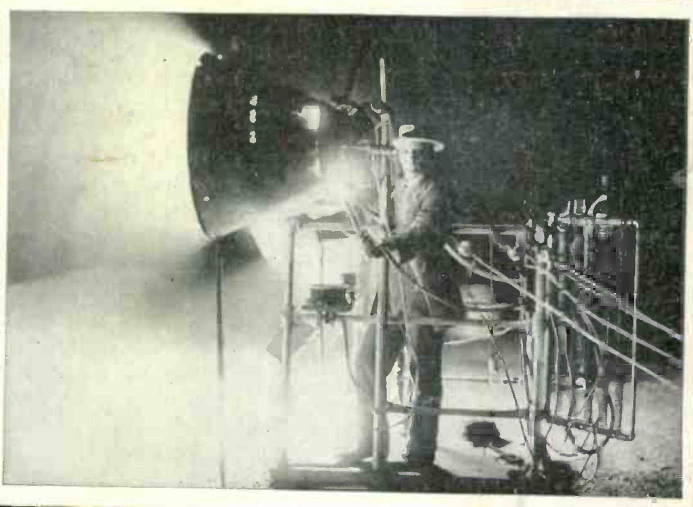
PRICE 10 CENTS

IN THIS ISSUE { Playing Baseball at Night
Every Man an Electric Runabout

# POPULAR ELECTRICITY

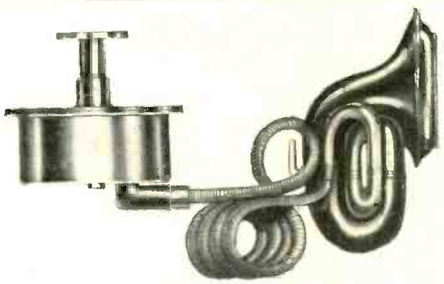
Trade Mark

## IN PLAIN ENGLISH

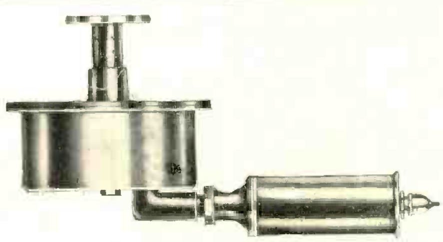


Searchlight for Illuminating Baseball Field at Night

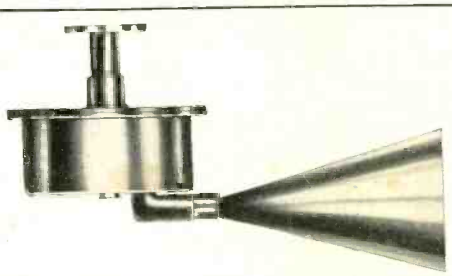
Vol. II. AUGUST 1909 No. 4.

Use It with the Regulation Auto-Horn



Or Apply the Beautiful Two-Toned Whistle



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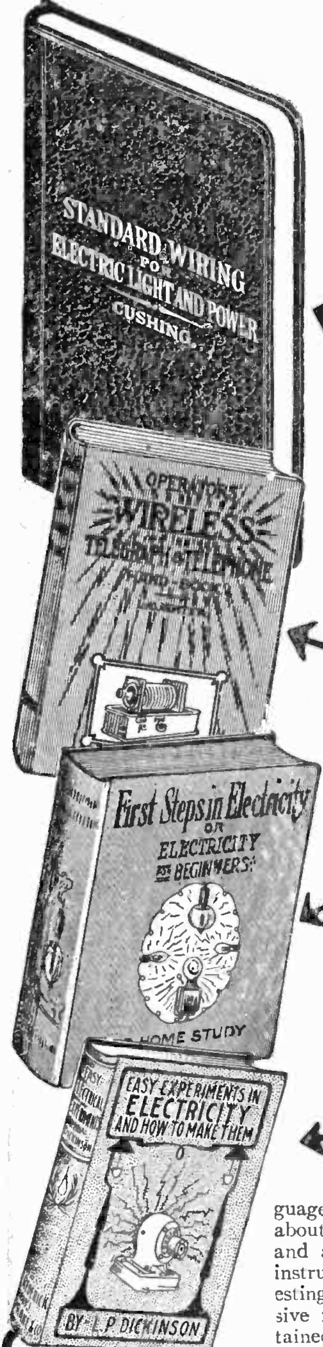


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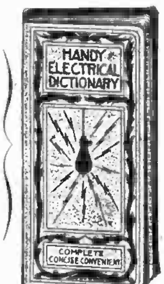


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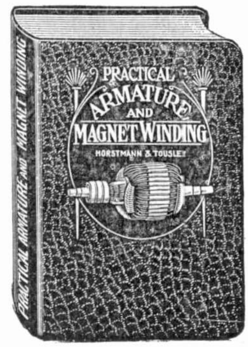


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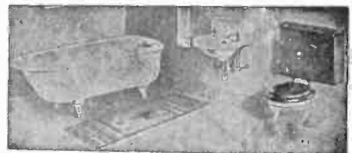

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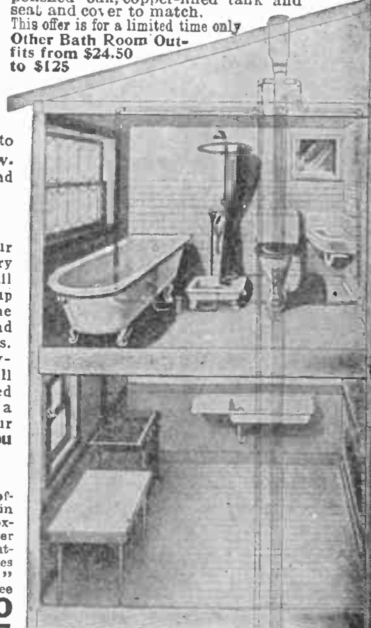

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# POPULAR ELECTRICITY

IN PLAIN ENGLISH

HENRY WALTER YOUNG, Editor

Vol. II AUGUST, 1909 No. 4

## CONTENTS



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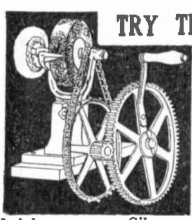

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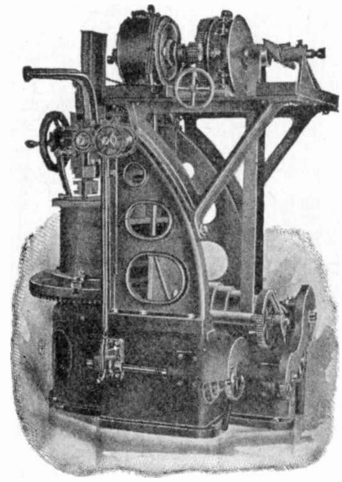

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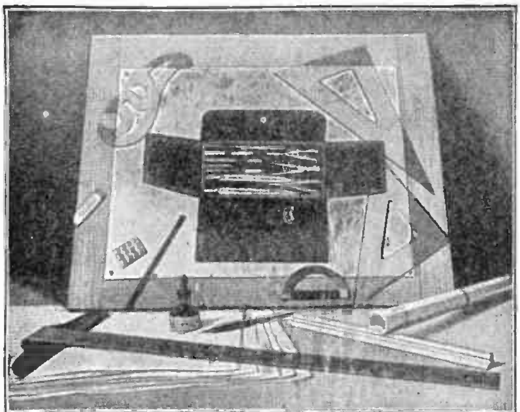

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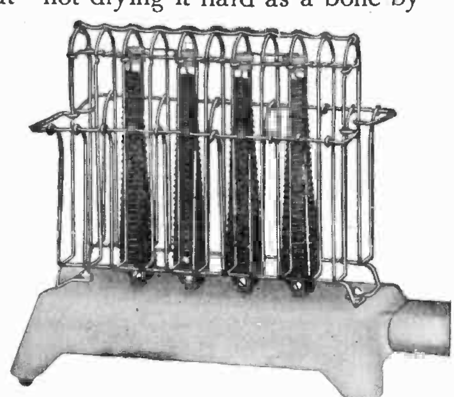

This adds a touch of interest to the convenience and usefulness of the toaster, and the novelty of watching the slices assume a golden brown color appeals to the appetite.

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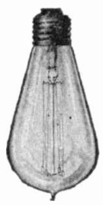
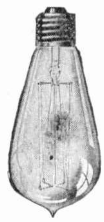


**Least**

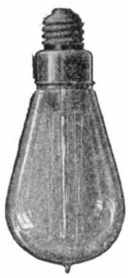
40 watt



**to**

40 watt (skirted)

60 watt

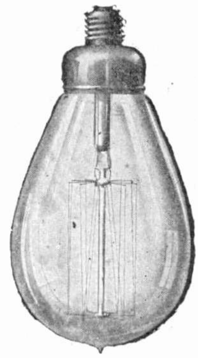


**the**

100 watt

**Greatest"**

250 watt



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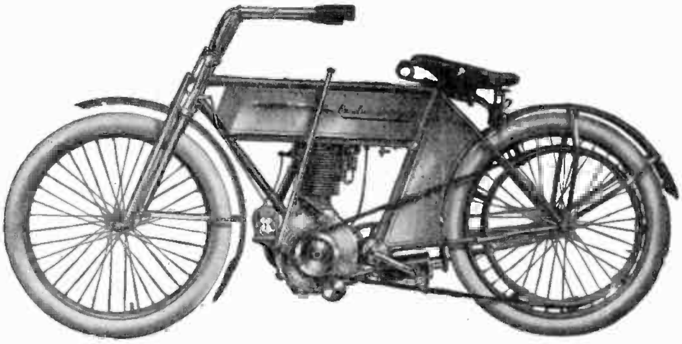

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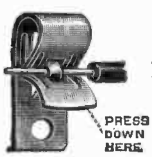


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GEORGE SIMON OHM

POPULAR ELECTRICITY
IN PLAIN ENGLISH

VOL. II AUGUST 1909 No. 4

# GEORGE SIMON OHM

The man who by independent discovery and announcement of a law in Nature's observed operations laid one of the foundation stones of modern electrical science and achievement

What is Ohm's law? Why is the unit of electrical resistance called the Ohm? These questions are best answered by a brief sketch of the career and work of George Simon Ohm, who lived more than a century ago, and for whom the law and the unit were named.

Ohm's law is known to everyone who makes the application of electricity a study. The discovery and announcement of this law by Ohm brought order and understanding where confusion had before reigned, for it is this simple law which governs all the operations of direct current electricity.

This law observed by Ohm is that the intensity of the current (measured in amperes) is directly proportional to the exciting force (measured in volts) and inversely proportional to the total resistance (measured in ohms). Stated another way: Current equals electromotive force divided by resistance; or, as we most often see it written $C=\frac{E}{R}$. Knowing any two of these factors we are able to find the third by solving the equation.

The unit of resistance to the flow of electricity was also named after Ohm and is defined as the resistance offered to an unvarying current of electricity by a column of mercury, at the temperature of melting ice, having a height of 106.3 centimeters, a uniform cross-sectional area and a weight of 14.452 grams.

Ohm was born at Erlangen, Germany, in 1789. His father was a humble locksmith, athirst for knowledge. An able mathematician himself, he taught his son mathematics, and trained the boy in the locksmith's trade.

Young Ohm grew up in the love of his electrical research work, and the treatise in which he first announced his great discovery, entitled "The Galvanic Battery Treated Mathematically," has become a famous classic of science. This was published at Berlin in 1827.

An independent discovery of the law governing electrical current flow was made by Cavendish in 1781, but it was not publicly recognized until the work of Ohm was done. Ohm obtained his results chiefly by experiment.

In 1841, the Royal Society of England honored him with the Gold Medal for the "most conspicuous discovery in the domain of exact investigation."

He died of epilepsy on July 6th, 1854, at the age of 65. His Spirit, devoted on earth to the search for Truth, still lives as a power in the great Cause World.

# ELEMENTARY ELECTRICITY

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

## CHAPTER XVI.—FRICTIONAL AND ELECTRO-STATIC ELECTRIC MACHINES.

There are various forms of electric machines that depend for their operation on friction. Before being able to understand them, however, it is necessarv that an explanation be made as to the manner in which electricity can be produced by what is called induction.

Perhaps the simplest definition of electrostatic induction is the influence produced by an electric charge on a neighboring body through an intervening non-conductor. Suppose, for example, that the insulated metallic sphere (C), Fig. 102, is given a positive electric charge, and is then brought near an

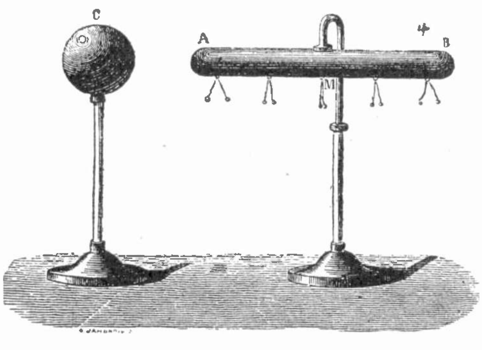



FIG. 102. ELECTRIFICATION BY INFLUENCE

insulated metallic cylinder (AB), provided with a number of pith ball electroscopes. Although the two cylinders are separated by a fairly considerable mass of air, a non-conducting substance, the charge on (C) produces an electric charge on (AB), as is shown by the repulsion of the pith balls. The amount of this repulsion is greatest both at the end (A), nearest (C) and at (B) furthest from (C), the divergence becoming less as we pass from either end towards the middle of the cylinder.

The electrification thus produced by an electric charge in a neighboring body through an intervening non-conductor is known as electro-static induction. In order to distinguish this induction from that produced by a magnet, it is sometimes called influence. The term electrostatic induction, however, is more frequently employed.

It can be shown that the charges produced in the cylinder (AB) consist of opposite electricities. If the sphere (C) is charged with positive electricity, then the charge at the end (A), nearest (C), is negative, while that at the end (B), furthest from (C), is positive. The character of these charges can be determined by bringing a rod of sealing wax, rubbed so as to become negatively excited, into the neighborhood of the pith balls at (A). The fact that these are further repelled shows that their charge is negative, or the same as the charge on the sealing wax. If, however, the sealing wax is brought into the neighborhood of the balls at (B) they are attracted, thus showing that they contain a positive charge.

What takes place in the above experiment is as follows: According to the single-fluid hypothesis, which we shall use on account of its greater simplicity, the free positive charge on the insulated cylinder repels the electric fluid in (AB) to the end furthest from (C), thus giving that end a surplus of electricity and rendering it positive, at the same time leaving a definite amount of electricity at the end nearest (A), thus making it negative.

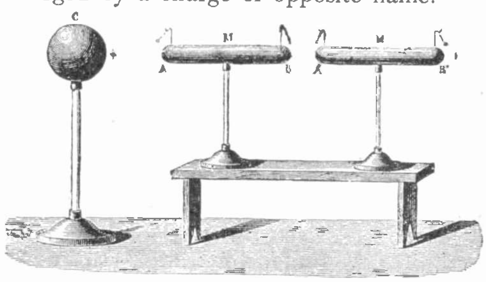
If the cylinder (AB) is slowly moved away from (C), care being taken not to touch it, the pith balls will show a smaller and smaller divergence until, when a certain distance is reached, varying with the value of the charge in (C), they will come together showing that the cylinder has completely lost its induced charge.

If, however, while under the influence of (C) the cylinder is momentarily touched, say near the end (B), by a body connected with the earth, as by a person standing near it, then, on its removal from the neighborhood of (C), it will be found to possess a permanent electric charge which is negative over all parts of its surface.

It is not difficult to see why a body can only be permanently electrified by induction when momentarily touched by an earth-connected body. When the cylinder (AB) is touched, the repulsion produced by the positive charge on (C) drives the positive electricity to the ground. The negative charge near the end of (A) however, remains on the cylinder, being held in place by the attraction of the opposite charge on (C).

When (AB) is removed from the influence of (C) its charge, being no longer held in place, is free to distribute itself evenly over the entire surface.

It is evident that charges produced by induction must always consist of the two opposite electricities; that these charges will manifest their presence only while the charged body remains in the neighborhood or influence of the electrified body. If, however, during this time the charged body be momentarily connected with the earth, it will lose a charge of the same name as the inducing body and become permanently charged by a charge of opposite name.



103. ELECTRIFYING A SERIES OF CONDUCTORS BY INFLUENCE

It is possible to produce successive electrifications by induction. If, for example, two insulated metallic cylinders (M) Fig. 103, be brought as shown in the neighborhood of a positively charged insulated sphere (C), then alternate negative and positive charges will be produced by induction on the ends of (M) and (M) as marked, negative charges being found on the ends (A) (A′), situated nearest (C), and positive charges on the ends (B) (B′), furthest from (C), the presence of these charges being manifested by the movements of the pith balls as shown.

It is evident, from the above, that an electric charge may exist on the surface of an insulated body in two different ways; namely, in what is known as a free charge, and in what is known as a bound charge. A free charge is immediately lost by an insulated body when touched to an earth-connected body. The bound charge, however, remains on the insulated body, notwithstanding the fact of its being connected with the earth, since it is held in place by the attraction of an opposite charge.

We are now able to understand why an electric charge produces alternate attractions and repulsions in unelectrified bodies brought near it. Electric attraction is invariably preceded by electrostatic induction. Suppose, for example, Fig. 104, (C) is an insulated body containing a positive charge, and that (ab) is a movable body suspended by an insulating thread. On the approach of (C), induction occurs in the movable body, a negative charge being produced on the side nearest (C) at (a) and a positive charge on (b), the side furthest from (C). Under the influence of the opposite charges the movable ball is drawn towards (C). It there has its negative charge neutralized, and becomes charged with the same kind of electricity that exists in (C), i. e., positive electricity, is now repelled.

If the movable body has no means for losing its positive charge, it will remain repelled for a long while. If, however, it is able by repulsion momentarily to touch an earth-connected body, it loses its charge, again receives opposite charges by induction, and is again attracted or repelled, the alternate motions being kept up as long as a charge remains in (C).

The non-conducting medium existing between the charged body and the body in which electro-static induction takes place is known as a dielectric. All non-conductors of electricity are capable of acting as dielectrics. They differ, however, considerably

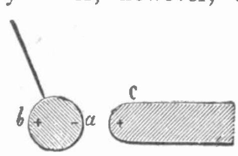


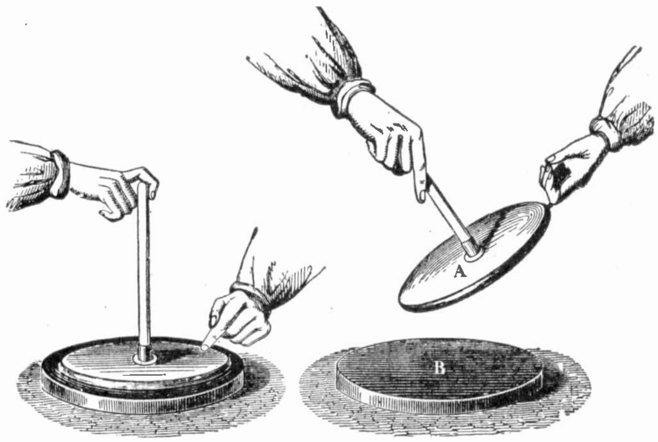

FIG. 104. ILLUSTRATING ELECTRO-STATIC INDUCTION

in their power of thus permitting induction to take place through them. For example, if a plate of thick glass is placed between the insulated sphere (C) and the end (A) of the insulated cylinder, the induction will not only take place through the glass, but will take place more freely as will be indicated by the greater repulsion of the pith balls.

In the following table the dielectric capacity, or specific inductive capacity of different non-conductors are given, or the ability to permit electrostatic induction to take place through them. In this table the dielectric capacities of the different substances are compared with air taken as unity.

| | |
|---|---|
| Air | 1.00 |
| Solid Paraffine | 1.99 |
| India-rubber | 2.22 |
| Vulcanite | 2.28 |
| Gutta Percha | 2.46 |
| Sulphur | 2.58 |
| Shellac | 2.74 |
| Glass | 3.25 |

The first, if not the simplest form of electric machine for producing electricity by friction was an instrument invented by Volta and known as the electrophorus. This device consists, as shown in Figs. 105 and 106, of a cake of resin (B) about twelve inches in diameter and an inch in thickness, placed in a metallic dish. The simplest way to form this cake is to melt equal parts of ordinary resin and shellac in a metal plate. When thoroughly fused and mixed together remove the pan from the source of heat, placing it on a flat support and taking care before the liquid hardens to break up any air bubbles that may form. When hardened there will be produced a smooth surface of resin filling the metal pan.



FIGS. 105 AND 106. THE ELECTROPHORUS

The remaining part of the electrophorus consists of a metallic disk (A), smaller in diameter than the resin disk (B), provided with an insulated glass handle, so that it can be moved without touching its metallic surface.

The electrophorus is operated as follows: The disk of resin (B) is given a negative charge by rubbing it briskly with a piece of cat's skin. The metallic disk (A) is then placed in the middle of (B) and momentarily touched by a finger. It immediately parts with a negative charge, so that when removed from the resin, it will

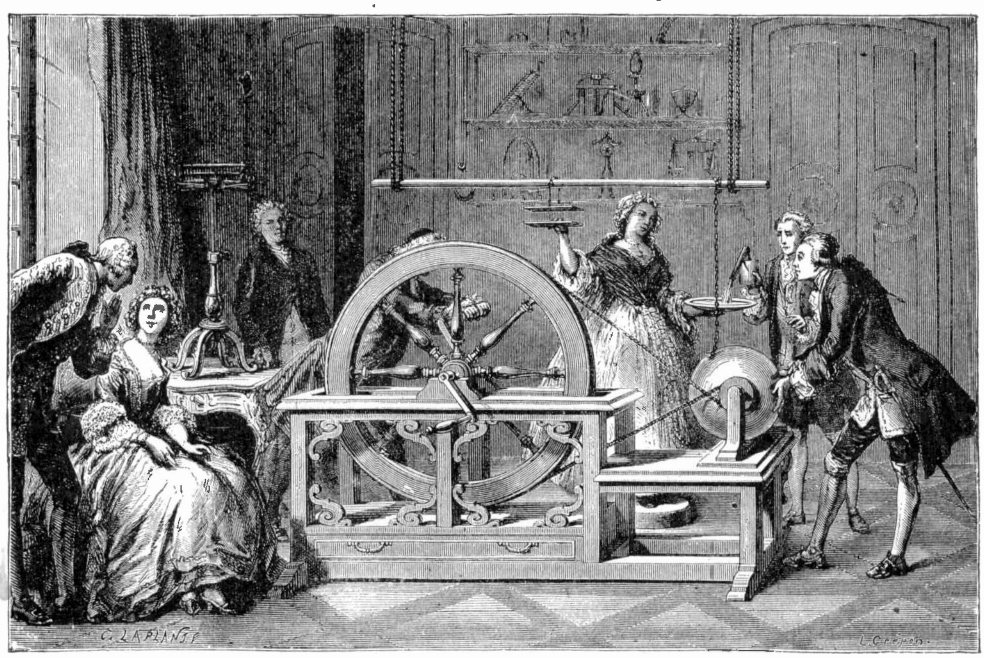


FIG. 107. HAWKSBEE'S FRICTIONAL ELECTRIC MACHINE

possess a positive charge, and if, while being held in one hand by the glass rod, it is held near the knuckle of the other hand, a bright spark accompanied by a crackling sound will be produced.

The explanation is evident. When the metallic disk is placed on the negatively charged resin surface, a positive charge is produced on its surface near the resin disk;

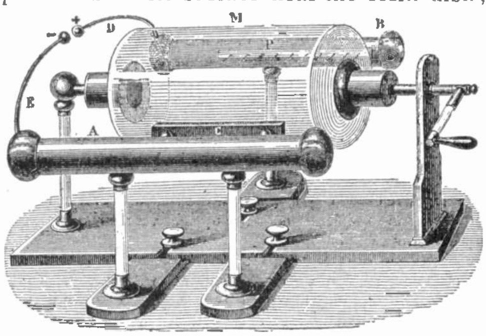



FIG. 108. EARLY METALLIC COMB MACHINE

and a negative charge on the surface furthest from it. While momentarily touched, it loses this negative charge and, therefore, remains positively excited after its removal from the resin.

Electricity produced by means of friction was originally obtained by rubbing glass rods with silk handkerchiefs. The first frictional electric machine was devised by Guericke, the inventor of the air-pump. This machine consisted of a ball of sulphur, the friction being produced by the hands of an assistant held against the ball while rotated. Fig. 107 represents Hawkesbee's modification of Guericke's electric machine in which the ball of sulphur is replaced by a hollow globe of glass. The construction and operation of the machine will be understood from an examination of the above figure, as will also the means employed for carrying, by a metallic chain, the charge so produced on the glass to a conductor consisting of a metallic rod suspended from silk cords attached to the ceiling of the room. In the figure a woman is seen standing on an insulating cake of resin holding one hand near the insulated rod and in the other a metallic disk that receives the electricity through her body. The rotation of the sphere by means of a cord passed over the wheel and pulley is also shown.

The simple electric machines of Guericke and Hawkesbee were greatly improved by two additional devices. The first consisted of a leather cushion to press against the surface of the rotating globe and thus replace the friction of the hand. An amalgam, consisting of a mixture of tin and mercury was spread over the surface of the cushion that was pressed against the glass by means of springs.

But the most important addition to the early machine of Hawkesbee was a metallic comb or series of points that, as shown in Fig. 108, were connected with an insulated metallic cylinder (B), known as the prime conductor or positive conductor of the machine. A similarly insulated metallic cylinder (A) electrically connected with a piece of metal containing the leather cushion, forms the negative conductor. When these two conductors (A) and (B) were brought near together by rods, (E) and (D) on the turning of the handle of the machine, the friction of the rubber against the glass, produced a series of electric sparks.

The action of the comb or points is as follows: The increased density of the charge at the points, produces, as already mentioned, an electric wind or convective discharge that is blown against the surface of the rotating plate, thus giving it a charge of the same name as that on the pointed conductor. This wind consists of molecules of air that have received minute charges from the electrified pointed surfaces.

It has been found that in order to obtain the best results in the use of the positive

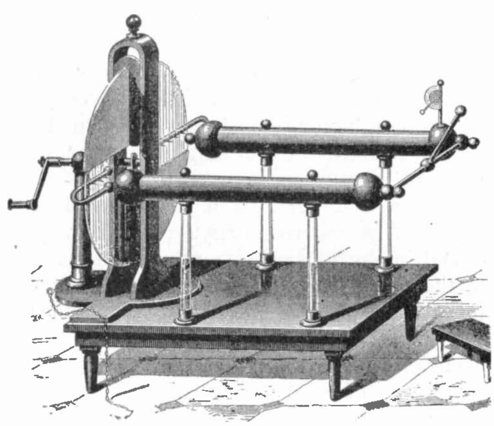


FIG. 109. RAMSDEN'S FRICTIONAL MACHINE

electricity produced on the prime conductor it is necessary to connect the negative conductor to the ground by means of a metallic chain.

A modification of the cylinder machine was the plate machine of Ramsden, represented in Fig. 109. Here, the glass cylinder is replaced by a circular glass plate mounted on a horizontal axis, so as to be rotated between two leather cushions covered with amalgam and placed, as shown, so as to press against both surfaces of the plate at the upper and lower part of its diameter. On rotation, the plate becomes charged with positive electricity, which is conveyed to a prime conductor, consisting of two horizontal insulated cylinders, by means of a series of metallic points connected, as shown, with the cylinders. The best results are obtained when the negative charge, produced in the rubbers, is permitted to escape to the earth by means of the metallic chain represented in the lower left-hand side of the figure. In order to prevent a loss of electricity from the charged glass plate, quadrants of oiled silk are placed as shown so as to cover both sides of these portions of the plate.

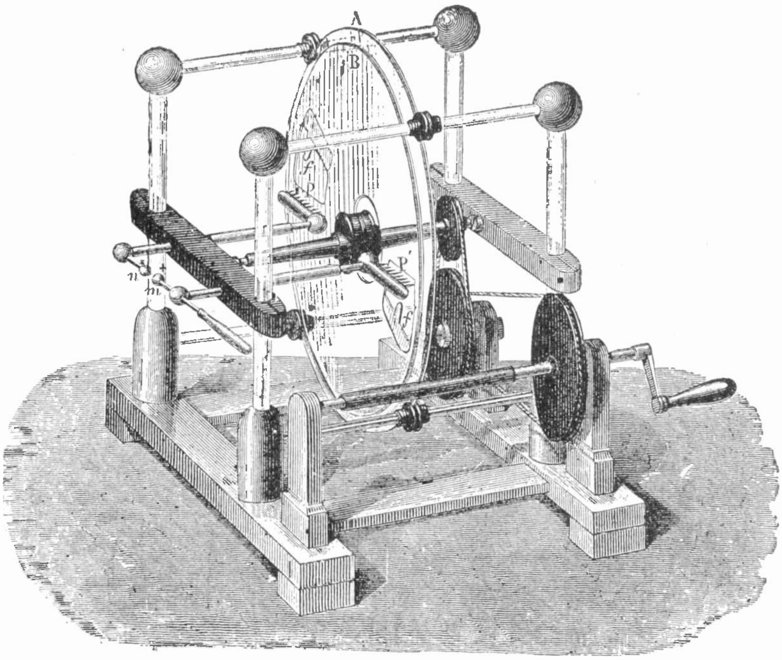



FIG. 110. THE HOLTZ MACHINE

A frictional electric machine has its best action when the air is dry and free from moisture. It is also necessary to avoid the collection of dust either on the surface of the glass plate, or on the conductors, since the dust particles acting as points, will permit leakage into the air, thus decreasing the amount of useful electricity obtained.

The older forms of frictional electric machines are now generally replaced by machines that operate on the principle of a revolving electrophorus. Such machines are known as electrostatic induction or influence machines. When properly constructed and operated they are capable of producing powerful discharges in practically all kinds of weather.

A common form of influence machine known as the Holtz machine is represented in Fig. 110. It consists of two glass plates (A) and (B), thoroughly insulated from each other and from the ground. The smaller of the plates (B) is so supported on a horizontal axis that it can be rotated close to the surface of (A) by the turning of the handle. The fixed plate (A) is provided with two large openings or windows, placed as shown near its horizontal diameter. Paper bands or armatures (f), (f′), are glued to the plates across the windows so as to partially cover them. Each of these

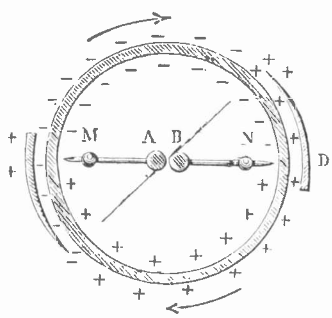



FIG. 111. DIAGRAM OF ACTION OF HOLTZ MACHINE

armatures is provided with a paper point extending in a direction opposite to that in which the plate is rotated. Two metallic combs (P), (P′), placed opposite the windows on the side of the revolving plate furthest from the fixed plate, are connected with two insulated conductors that are provided with polished metallic balls (n) and (m). These conductors become respectively charged with negative and positive electricity. The distance between them can be altered by the movement of (m) towards or from (n) by an insulated handle.

In order to start the machine, (m) is brought into contact with (n), and one of the armatures, say (f), is charged by holding

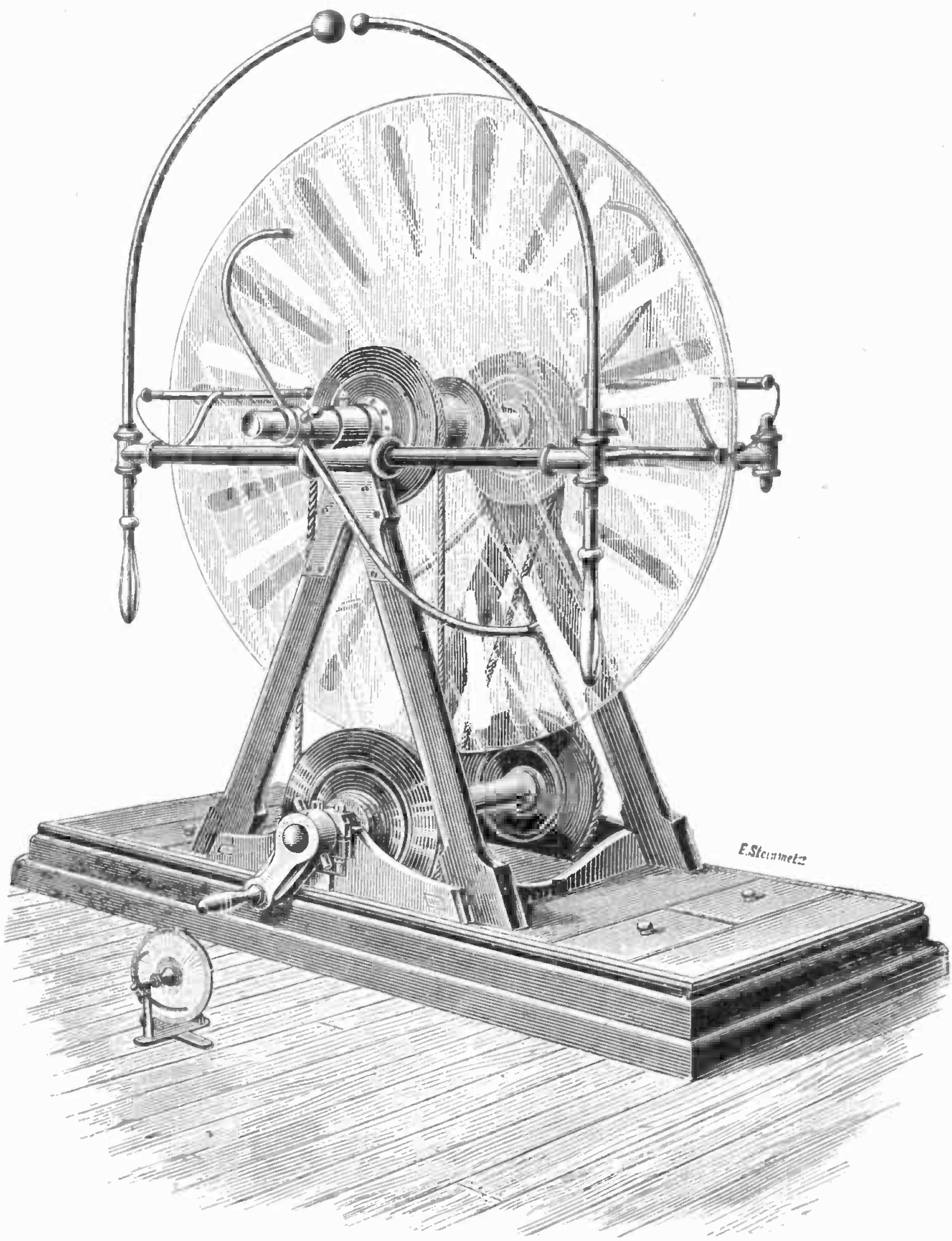



FIG. 112. THE WIMSHURST MACHINE

against it a sheet of vulcanite that has been negatively electrified by friction. After turning the plate for a few seconds the knobs are gradually separated when an electric discharge passes in the gap between (m) and (n).

The operation of the Holtz machine is thus described by Prof. Sylvanus P. Thompson, in his translation of Guillemin's "Electricity and Magnetism." In Fig. 111, the paper armatures on the fixed plate are represented by two segments (D). (A) and (B) are the conductors terminated by points (M) and (N) corresponding to the metallic combs of the machine. The movable plate is represented by circular lines so as to avoid confusion. The arrow shows the direction of rotation of the plate, which, as will be seen, is opposite to the direction in which the tongue of paper on each paper armature extends.

Suppose, now, that a sheet of rubbed vulcanite is brought into contact with the broad portion of the paper armature opposite (D), thus producing a positive charge in the near portions of the paper, and a negative charge near the tongue. The tongue now sets up a charge in the back of the rotating plate. Since the conductors (A) and (B) are in contact, the negative charge escapes from the comb (M) onto the glass, and a positive charge from the comb (N). The other paper armature is thus electrified by induction and a discharge of positive electricity from its point leaves its wide portion negatively charged.

The result of the above actions is to charge the rotating plate on both its front and back, one-half with the negative charge and the other half with a positive charge. The mutual reactions of these opposite charges from both the paper points and the comb rapidly increase until in a few moments the conductors can be drawn apart when a torrent of sparks passes between the balls (n) and (m).

There are a great variety of influence or induction electric machines. One of the most important is known as the Winshurst induction machine. In this machine, as shown in Fig. 112, there are two plates of glass that are rotated in opposite directions. Broad strips of metal foil, called sectors, are glued to the front of the front plate, and to the back of the back plate. These sectors act both as carriers and inductors. An uninsulated diagonal conductor, provided at its ends with metallic brushes, known as neutralizing brushes, is arranged so as to touch the front sectors at the ends of a diameter. A similar uninsulated conduc or extending in the opposite direction is placed across the back plate.

It is not necessary to start a Wimshurst machine by bringing a charged plate of vulcanite against any of its sectors, since the friction of the neutralizing brushes produces a charge sufficient for this purpose.

(To be Continued.)

## THE ELECTRIC SYSTEM OF THE FUTURE

Philip Torchio, well known electrical engineer, made the following interesting forecast of the future developments of the electric light and power industry of this country, in a paper before the convention of the National Electric Light Association recently held in Atlantic City. "In the progress of the gradual uplifting of the industrial efficiency of the country, it is the province of the central station companies to furnish to the nation all of the power required by it in all commercial, industrial and agricultural needs. With thousands of central stations dotting the map of the United States from East to West and from North to South, with a closely woven network of power wires connecting the heaviest centres to the most humble hamlets, is it not reasonable to expect that this wonderful organization should ultimately command and control within this territory the generation and distribution of power for everything that lights, or heats, or operates machinery, or propels vehicles or trains?"

## POWER TRANSMISSION THROUGH SPACE

It has been widely reported in the newspapers that electric current for the illuminations at the recent Omaha electrical show was furnished by wireless apparatus, and many were the rash statements about hundreds of horsepower transmitted through space. As a matter of fact no one has been able thus far to transmit anything like a small fraction of a horsepower, even, in this manner. What was done at Omaha was to simply send out waves as in wireless telegraphy, the power of which was comparatively insignificant. But the power was sufficient to affect a detecting device, as in wireless apparatus, and through this detecting device a secondary wire circuit was closed, which, in turn, was able to close the circuit of the lighting current from the regular city light wires.

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### THE STORY OF ELECTRICAL WIRE

The very root and branch of the electrical business is wire. Millions of pounds of copper, iron and aluminum are made up into all sizes of wire every year. Some of these wires are as large as a man's wrist and others are so fine that a million feet of it would weigh but 25 pounds. Most of this wire has to be carefully insulated.

The telephone, the telegraph, signals, electric bells, the ocean cable, the electric light, and nearly every other application of electrical energy would be impossible were it not for the bars of steel and copper converted yearly into wire.

Excavations in Egypt have brought to the surface ornaments of wire, showing that the art of making it was practiced thousands of years ago. The method employed by the ancients was very different from that of the present, the old way being to beat metal into thin sheets which were cut into continuous strips, these being rounded by hammering and filing.

Apparently this method was employed until the fourteenth century when the steel die plate came into use. At first, wire was drawn entirely by hand, but in the latter part of the Fourteenth Century a machine was made to operate by water power and the production of wire became more of a commercial process.

The die plate was a German invention and nearly three centuries passed before it was introduced into England. For many years the industry was comparatively unimportant, but during the last half century the uses for wire have increased until it is now giving a service the value of which can scarcely be estimated.

To produce wire requires the treatment of a large number of metals, and varied processes of manufacture. Bars of metal, four inches square, are heated and passed while hot and plastic through rapidly revolving rolls, reducing them to wire rods which vary from one-quarter of an inch to an inch or more in diameter, depending upon the finished size of wire wanted.

These rods, which are formed into coils as they pass through the rolls, are dipped in acid baths to remove loose scale and provide a lubricant for drawing. Drawing consists of pulling rods while cold through holes of gradually decreasing diameter drilled in steel plates. During this process the particles of metal become elongated and strained, making the wire harder and more brittle. To restore it to a proper temper, it is necessary to heat or anneal it.

When a very fine diameter is required, there must be repeated annealings and drawings. This may be done until the bar, which originally was four inches square and four feet long, becomes reduced to a diameter of a single thousandth of an inch and extended 13,000 miles in length. Before so fine a size is reached the wire will cut into the steel of the die plate, so the usual die plates must be discarded and the drawing continued through holes drilled in diamonds, the diameter of these diamond dies decreasing by fractional parts of a thousandth of an inch. This wire affords a striking illustration of a material made more valuable by the application of labor.

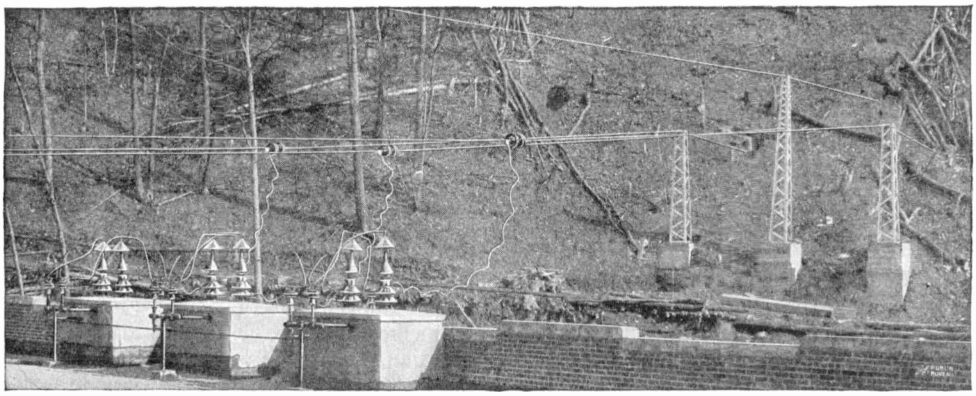
From the time the bar of metal enters the furnace nothing is added to it. All the work is done with one article which is passed through rolls and drawn through die plates until it is finished. Steel wire, for instance, may be made from an extra high grade of steel worth in the bar six cents a pound, which is much above the price of the greater bulk of steel. In the finished wire the value is increased from six cents to $50.00 a pound.

The insulation of wire for electrical work is one of the most important processes. If it wasn't for the many ingenious machines which cover all sizes of wire with the silk, rubber, linen and varnish insulating material the cost of all electrical devices would be far higher than it is today. The machine which winds the silk threads on the tiny copper wires, such as are used for electric bells, etc., works with almost human precision and wisdom and at a speed no human hands could hope to attain.

It was also found that electrical cables kept better if they were covered with a tube of common lead, so some genius set to work and perfected a machine to do this work. The cables, properly covered with insulating material, go in one end of this machine and come out of the other encased in a perfect tight fitting tube of shiny lead.

The wires, properly insulated, are wound on spools and reels and stored away until the time comes for them to take their place in the electrical world.

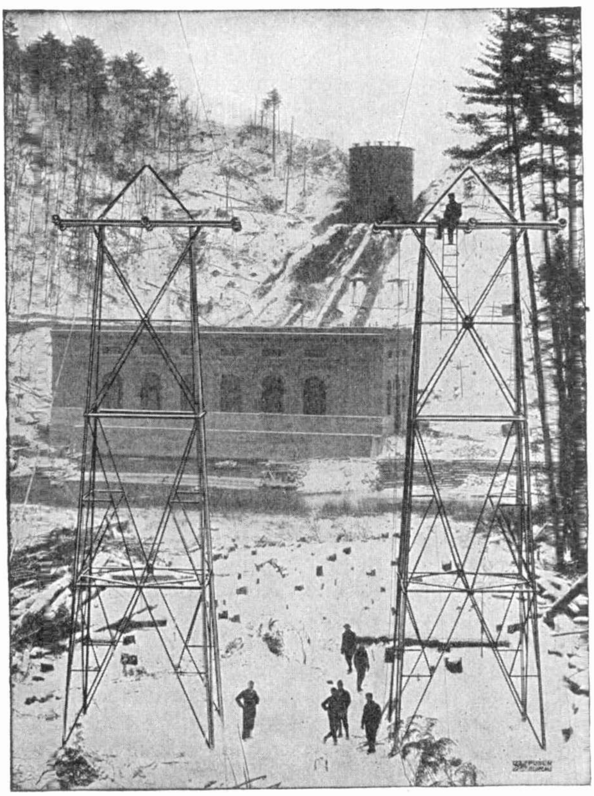
# THE MAKING OF A TRANSMISSION LINE



THE WIRES EMERGE FROM THE ROOF OF THE POWER HOUSE

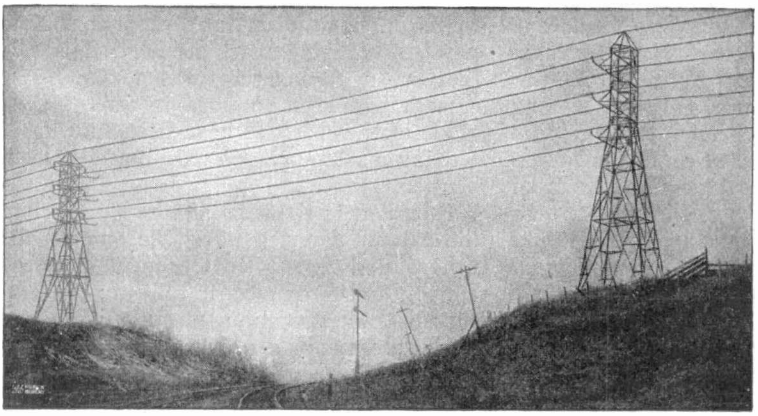
From Schaghticoke, on the Hoosic River, to Schenectady, in New York State, a distance of 21 miles, there stretches away across the country a line of skeleton steel towers which support six cables of hard drawn copper wire. Each cable is made up of seven strands, equivalent in all to a single wire a little less than half an inch in diameter, yet each three of these cables, forming what is known as a three phase circuit, is capable of transmitting 8000 horse-power of electrical energy, which is generated by the busy waters of the Hoosic and available in the distant city an infinitesimal fraction of a second after its production. Stand for a moment and watch the line. Not a spark is to be seen—not a sound heard. Yet in those insignificant appearing wires the power of 16,000 horses is confined and directed.

There is something mystifying and almost awe inspiring about the force which lives in these wires, though not more wonderful, perhaps, than the physical phenomena of light or heat or life; all indefinable. But the line itself, which we can see, is the work of man, and over it is transmitted this wonderful electric power, which he has never seen, and may never be able to exactly explain. The mechanical elements entering into the construction of a big power transmission line are therefore tangible and very interesting even to the layman. The accompanying views, obtained through the



BEGINNING OF THE LINE, SHOWING POWER HOUSE courtesy of the General Electric Review, show some of these features.

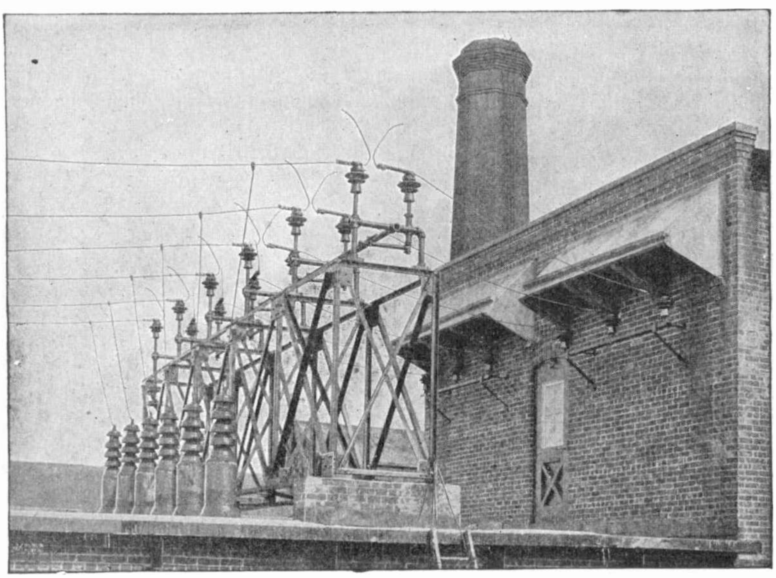
The current is generated by the water driven dynamos, transformed to 32,000 volts pressure, and the wires carrying it emerge from the power house to insulators mounted on the roof. Immediately over these insulators are stretched the line cables, held rigidly by anchor towers. The transmission cables and the terminals from the interior are then connected. One of the views shows the power house and first pair of towers and another shows the top of the power house and the anchor poles as described.


A LINE OF STEEL TOWERS ACROSS THE COUNTRY

Owing to the irregular contour of the country through which the line passes, the spacing of the towers varies within wide limits. The standard span is 600 feet, but other spans range all the way from 150 feet to 1263 feet in length, the latter distance being required where the line crosses Sanders Lake, situated near Schenectady. Where the line crosses the Hudson River the span length is 1125 feet; the line was carried across on standard angle towers. However, in order to obtain the required clearance, it was necessary to increase the tension at which the cables were strung to about 3000 pounds per cable, the average tension of the cables throughout the line being approximately 2300 pounds.

In designing the transmission line an extreme wind velocity of 85 miles per hour on the bare cable was assumed, or 40 miles per hour on the cable when coated with ¼ inch of sleet. Under these conditions, when strung on the towers, the cable would have to stand a stress of 4600 pounds, the normal operating tension, as stated above, being 2,300 pounds. But the cables were made to have a breaking strength of 7,500 pounds, so there is a large factor of safety.

Running along the tops of the towers and firmly clamped to each peak is a lightning guard wire made of ⅜ inch stranded steel. This is the seventh wire seen in the picture


THE END OF THE LINE

of the line. This guard wire is grounded at every tower and has to date proved to be an efficient protection against lightning.

But how is the current prevented from escaping from the wires to the ground? This is provided for by disk insulators. These consist of solid disks of selected porcelain, laced together, by means of wire and drop forged steel links so that they hang one above another. They are then hung by the top to arms projecting from the towers and the transmission cables are hung from the bottoms of the strings of insulators. In order to reach the ground the current would have to puncture every one of the porcelain disks.

Finally when the line has reached the substation in Schenectady, where its pressure or voltage is to be transformed or "stepped down" to a low voltage practicable for use, a special construction was necessary to run the cables safely into the building. Here are some more heavy strain insulators to hold the stress of the cables. The dead ends are provided with horn gap lightning arresters, across which lightning bolts may jump if they get as far as the building, and be led to the ground without doing damage.

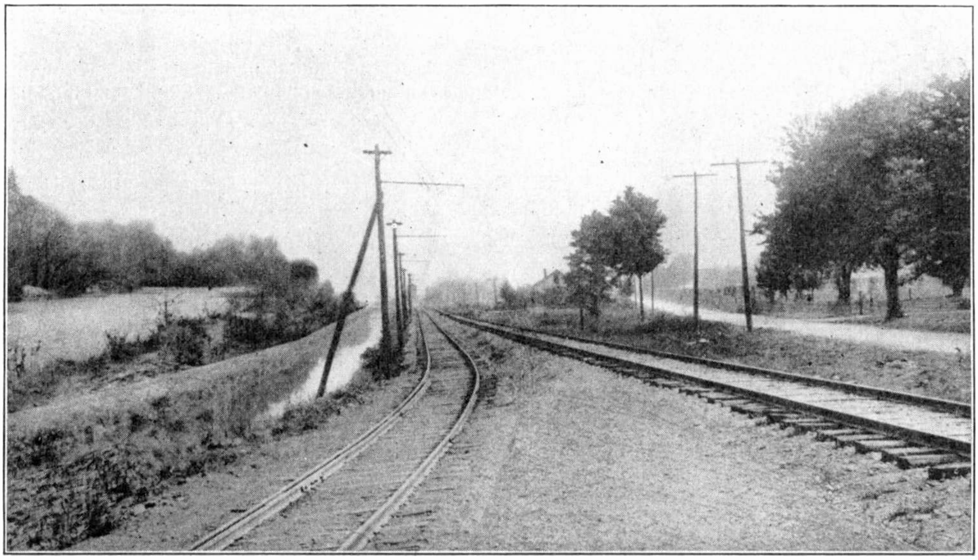
## FIVE METHODS OF TRANSPORTATION

Something strikingly novel is shown in the accompanying illustration, for here, side by side, are five distinct modes of transportation, conditions probably not duplicated in any other place in the country. The photograph was furnished by Harrie P. Clegg, president of the Dayton and Troy Railway Company, of Dayton, Ohio. Dayton is the home of Wright brothers, famous builders of flying machines, and it is said that when the picture was taken, if the camera had been snapped in time, a sixth mode of travel would have been shown, for a flying machine passed over but a moment before.

From left to right the picture shows: first, the Miami River, a navigable stream; the Miami and Erie Canal; the high speed Dayton and Troy electric railway; the Cincinnati and Hamilton (steam) line; and finally the turnpike which was formerly the route of stage coaches.

## VALUE OF CLASSICS TO THE ENGINEER.

In this intensely practical age we often hear the questions asked: "What is the good of studying Latin and Greek; why spend one's time delving in the dead languages of the past when the problems of the present are waiting to be solved? If we spend a certain period of our lives in obtaining an education, why not devote this study period to subjects of immediate practical value?" This tendency toward practical things has led to a great change in the curriculum of the modern university and college and as a



FIVE METHODS OF TRANSPORTATION SIDE BY SIDE consequence the schools of technology—the practical schools—flourish as never before. But there is another side to the question, and we find it argued for by one of the foremost electrical engineers of the day, Mr. Charles P. Steinmetz. No more practical man ever lived than Mr. Steinmetz and, though a profound thinker along almost any line, and perhaps the greatest mathematician in this country today, he spends most of his time in putting his theories to practical use in his favorite field—electricity. Therefore when one so "practical" as Mr. Steinmetz upholds the classics, as he does in a recent paper before the American Institute of Electrical Engineers, it behooves us to weigh his words carefully if "we" are a young man about to enter college, or are parents seeking to give a son advice as to the pursuit of his electrical engineering education. The gist of the above mentioned paper is as follows:

"Education is not the learning of a trade or profession, but is the development of the intellect and the broadening of the mind, afforded by a general knowledge of all the subjects of interest to the human race, as required to enable a man to intelligently attack and solve problems in which no previous detail experience guides, and to decide the questions arising in his intellectual, social, and industrial life by impartially weighing the different factors and judging their relative importance. These problems, and thus the educational preparation required to cope with them, are practically the same in all walks of life, and the general education of mind and intellect, required by the engineer, the lawyer, the physician, etc., thus is essentially the same. The only legitimate differences in the training for the life's work, required by the different professions, thus are those pertaining to the specific instruction and study of the details of the particular branch of human knowledge, by which the student desires to make his living.

"For ages the classics, comprising the study of the Latin and Greek languages and the literature of these languages, has been the foundation of all education; but in the last two generations it has been more and more pushed into the background by the development of empirical science and its application, engineering. It is my opinion that this neglect of the classics is one of the most serious mistakes of modern education, and that the study of the classics is very important and valuable, and more so in the education of the engineer than in most other professions, for the reason that the avocation of an engineer is specially liable to make the man one sided. By dealing exclusively with empirical science and its applications, the engineer is led to forget, or never to realize, that there are other branches of human thought besides empirical science, and equally important as factors of a broad general education and intellectual development. An introduction to these other fields is best and quickest given by the study of the classics, which opens to the student other worlds entirely different from our present, the world of art and literature, of Hellas, and the world of organization and administration—and of citizenship—of Rome, and so broaden his horizon beyond anything which can be accomplished otherwise, and show relative values more in their proper proportion, and not distorted by the trend of thought of his time.

"It is true that the classics are not necessary if the aim is to fit the student to ply the trade of engineer, just as that of plumber or boiler maker, and the world, and especially the United States, is full of such men which have learned the trade of engineer. But such learning of the engineering trade can hardly be called receiving an education, and certainly does not fit the man to intelligently perform his duties as citizen of the republic during the stormy times of industrial and social reorganization, which are before us.

"The modern languages are not in the same class with the classic languages, as they open to the student no new world, no field of thought appreciably different from our own, and I therefore consider them of practically no educational value. Their utilitarian value to the college student is negligible, as due to the limited time, the absence of practice, and the large number of other more important subjects of study, very few of the college graduates retain even a rudiment of their knowledge of modern languages, and even those few only because they are especially interested in them, have occasion to practise them, and therefore would probably have learned them outside of college. To the engineer particularly, the knowledge of foreign modern languages offers no appreciable help in following the engineering progress of other countries, as practically all that is worth reading is translated into English either in full or in abstract, and engineering publications written in a foreign language are closed to the reader, even if he has some knowledge of the language, by his lack of knowledge of the technical terminology of the foreign language. Since the modern languages have no appreciable educational value, they should be dropped from the engineering curriculum of the college, as their retention violates the principle of the modern college curriculum, to restrict, due to the limited available time, to that instruction which the student can not acquire outside of the college by self study, or can acquire only under great difficulties.

# THE NEPTUNE CAP

The dread of a sea voyage, due to sea sickness, amounts with some people almost to actual terror, and those who have experienced the sensation know that this terror is not without foundation. Various expedients have therefore been tried to alleviate the torture, among them the "Neptune Cap," an invention of one Herr Paul Kappmeir. He states that he has studied the subject for many years and made numerous experiments and observations, and he has come to the conclusion that the principal to overcome sea sickness. The inventor states that the treatment consists in providing pressure to act upon the head, in the form of a compress, together with an application of heat. He maintains that the compress acts upon certain of the arteries of the head, without, however, prejudicially affecting the main artery, which is so important in its action. By the equipment of modern steamers with this new device he says that every passenger may be assured of enjoying his or her sea voyage

THE NEPTUNE CAP TO PREVENT SEA SICKNESS

cause of sea sickness is a reflex irritation of the cerebral vasomotor nerve, the fifth and tenth pair of nerves being likewise involved in the trouble.

The electric Neptune Cap consists of a compress, the employment of which tends without the disagreeable sea sickness due to the motion of the boat.

Heat necessary for the treatment is derived from electric current which is made to circulate through resistances located in the compress.

# ELECTRICITY VS. GAS IN VENTILATION

BY C. M. RIPLEY

It costs money to purify anything; whether it be the Panama Zone that must be made habitable—or a political situation which requires a housecleaning. Such worthy enterprises require considerable expenditure and there will always be found some who protests. Even our Pure Food Law came in for its share of complaint, and now we learn that the New York Labor Law requiring a supply of fresh air for the employees of workshops and factories is being subjected to some criticism.

The law reads as follows:

"The owner, agent or lessee of a factory shal provide, in each workroom thereof, proper and sufficient means of ventilation, and shall maintain proper and sufficient ventilation; if excessive heat be created or if steam, gases, vapors, dust or other impurities that may be injurious to health be generated in the course of the manufacturing process carried on therein, the rooms must be ventilated in such a manner as to render them harmless, so far as is practicable."

Mr. William W. Walling, Chief Factory Inspector for the State of New York, interprets the law as follows:

"As defined by Dr. John S. Billings, perfect ventilation means that any and every person in a room takes into his lungs at each respiration, air of the same composition as that surrounding the building, no part of which has recently been in his own lungs or those of his neighbors, or which consists of the products of combustion generated in the building, while at the same time he feels no currents or drafts of air, and is perfectly comfortable as regards temperature, being neither too hot nor too cold.

"How much air is required to meet these conditions?

"Not less than 2,000 cubic feet per hour for each person, with the same amount per hour for each cubic foot of gas consumed whether for light, heat or power."

Some landlords in New York City have put forth the claim that the amount of fresh air specified by the Department of Labor was an "arbitrary quantity." Several authorities on the subject of ventilation who have been consulted in the matter and who are also entirely disinterested—agree that 2,000 cubic feet per hour per person is common practice and is based upon definite laws or rules which have been followed for many years in the design of ventilating systems.

On the above basis in a loft 25 feet wide and 100 feet long, containing 80 workmen, and lighted with electricity, the amount of air required would be 80 times 2,000=160,000 cubic feet per hour. This amount of air per hour would move at the rate of about ⅛ of a mile per hour—and would be sufficient to change the air in the loft six times per hour, assuming a 10-foot ceiling. Since the Massachusetts and New York State laws for school rooms require eight changes per hour and since some authorities recommend even 50 per cent excess of this—it appears that the action of the Factory Inspector hardly comes within the definition of the word "arbitrary."

Regarding the use of gas lighting Dr. Daniel R. Lucas of New York City states that it is a well known law of hygiene that one gas jet will consume as much oxygen as five persons. Since electric lighting—thanks to the new high efficiency lamps—has been reduced in cost 50 per cent or more, it appears that the easiest way to comply with the Labor Law regarding ventilation would be to abandon gas lighting.

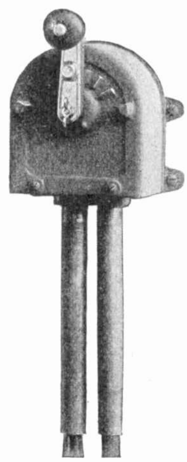
Since the average gas light is equivalent to five persons, as far as its vitiating effect is concerned, it can be readily seen that the ventilation required will be reduced 5-6 by abandoning gas light, assuming one gas jet to each workman. Or stating it in another way, the landlord who clings to gas lighting must install ventilating apparatus six times as large as would be necessary if electric light were used. This calculation is also based upon conditions where one gas jet is provided for each workman.

The operating cost for a ventilating system is made up of two items: (1) Power for turning fans; (2) additional heat for incoming air. In a loft building where the tenant will pay for the power, the expense will automatically be divided and the landlord will pay for the extra heat required since heat is included in the rent. It will also be noticed that again the adoption of electric lighting will cut the bills for operating expenses to a remarkable degree. This cut in expense will affect the tenant, since a much smaller ventilating motor will be required, and it will also affect the landlord because less air will have to be drawn in and hence the cost for heating will be diminished.

# HOW ELECTRIC TRAINS START SMOOTHLY

BY ALBERT WALTON

An inkling of the desirability of starting smoothly is received and usually remembered by any one who has had the misfortune to ride on an ordinary trolley car behind a green motorman or one who seemed bent on making his passengers suffer for his own ill temper or nervousness. If one has experienced that sensation of "neck-snapping" that comes with the too rapid starting of a car he knows at least one of the points wherein a careful motorman excels an ignorant or willful one. The same thing that makes it uncomfortable for the passengers is also hard on the electrical apparatus as well as the parts under the car.



THE MASTER CONTROLLER

On roads where trains of electric cars are run such as elevated railways, subways and electrified steam roads items like waste of power during starting, deterioration of apparatus due to heavy rushes of current and discomfort of travelers, all become of prime importance and steps must be taken to insure economy and smoothness.

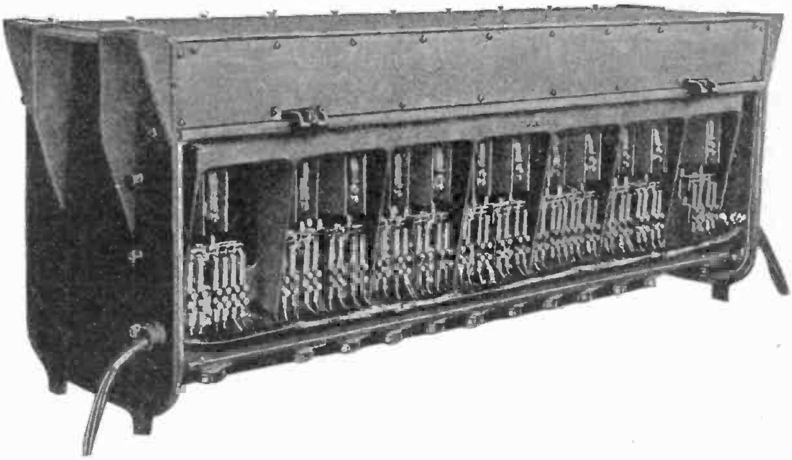
Even though it is possible to employ a more intelligent class of operatives on such roads, it is still found that damage to apparatus occurs, and temptations to make up lost time prove so great as to cause even the older and more skilled motormen to overdo the speeding up after a stop.

In addition to this is the fact that it is no longer a question of starting a single car from the motors mounted on that car. Trains of six or seven or more cars are run as a unit in each train and no one car has power enough to start the whole train quickly enough to meet the requirements of modern rapid transit. So in a train of seven cars it is necessary to have at least four of the cars equipped with motors. Not only would it be expensive to have a motorman on each of these cars, but even should this be done, the troubles of the single car would be multiplied by four. They would not start together and one set of motors would for an instant be trying to do the work of four and then, perhaps, all would get in at once and the train would give a lurch that would take the strap-hangers off their feet like a row of dominoes. Power would be wasted and machinery injured.

In order to get all the cars of a train to start at the same time and to start as rapidly as possible without discomfort or damage, the whole operation is now made automatic. The motorman sits in his little cab in the front car and moves a handle on a little cylinder to one side and instantly, in all the cars, switches, worked by air pressure, are connected so all the motors start together. Without further motion on the part of the motorman these switches are then closed step by step so the cars gain more and more speed until they have attained about half their best rate. Then, if it is desired to increase this speed the motorman is called upon to make a second motion and throw the handle to the second notch. Smoothly all the cars throw on their additional power in gradual increments till full speed is reached. The rate at which the speed increases is beyond the power of the motorman to control. It is fixed at the shops so that all he has to do is to start the mechanism working and let the compressed air and the magnets take care of the rest.

For example, the valves can be set so a six-car train will come from rest to half speed in ten seconds, and it will do this every time, regardless of the man in the cab. All the motors do their proportional share of the work and the valves are so arranged that the air is not permitted to close a switch to give more power to the motors, till the train has increased its speed enough so the throwing in of additional power will not cause a jump in speed.

In these automatic systems the motorman does not work at all with the current that runs the motors. He simply turns on and off a current that comes from a small storage battery on the train. This current operates



THESE SWITCHES CLOSE AUTOMATICALLY STEP BY STEP

Furthermore, in the latest systems, if the motorman should take his hand off the little handle in the cab the train would be brought to a stop, for it is necessary to actually hold it in place to keep the current on, a spring tending to throw it back to the stopping position at all times. This arrangement is provided so that

small magnets which open valves admitting compressed air from the air-brake pipes into small cylinders. By this compressed air the switches which handle the main current from the third rail or trolley wire to the motors are opened and closed in regular order. They are so inter-locked that it is impossible to throw the wrong one first or to throw them in anything but the right order and at the right time to give the predetermined speed.

if a motorman should faint or fall asleep, due to overstrain, the cars would stop of themselves and no damage result. If anything should happen to the air-brake system so the pressure should become reduced, this, too, would stop the train, for the switches are also held in place against springs which will open them if the air pressure is removed. In fact, when the motorman wishes to stop his train, all he does is to move the lever back to the stopping

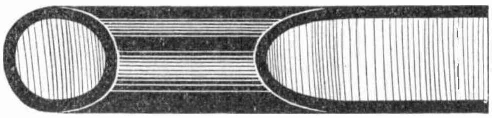
MULTIPLE UNIT CONTROL APPLIED TO ELECTRIC LOCOMOTIVES position which cuts off the air pressure and allows these springs to open the switches and cut the current off the motors. This is done on all the cars of the train at the same time. In this way the motor current enters each car directly from the wire or rail and does not have to be sent from one car to the next. All that has to be carried from car to car is the small current from the storage batteries to operate the little magnets on each car.

This multiple unit system has been used on city elevated roads for a number of years to control the speeds of the trains that are run by electricity. It is now being used on a larger scale by the steam roads that have installed electric traction for part of their equipment. It is very convenient, also, on such roads as are using electric locomotives to haul regular passenger trains the coaches of which are not equipped with motors. If one locomotive is not heavy enough to do the work another is added in front of it, the motorman gets into the front cab and the two machines then act as one with twice the power yet still under the hand of the one man. If two are not powerful enough more can be added as desired and yet one engineer runs the group with the same motions and the same ease as he would with one single machine. And the speed will be smooth and the motors protected from damage while the passengers feel even less motion than was felt with the old steam locomotives.

## A NEW ELECTRICAL WIRE

Two elements enter into the requirements for wire used in the transmission of electric current; namely, conductivity or ability to pass the current with little resistance and mechanical strength. Now copper has very high conductivity but its strength is not nearly as great as that of steel, which latter, however, has low conductivity. In using wire made entirely of copper for telephone and telegraph lines, particularly if long spans are desired, a larger copper wire than would be actually necessary to pass the current must be used, in order to obtain sufficient mechanical strength to stand the stress placed on the wire; and copper is too costly to use much in excess of the actual requirements. This high cost of copper makes it necessary to use iron or steel wire for most telegraph and telephone lines, although copper is really better.

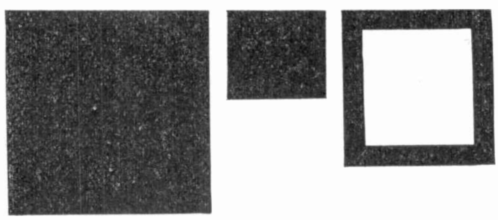
As a consequence of these conditions a new kind of electrical wire has been invented which has a core of steel to give mechanical strength, and an outside coating or jacket of copper to give the necessary conductivity for the flow of the electrical current. In making the wire a billet of steel with a jacket of copper is rolled and then drawn as in making ordinary wire, and the result is a wire with



COPPER JACKETED STEEL WIRE

a core of steel, the copper jacket being actually welded to the core so as to form a homogenous mass.

What this new wire really means to electrical construction is graphically shown by the three squares. Taking an imaginary case where a given resistance is allowable per mile of wire; if all copper wire were to



COMPARISON BETWEEN ALL COPPER AND THE NEW WIRE

be used, a No. 12 copper wire would be necessary to obtain the required strength, its cross section would be represented by the large square at the left, its elastic limit would be reached at 184 pounds and it would cost $16.43 per mile. The middle square represents the size of wire which would be actually required as far as electrical conductivity is concerned (No. 18), but it wouldn't be strong enough. Its cost would be $4.33 per mile. The hollow square represents the relative size of the copper clad wire (No. 14) which would do the work, the black portion representing the copper. This wire would have an elastic limit of 320 pounds, stronger than the No. 12 pure copper; it would have nearly the conductivity of the No. 18 pure copper and it would only cost $8.41 per mile.

## DETECTING CURRENTS

Persons connected with the operating departments of electric light and power companies have felt the need of a satisfactory device for determining whether current is flowing in a cable or not. Valuable time is frequently lost in locating trouble owing to the trouble men not being provided with satisfactory testing outfits. Accidents have also occurred due to jointers cutting cables which they supposed to be "dead." Any system of numbering or tagging cables is likely to become wrong, due to changes, and should not be depended on absolutely, particularly with high tension cables.

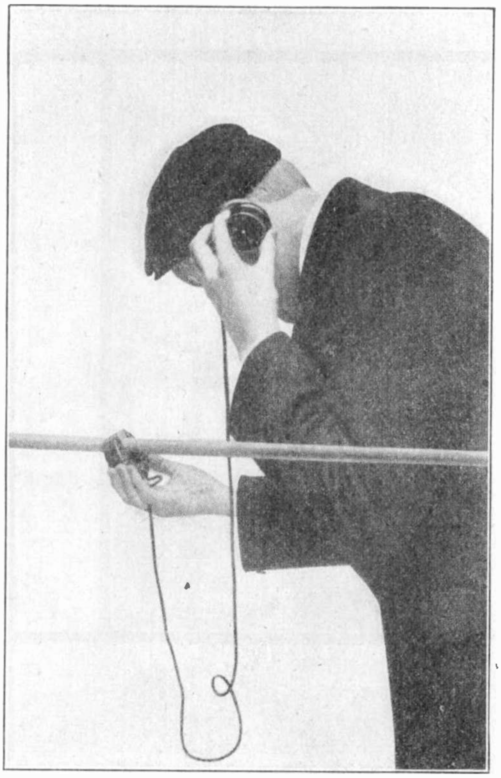


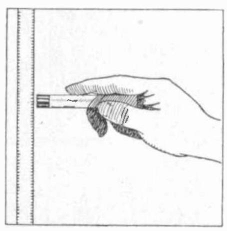
FIG. 1. DETECTING CURRENT BY MEANS OF A TELEPHONE

The compass method of testing, while generally satisfactory for direct current cables, will not answer on alternating current. The testing outfit illustrated in Fig. 1 is designed for use on alternating current lines, but is also satisfactory for direct current work, provided the current is supplied from a generator. It would not work on a battery circuit, as the sound heard depends on the commutating action of the generators.

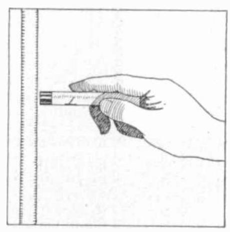
The testing outfit consists of a telephone receiver and a small current transformer with a hinged core. The secondary wiring of the transformer is connected to the telephone receiver and the hinged core is clamped around or against the cable to be tested, the cable forming the primary of the transformer.

The device will be found very sensitive, and will work on single, duplex or three-conductor cable. It will be more sensitive on single conductor cables than on the others. On single conductor cables an alternating current of one ampere, or a direct current of two amperes, will give a distinct, audible indication in the telephone receiver.

The electroscope, Figs. 2 and 3, was devised for the purpose of affording a rough-and-ready means for determining the presence of a dangerous potential in an electrical conductor. Workmen are thus enabled to make their own determinations and take their own precautions against danger to life before touching any electrical conductor that may carry a dangerous potential.



Conductor "Dead"



Conductor "Alive"

FIGS. 2 AND 3. USE OF THE ELECTROSCOPE

The device consists of a glass tube, in which is hermetically sealed a copper plate carrying the indicating foil leaf. In using, the end of the electroscope is held in close proximity to the conductor to be tested. It will indicate positively all potentials in excess of 500 volts. If the conductor is "dead," the indicating leaf will remain flat. If the conductor is "alive" the indicating leaf will tend to take a position at right angles to the tube. It will not, however, work on a grounded conductor, or a conductor surrounded with a lead sheath.

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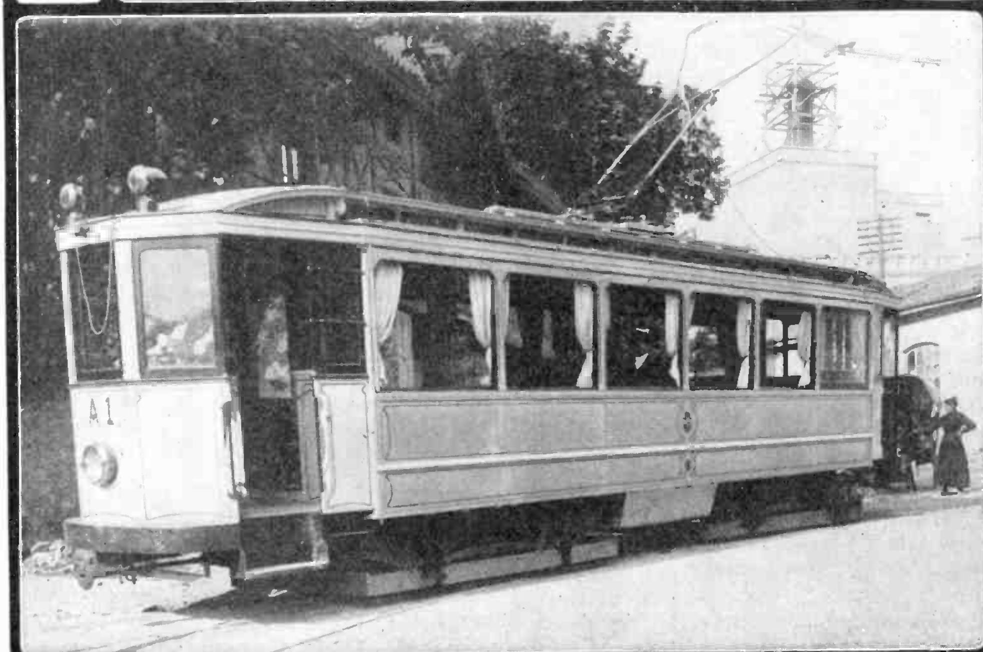
A powerful electric blower has been devised for plucking chickens. When the dead chickens are placed in the strong suction all the feathers and down are quickly removed.

# ELECTRIC RAILWAYS OF SPAIN

BY DR. ALFRED GRADENWITZ.

In far away Spain electric railroading is not carried on under conditions prevailing in this country, and it would be reasonable to suppose that we would not find there electric railways operating on as extensive a scale as here, where there are so many more people. Then too, methods of operation which might be highly satisfactory to the more easy going Spaniard would probably not be swift enough in this land of the hurry-ups.

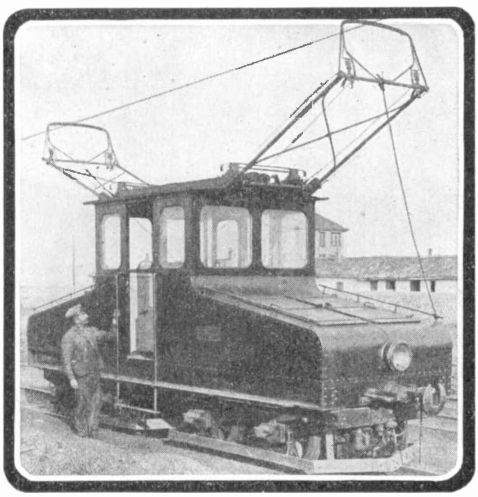
Nevertheless the modern cities of Spain have very well equipped electric railway sys-

tems admirably designed to meet the requirements of their citizens. Santander, for instance, an enterprising industrial town, has a new electric railway system, connecting it with Penacastillo and Astillero.

As in this country direct current is used, of 500 to 600 volts pressure, but the method of collecting the current from the trolley wire is different. There they use what is known as the bow trolley instead of the trolley pole and little wheel so commonly seen on our streets. This would look a little peculiar to us at first.

There are in all just 18 cars operating on this system. Those used within the city limits are able to accommodate only 18 passengers. To handle the rush hour traffic in one of our large cities with cars of this size would be like filling a bath tub with a teacup. But it must be remembered that Santander is a small city, and its people are not in a hurry to get down to work in the morn-



ing on the minute. Therefore the small cars serve them adequately and are at the same time models of neatness and well kept-up equipment, judging by the pictures.

The interurban traffic between the above named cities is expected to develop to a large degree, so a number of electric locomotives, similar to the one shown, have been procured, which are capable of drawing several cars in a train.

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One of the first electric locomotives was built by Stephen D. Field, of Stockbridge, Mass., and the motor is still preserved in the cellar of the Field house as souvenir.

## FACTS ABOUT LIGHT AND LIGHT SOURCES

The source of all light is a substance which is raised to such a temperature that it sets up waves in the surrounding air, which, when falling upon the eye, produce the sensation we know as light. It is acknowledged that the source of light in the sun is a great mass of white-hot matter and the source of light in an arc lamp is the heated gas between the carbons which are raised to a high temperature by electricity. In an incandescent lamp the light source is a thin filament inside the glass globe which is maintained at a high temperature by the passage of a current of electricity.

The character of light given off by the different illuminants depends upon the source; for instance, the old carbon filament lamp gives off light which has an abnormal amount of red in it, while the new tungsten filament has more nearly the proportion of daylight. This difference in the quality of light is due to the difference in temperature at which the filaments operate. Tungsten can be operated at a much higher degree of heat than any other form of filament.

To fully understand light one has to assume the presence of a wave motion set up and maintained by the source itself. The color of the light depends on the length of the wave. The light waves producing the colors in the blue end of the spectrum are very short compared with those that produce the colors near the red end. The light source which we know as red gives off only waves of the length which produce that particular color. A body appears red because its surface is capable of reflecting only waves of lengths corresponding to red. If we attempt to illuminate a blue body by a red source we will fail, because the blue body is capable of reflecting only the short waves producing the blue, and since the red source contains none of these there will be no reflection and the body will appear black. If we have objects of a variety of colors, and wish to display them in their true relation, we must evidently have waves of lengths corresponding to every color we wish to display. The ideal conditions would be to have a source of light that would give out waves corresponding to all colors; in other words, a white light. We see objects by the light reflected from them, and since all surfaces do not reflect the same per cent. of the incident rays, it is evidently necessary to display them under different light intensities to have them appear equally illuminated. In a department store we may have white goods displayed on the same floor as dark woolen goods. In this case if the intensity of the light is the same throughout the store, the section containing the dark goods will appear poorly lighted as compared to the ection containing the white.

This property of surfaces of reflecting, or rather absorbing light, is shown in the following table, which gives the per cent of the total incident light that is reflected.

| | |
|---|---|
| Mirror | 95. |
| White blotting paper | 82. |
| Chrome yellow | 62. |
| Orange | 50. |
| Yellow | 40. |
| Pink | 36. |
| Emerald green | 18. |
| Dark brown | 13. |
| Vermilion | 12. |
| Black paper | 0.5 |
| Deep chocolate | 0.44 |
| Black velvet | 0.4 |

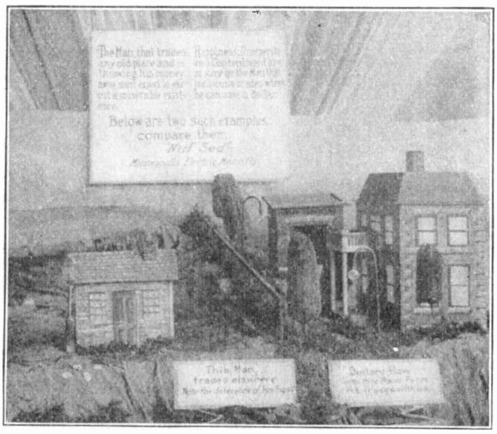
The question of reflection depends also on the angle at which the ray of light strikes a surface. Take, for instance, the polished surface of a plate glass and give the ray of light an angle at which the light no longer penetrates the glass, and it will be totally reflected.

The quality and distribution of the light as it is given off from the light source is quite often changed by transmitting the light through substances other than air. The things that are true in connection with reflection can be applied, in a great measure, to transmission. Thus a piece of glass when held up to a light appears some particular color because it transmits waves of the length corresponding to that particular color. If we attempt to transmit white light through a red glass only the red ray will be transmitted, the others being absorbed by the glass. Instead of getting all the energy of the white we get only that part included in the red ray. If we have a light source which contains an abnormal amount of light of some colors and the correct proportion of others, we may correct this by inclosing the source in a glass globe of such a character that it will absorb the excess light of the colors which are abnormal, thus giving a white light. A case of this is found in the arc lamp, which has an excess of blue and violet. This may be corrected in a measure, but the quality is obtained at the expense of efficiency.

The question of the color of light is of very serious moment to storekeepers and clothing houses or other places where colors have to be matched. Until the new tungsten metal was discovered for incandescent lamps this work could not be done after dark because all the artificial illuminants carried too many foreign light waves. But the tungsten lamp so nearly approaches the clear white light of actual sunshine that in nearly every instance it can be used to take its place.

## UNIQUE WINDOW DISPLAY

Considerable ingenuity is shown in the design of the allegorical window display of a prominent electrical supply dealer in Minneapolis. The story it tells is this: The man who uses electricity in his home is the progressive citizen. His surroundings are almost certain to be pleasant and indicative of prosperity. On the other hand the man who has not progressed far enough



UNIQUE WINDOW DISPLAY

to recognize the benefits and economy of electricity is more apt to be found surrounded by conditions much lower in the scale of living. Moral: Character is largely determined by environment. Use electric lights as the first step in bettering living conditions; it will lead to other improvements.

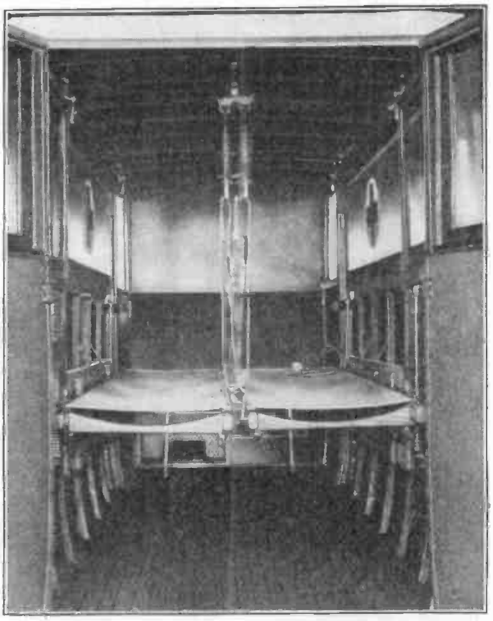
A peat-gas plant is being erected near Svedala, Sweden, which will transform power from the heat in peat into electricity, and this electric power will be conducted to neighboring towns for consumption by municipalities and industrial plants.

### MODERN ELECTRIC AMBULANCES

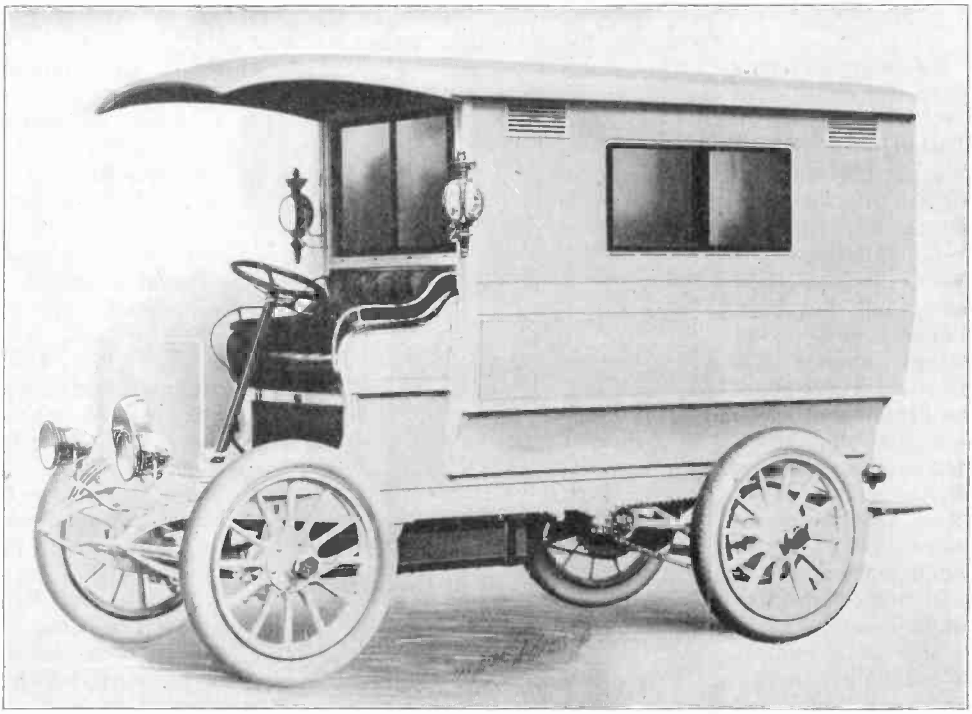
The clang of a gong, the flash of a swiftly moving white vehicle, and the electric ambulance has come and gone almost before we have had time to be aware of its approach. Once inside, its stricken passenger hardly knows that he is riding, so carefully has everything been arranged for his comfort. There is no sound of thundering hoofs, no vibration of a gasoline engine. By means of a special controller for the motor, the ambulance is started and accelerated without shock, and a speed of 20 miles an hour may be obtained in cases of special emergency.

A type of electric ambulance operated by the Board of Health of Indianapolis is shown in the illustrations.

This electric ambulance is provided with two folding seats on the side, the cot being 85 inches long and 26 inches wide. The cot base is 16¼ inches above the floor and hinged so that it can be raised when desired. The cot is adjustable for reclining, the lining being removable for sanitation. There are three drawers in the base for medicine and instruments, and the interior and exterior are finished in white with red upholstering.



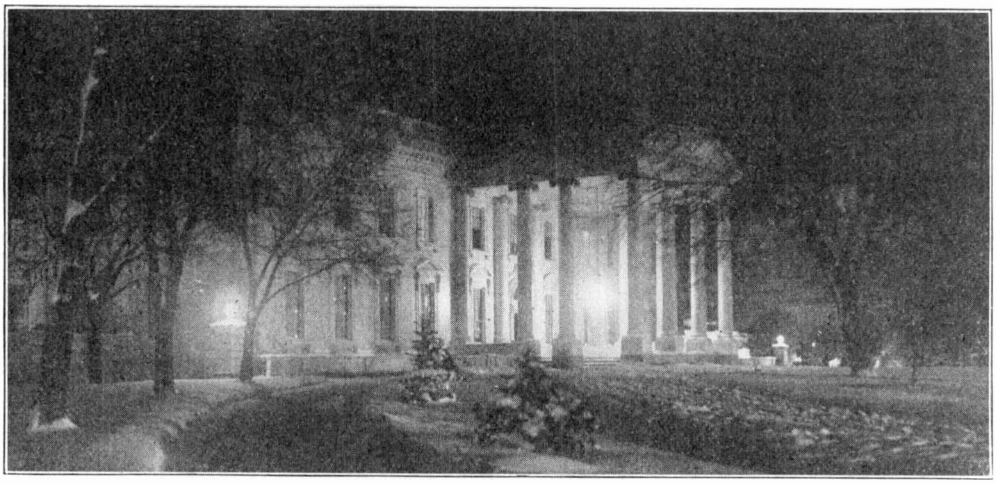
INTERIOR OF AN ELECTRIC AMBULANCE



A MODERN ELECTRIC AMBULANCE

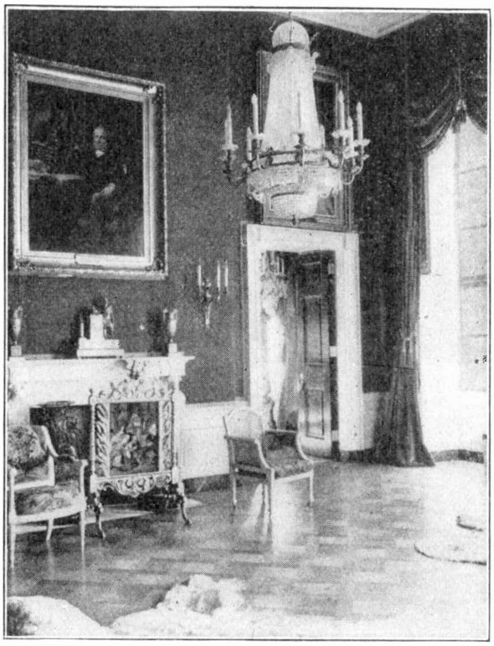
This electric ambulance is said to be economical in the use of current and far more reliable than gasoline equipment, while the storage batteries allow the use of electric lights at night inside and outside and are a great convenience to the surgeons. It is maintained that the electrically driven ambulance is particularly well adapted for town as well as city service. Its batteries may be readily charged from any direct current lighting circuit and a small motor generator set or mercury converter being all that is necessary on an alternating current system.

# ELECTRICITY IN THE WHITE HOUSE



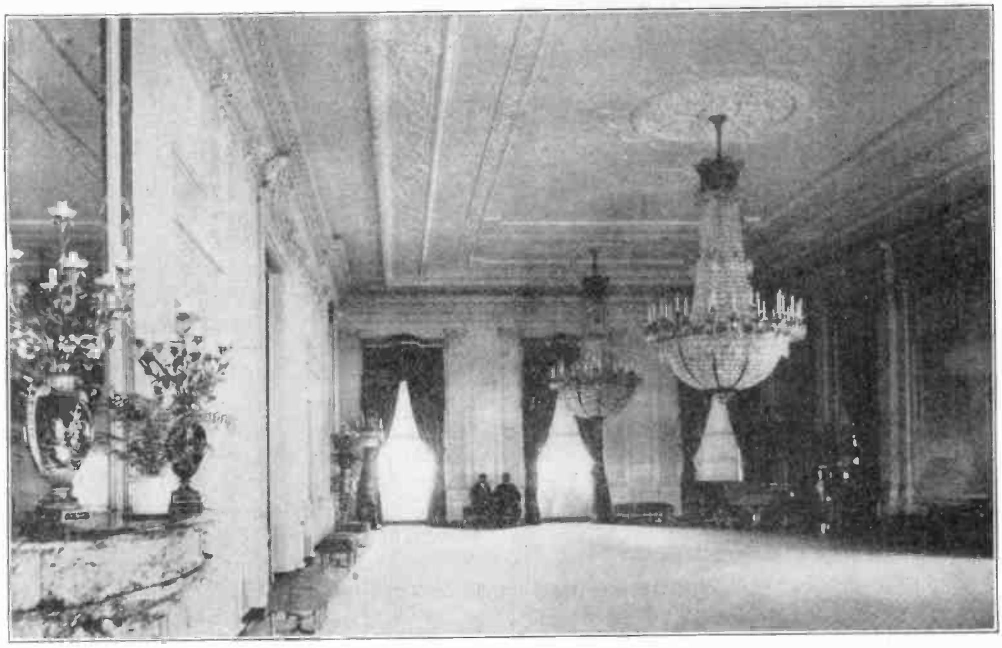
ENTRANCE TO THE WHITE HOUSE AT NIGHT

Electricity is the only illuminant employed at the White House in Washington, and, as is befitting the home of the nation's chief magistrate, the electrical installation is in many respects the most elaborate and the most complete to be found in any residence in America. There are in the presidential mansion and the White House office building adjoining, a total of 1,800 incandescent lamps—some of 16 candle-power, but a good proportion of 32 candle-power each—as well as a number of arc lights, the latter being employed particularly for lighting the grounds and drives and illuminating the exterior of the mansion so that no person could approach the President's home at night without being seen by the secret service men and police officers on guard. A considerable portion of the electric lights at the White House are in use during every hour of dusk or darkness, week-days and Sundays, from one end of the year to the other, so that it can be appreciated that merely the maintenance of this lighting system, the renewing of lamps, etc., is a considerable chore.

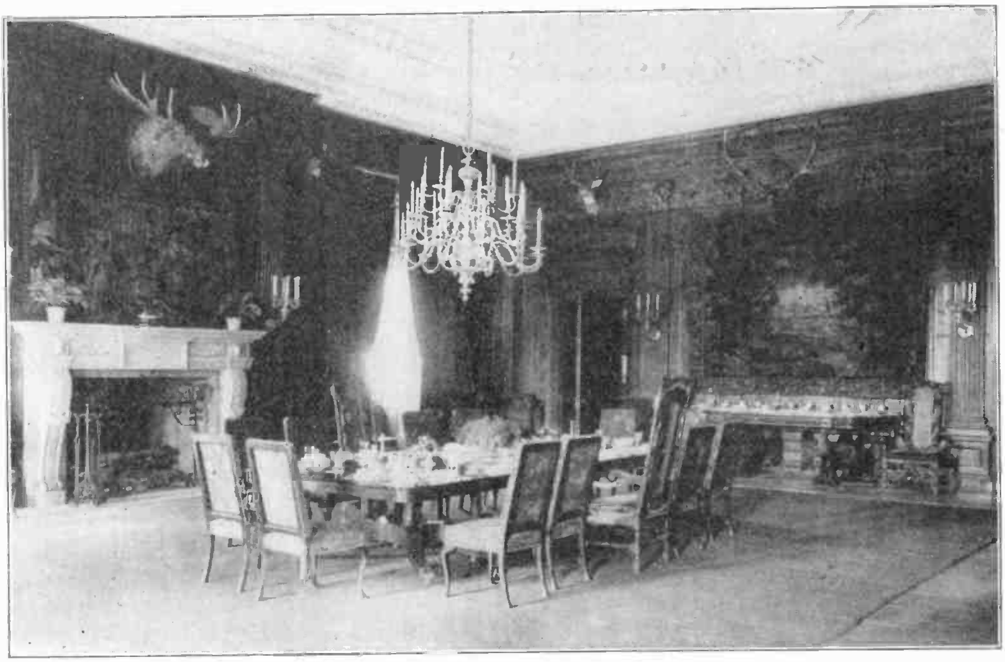


THE RED PARLOR

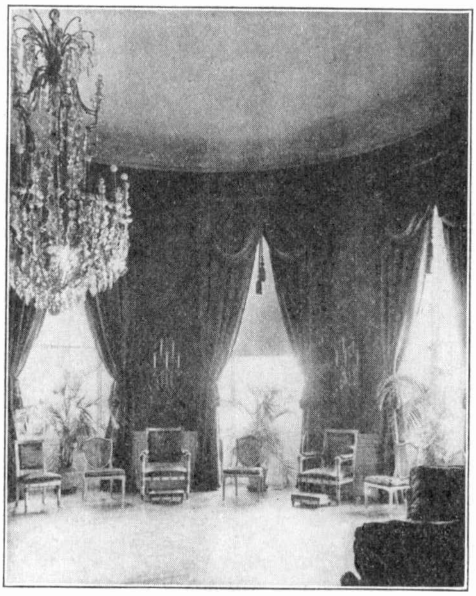
When, early in the first Roosevelt administration, the White House was reconstructed and enlarged, the electrical equipment underwent a corresponding expansion and transformation. It is now in all respects thoroughly modern and up-to-date. Indeed, the White House might be cited as a Twentieth Century model "electrical residence", for not only is the magic current



FAMOUS EAST ROOM SHOWING ELECTRIC CHANDELIERS



THE STATE DINING ROOM



THE BLUE PARLOR

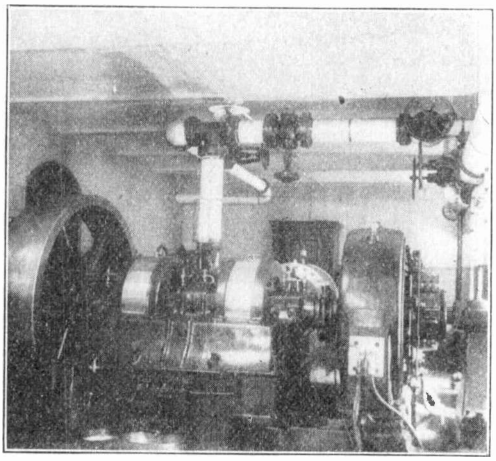
used for a lavish illumination but electricity is employed to operate an automatic elevator and dumb waiters; supplies the energy for a vacuum cleaner for carpets, curtains, etc.; drives upward of two hundred house fans and a number of exhaust fans for ventilating purposes; provides a private telephone system with stations in all parts of the mansion and grounds; and, finally, does much of the cooking in the kitchen and the ironing in the laundry.

The power plant which supplies the electricity for the White House is not located in the mansion but in the sub-basement of the State, War and Navy Department Building directly across the street. The machinery was thus placed because it was not desirable to have the dirt and noise incident to a power plant at the White House and also from considerations of the danger from fire. The power plant has a 200 horse power engine and two Curtis turbines of 75 and 150 kilowatts capacity, respectively. The White House receives a 220-volt direct current for power and a 110-volt direct current for lighting. There is a lighting circuit at the White House stables, located nearly a square from the mansion, and facilities haye lately been installed for the charging of Mrs. Taft's new electric automobile.

As the White House is absolutely dependent upon electricity as an illuminant (the mansion not being supplied with gas), it is of supreme importance that dependable current be available every minute of the twenty-four hours. The equipment in the dynamo room presents three sources of electrical energy any one of which is all-sufficient for White House needs and in the unheard of event that all three installations should be simultaneously out of commission or unable to carry the load from any cause the White House may be immediately thrown on to an emergency street service supplied by the leading commercial company at the national capital.

Although it is a unique thing for a private residence to have an electrician who devotes himself exclusively to its service the electrical expert at the White House is constantly kept busy. The present chief electrician at the Executive Mansion is Mr. George W. Riley, who was for years the chief electrician at the U. S. Military Academy at West Point. He relieved Mr. A. R. Raymond, who had been in charge of the White House electrical department for six years. The White House electrician does not need to concern himself with matters at the power plant, where six electricians are on duty in three shifts of eight hours each. However, the mere maintenance of the White House equipment is a heavy responsibility, the more so because of the fact that all repairs of any magnitude must be postponed until summer, when the President and his family are not occupying the house.

One of the chief duties of the White House electrician is found in the arrangement of

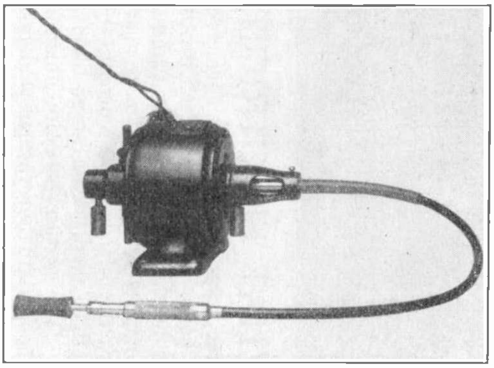


ELECTRIC PLANT OF THE WHITE HOUSE

the special lighting effects for social functions at the Presidential home. Sometimes very elaborate table designs involving the use of numbers of miniature lights are required for the state dinners or banquets at the mansion. The electrician is always on duty until late at night when there is a social entertainment in progress, and often it is necessary or at least desirable that all the wiring and paraphernalia for a special electrical display shall be removed ere the mansion is opened to the public in the morning. The great, ornamental chandeliers which are among the most conspicuous features of the state parlors at the White House—the East, Green, Blue and Red rooms, require much attention. Some of these chandeliers contain hundreds of electric lamps, nestling among thousands of prisms. There are stately electric standards in several of the rooms and simple but impressive electric lanterns in the vestibule and under the porte cochère, just outside the north entrance to the mansion, which is the private entrance for the White House family and their guests.

## SHOE TIP BUFFER

In repairing patent leather shoes and tips an entirely new buffing process is now available in the form of an electric shoe tip buffer. No emery cloth or sandpaper is

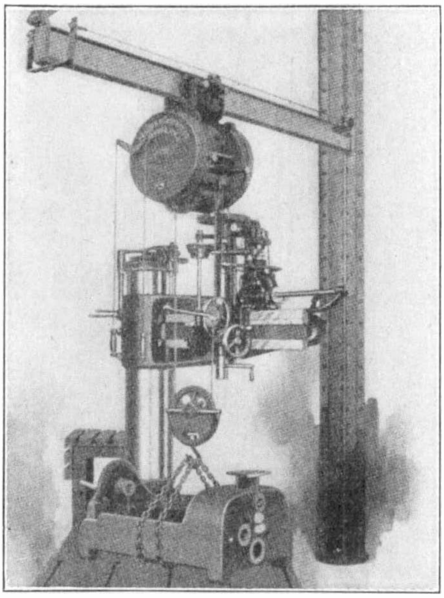


SHOE TIP BUFFER

necessary. It consists of a small electric motor with flexible shaft and buffing tool. In using it there is no possibility of cutting the stitch work.

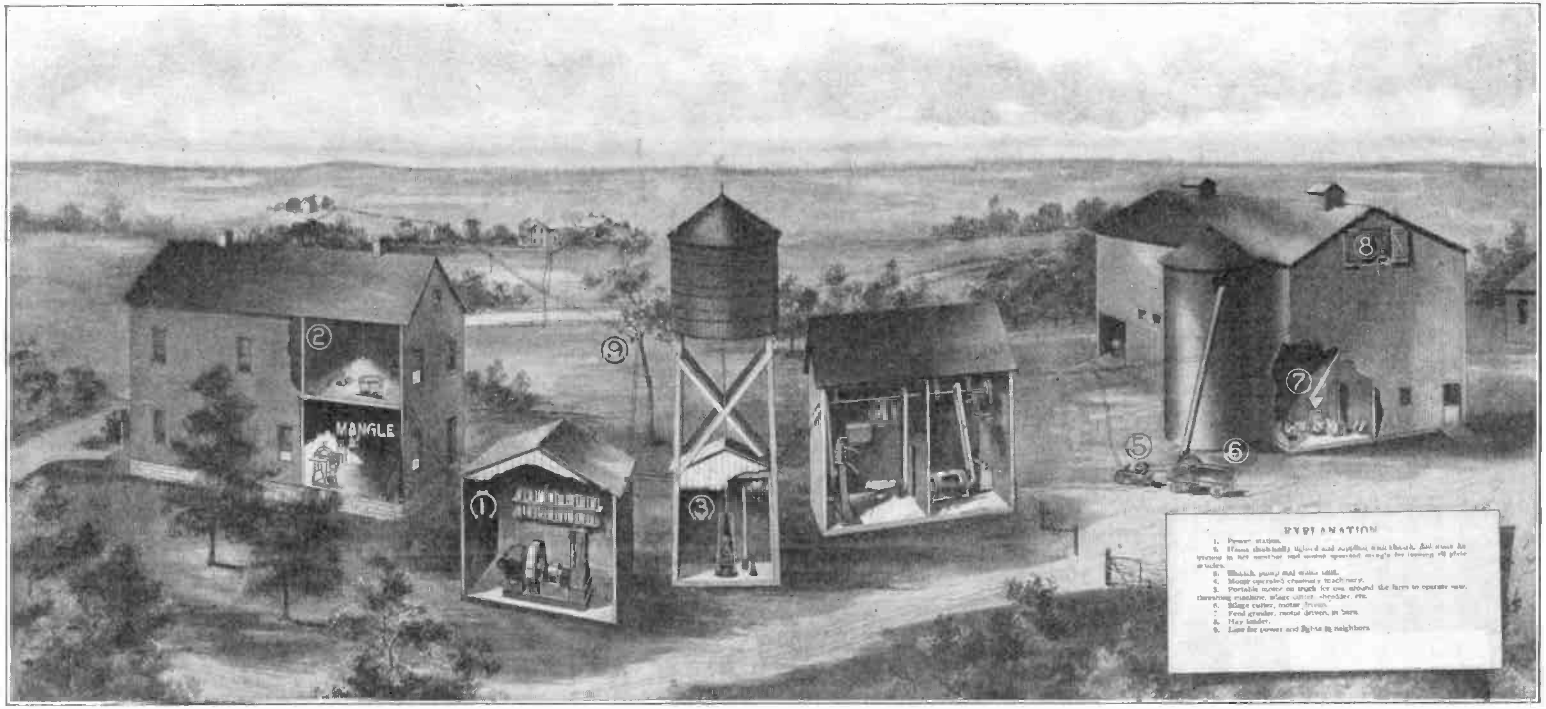
## ELECTRIC HOIST FOR THE MACHINE SHOP

Time has made great changes in machine shop methods. Principal among these has been the introduction of individual motor drive which does away with the forest of vertical driving belts. But the electrical engineers went one step further and devised ways to handle the heavy castings to and from the machines; result, a small electric hoist which picks the "work" up off the



MACHINE TOOL HOIST

truck as it comes from the car or foundry and swings it over onto the bed of the planer or poises it delicately over the lathe. In the picture one of these little electric lifts, weighing itself no more than 250 pounds, is swinging a heavy casting onto the bed of a vertical boring machine. The lift has a motor operated drum which does the direct lifting and is controlled by the machinist. It is mounted on little wheels which travel the length of the swinging crane arm. It takes but a moment to fasten the chain. Then with a whirr it does its work, raising the casting to a point where it is easily manipulated over the bed plate. This is all accomplished in a small fraction of the time it used to take with a block and tackle.




# WHAT ELECTRICITY WILL DO FOR THE MODERN FARMER

There are three ways in which the farmer of today may avail himself of the convenience and economy of electricity, and in that respect model his home after that of the city dweller. In many instances he may have a small water power on the farm which at a small outlay could be developed so as to supply electric current for the house, and most of the operations about the buildings which require power. In cases where the farm is near a city or town with an electric light plant, or near an interburban electric railway which makes a practice of supplying current, these sources are available. In the majority of cases, however, the farmer would necessarily need to install a small steam or gasoline driven plant on the premises. This latter undertaking, however, is not nearly as costly as many suppose. The picture herewith illustrates admirably what a progressive farmer may do with electricity. A study of it will create desire on the part of any farmer who takes pride in his property to possess such a plant.

## PROPERTIES OF WIRE

Many of the readers of Popular Electricity have asked questions concerning the weights, resistances, etc., of copper and German silver wire. Complete wiring tables are available in most electrical hand books and in the catalogues of wire manufacturers, but these books are not always at hand, so the following tables are printed for ready reference.

Table 1 gives the properties of copper wire. First is given the number of the wire as measured by the Brown & Sharpe standard wire gauge, generally spoken of as the B. & S. gauge. This is the English standard and also the one most commonly used in the United States. The second column gives the diameter of the wire measured in mils, a mil being the thousandth part of an inch. Following this are the weights of the various sizes, per thousand feet and per mile. From these figures it is possible to determine the weight of any given length of any size of wire. The last two columns give the resistances of thousand foot lengths of the various wires, measured in International ohms. The International ohm, by the way, was determined by the delegates of several governments, constituting the International Congress of Electricians. This congress specified that the International ohm shall be represented by the resistance offered to an unvarying electric current by a certain column of mercury at the temperature of melting ice. This column shall weigh exactly 14.4521 grams, shall be of uniform cross sectional area and shall be 106.3 centimeters in height.

In Table 1 it will be noted that the last two columns show the resistance of thousand-foot lengths of wire at 60° F. and 75° F. As copper wire is heated its resist-

**Table 2—Carrying Capacity of Wires**

| | Rubber Insulation | Other Insulation |
|---|---|---|
| B. & S. G. | Amperes | Amperes |
| 18 | 3 | 5 |
| 16 | 6 | 8 |
| 14 | 12 | 16 |
| 12 | 17 | 23 |
| 10 | 24 | 32 |
| 8 | 33 | 46 |
| 6 | 46 | 65 |
| 5 | 54 | 77 |
| 4 | 65 | 92 |
| 3 | 76 | 110 |
| 2 | 90 | 131 |
| 1 | 107 | 156 |
| 0 | 127 | 185 |
| 00 | 150 | 220 |
| 000 | 177 | 262 |
| 0000 | 210 | 312 |

**TABLE I—PROPERTIES OF COPPER WIRE**

English System—Brown & Sharpe Gauge

| Numbers | Diameters in mils | Weights | | Resistances per 1000 feet in International ohms | |
|---|---|---|---|---|---|
| | | 1000 feet | Mile | At 60° F. | At 75° F. |
| 0 000 | 460 | 641 | 3 382 | .048 11 | . 049 66 |
| 000 | 410 | 509 | 2 687 | .060 56 | . 062 51 |
| 00 | 365 | 403 | 2 129 | .076 42 | . 078 87 |
| 0 | 325 | 320 | 1 688 | .096 39 | . 099 48 |
| 1 | 289 | 253 | 1 335 | .121 9 | . 125 8 |
| 2 | 258 | 202 | 1 064 | .152 9 | . 157 9 |
| 3 | 229 | 159 | 838 | .194 1 | . 200 4 |
| 4 | 204 | 126 | 665 | .244 6 | . 252 5 |
| 5 | 182 | 100 | 529 | .307 4 | . 317 2 |
| 6 | 162 | 79 | 419 | .387 9 | . 400 4 |
| 7 | 144 | 63 | 331 | .491 | . 506 7 |
| 8 | 128 | 50 | 262 | .621 4 | . 641 3 |
| 9 | 114 | 39 | 208 | .783 4 | . 808 5 |
| 10 | 102 | 32 | 166 | .978 5 | 1. 01 |
| 11 | 91 | 25 | 132 | 1.229 | 1. 269 |
| 12 | 81 | 20 | 105 | 1.552 | 1. 601 |
| 13 | 72 | 15.7 | 83 | 1.964 | 2. 027 |
| 14 | 64 | 12.4 | 65 | 2.485 | 2. 565 |
| 15 | 57 | 9.8 | 52 | 3.133 | 3. 234 |
| 16 | 51 | 7.9 | 42 | 3.914 | 4. 04 |
| 17 | 45 | 6.1 | 32 | 5.028 | 5. 189 |
| 18 | 40 | 4.8 | 25.6 | 6.363 | 6. 567 |
| 19 | 36 | 3.9 | 20.7 | 7.855 | 8. 108 |
| 20 | 32 | 3.1 | 16.4 | 9.942 | 10. 26 |
| 21 | 28.5 | 2.5 | 13. | 12.53 | 12. 94 |
| 22 | 25.3 | 1.9 | 10.2 | 15.9 | 16. 41 |
| 23 | 22.6 | 1.5 | 8.2 | 19.93 | 20. 57 |
| 24 | 20.1 | 1.2 | 6.5 | 25.2 | 26. 01 |
| 25 | 17.9 | .97 | 5.1 | 31.77 | 32. 79 |
| 26 | 15.9 | .77 | 4. | 40.27 | 41. 56 |
| 27 | 14.2 | .61 | 3.2 | 50.49 | 52. 11 |
| 28 | 12.6 | .48 | 2.5 | 64.13 | 66. 18 |
| 29 | 11.3 | .39 | 2. | 79.73 | 82. 29 |
| 30 | 10. | .3 | 1.6 | 101.8 | 105. 1 |
| 31 | 8.9 | .24 | 1.27 | 128.5 | 132. 7 |
| 32 | 8. | .19 | 1.02 | 159.1 | 164. 2 |
| 33 | 7.1 | .15 | .81 | 202. | 208. 4 |
| 34 | 6.3 | .12 | .63 | 256.5 | 264. 7 |
| 35 | 5.6 | .095 | .5 | 324.6 | 335. 1 |
| 36 | 5 | .076 | .4 | 407.2 | 420. 3 |

ance increases slightly as shown by these figures.

When installing systems of wiring it is necessary to know how much current, measured in amperes, a certain size of insulated wire will carry safely. As will be noted in Table 2, rubber insulated wire will not carry safely quite as much current as wires with other insulations.

Table 3—German Silver Wire

| Numbers B. & S.G. | Resistance per 1000 feet | |
|---|---|---|
| | 18 per centum | 30 per centum |
| 6 | 7.20 | 11.21 |
| 7 | 9.12 | 14.18 |
| 8 | 11.54 | 17.95 |
| 9 | 14.55 | 22.63 |
| 10 | 18.18 | 28.28 |
| 11 | 22.84 | 35.53 |
| 12 | 28.81 | 44.82 |
| 13 | 36.48 | 56.75 |
| 14 | 46.17 | 71.82 |
| 15 | 58.21 | 90.55 |
| 16 | 72.72 | 113.12 |
| 17 | 93.40 | 145.29 |
| 18 | 118.20 | 183.87 |
| 19 | 145.94 | 227.02 |
| 20 | 184.68 | 287.28 |
| 21 | 232.92 | 362.32 |
| 22 | 295.38 | 459.48 |
| 23 | 370.26 | 575.96 |
| 24 | 468.18 | 728.28 |
| 25 | 590.22 | 918.12 |
| 26 | 748.08 | 1 163.68 |
| 27 | 937.98 | 1 459.08 |
| 28 | 1 191.24 | 1 853.04 |
| 29 | 1 481.22 | 2 304 12 |
| 30 | 1 891.8 | 2 942.8 |
| 31 | 2 388.6 | 3 715.6 |
| 32 | 2 955.6 | 4 597.6 |
| 33 | 3 751.2 | 5 835.2 |
| 34 | 4 764.6 | 7 411.6 |
| 35 | 6 031.8 | 9 382.8 |
| 36 | 7 565.4 | 11 768.4 |

In building rheostats and similar resistance devices German silver wire is often used. Table 3 shows the resistances per thousand feet of various sizes. Eighteen per centum means that there is 18 per cent of nickel in the alloy from which the wire is made, 30 per centum, 30 per cent of nickel.

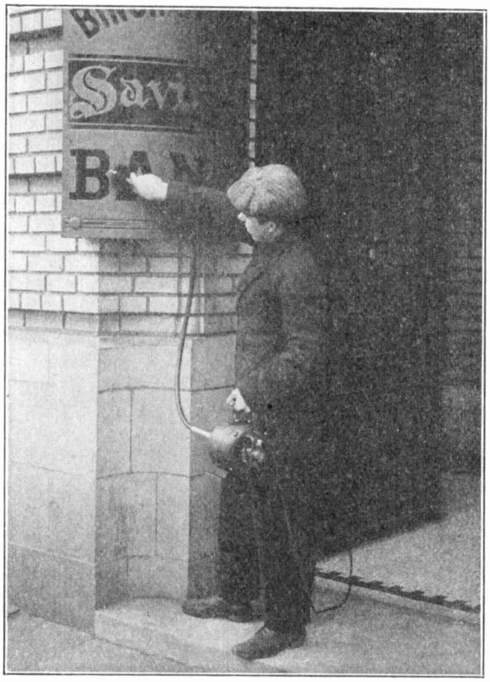
## TREND OF ELECTRICAL DEVELOPMENT

A few years ago every picture of a large factory had to show dense clouds of smoke issuing from great smokestacks and in the foreground had to be a large number of heavily loaded drays hauled by straining horses. All this is archaic now. The up-to-date factory picture shows no black smoke, for such smoke is the height of extravagance and a common nuisance. We have learned that economy and efficiency depend not only upon commercial centralization and co-operative manufacturing and distribution, but also upon co-operative and combined power generation and distribution. The hundreds of teams about the factory yards will some day all be supplanted by electric trucks and factory power be taken from central station wires.

## PORTABLE ELECTRIC BUFFER

For polishing automobile parts, brass signs, metal work in offices, hotels and engine rooms, and for innumerable purposes of a similar nature a small buffing machine which can be carried around in the hand will save a great amount of hard labor and produce results that are hard to obtain by the hand scouring process.

An electric portable buffer will do the work with neatness and dispatch. It embodies a



POLISHING METAL SIGN

little ⅛ horsepower motor with flexible shaft to drive the buffer and a long cord connection to go to the nearest lamp socket. The whole outfit weighs but 27 pounds.

An example of the efficiency of the machine is furnished by its use in a certain large chemical laboratory, where there are 50 or more large copper retorts. Great pride is taken in the brightness of these retorts and it used to take the time of one man for a day to bring one of them up to the proper degree of brightness to suit the exacting taste of the manager. With one of the electric buffers one man is now able to polish 15 to 20 of them in the same length of time.

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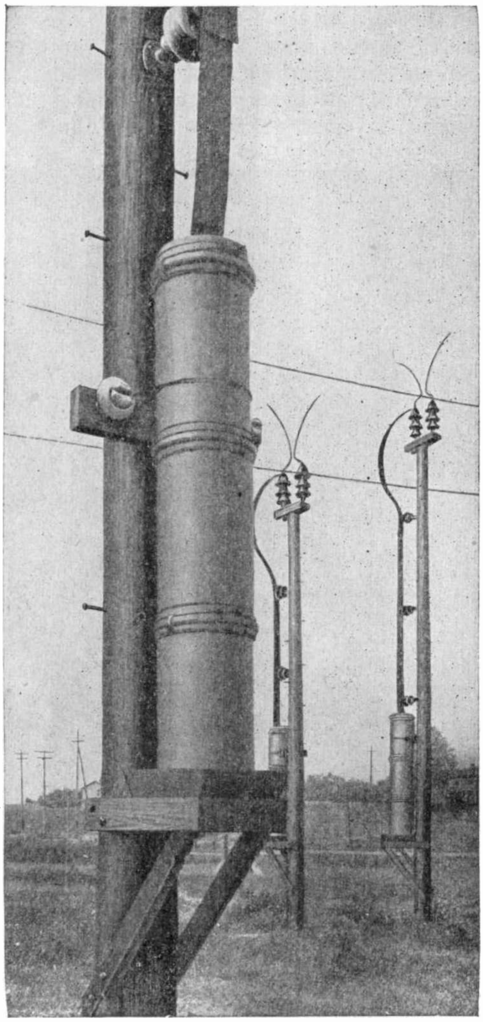
## LIGHTNING PROTECTION FOR TRANSMISSION LINES

The voltage of transmission lines may be from 5,000 to 100,000 volts and the electric current, backed by this enormous pressure, is constantly striving to reach the earth. The ordinary lightning arrester such as might be used on telephone or low tension lines in this case would be useless, for it would offer a weak point in the line where the line current might jump across, form an arc and possibly result in a shut-down of the service. The arrester for high tension lines must therefore present a break of sufficiently high resistance to prevent the escape of the line current, the barrier, however, being such that the lightning stroke, which is of infinitely higher voltage than that of the line, may leap over it or break it down for an instant and pass to the earth.

Among the numerous types of lightning arresters for high tension lines is one which is known as the electrolytic, the operation of which is very interesting. This arrester consists of a number of aluminum trays mounted on a central rod and stacked one above the other as dinner plates might be stacked. These trays are filled with an electrolyte or liquid which forms a very thin film between each pair of plates. The trays are then placed in a cylindrical casing which is filled with oil, and are mounted on a pole as shown in the picture.

One end of the series of trays is connected with the earth. The other end is connected with a heavy metallic strip which leads up to a horn-shaped wire placed close to the line wire. The open space between the horn and the wire is known as the spark gap. Ordinarily the line voltage cannot break down the resistance of the gap and leap across, but when lightning strikes the line the surging which is set up is so powerful that the discharge leaps the gap and passes down into the arrester. Here a peculiar action takes place. The electrolyte, under ordinary voltages is of very high resistance and could not be broken down by the line voltage. But the extremely high voltage of the lightning discharge, which lasts only an instant, punctures the electrolyte in a myriad of places, and for the moment allows the current to flow to earth and relieve the stress on the system. As soon as this is over, the punctures close up and prevents the line voltage, generated by the distant dynamos, from following up the advantage and forcing current to the earth through an arc of conducting vapor which would be formed in the gap. As a double precaution against the formation of such an arc, the gap is made with two horns, diverging as shown. An arc formed down in the narrow part spreads upward and outward in a fan shape and is eventually "blown out" of itself.



ELECTROLYTIC LIGHTNING ARRESTER

# NATIONAL ELECTRIC LIGHT CONVENTION

Furnishing electric current for light and power purposes is one of the greatest industrial undertakings of the age, and it is fitting that all the individual interests which are devoted to the "manufacture" of electricity should have a great and powerful national organization as a medium for the interchange of ideas on the technical and commercial phases of the business. Such an organization is the National Electric Light Association, which has over 3,100 members representing the principal electric lighting companies in the United States. Every year this association holds a convention which is the Mecca of electrical men. There they meet and for a week the men from Seattle and Salt Lake City shake hands with men of Boston and New York and bronzed managers from Texas trade ideas with their friends from Chicago and Minneapolis. Papers treating of the technical features of the equipment are prepared and read by the most prominent electrical engineers in the country. Various phases of the commercial conduct of the business are discussed, and new ways of advertising to the general public the convenience and economy of electricity are propounded. And last, but not least, the electrical manufacturers exhibit the latest appliances which make possible the "wonders of electricity," which we see on every hand.

CONVENTION HALL AT NIGHT—YOUNG'S MILLION DOLLAR PIER, ATLANTIC CITY

In all these things a helping hand is held out to the management of the small lighting plant as well as to those who conduct the affairs of the great central stations of the large cities. "We're all in the game to boost," they say. If the man from Texas has found a new way to cool the condensing water for his engines and work an economy in the use of the precious fluid, the men from every dry locality find out about it in short order. How the Middle West Electric Company overcame an adverse public opinion and gained the confidence and enthusiastic support of the community is carefully considered by the east and west and north and south companies.

This year the annual convention of the Association was held in Atlantic City, N. J. No place is perhaps better fitted for a convention than Atlantic City, for it has the capacity for hundreds of thousands of transients, and a convention crowd which would seriously tax the resources of many cities is hardly noticed in the "Bagdad of the Atlantic."

The convention was held June 1 to 4 and the headquarters were on Young's Million-Dollar Pier.

The great hall which forms the shore end of the pier was a sight long to be remembered, for it is of enormous proportions and electricity was lavishly used in the decorations. The scene was especially beautiful at night, for the pure white light of the tungsten lamps, which replaced every carbon filament lamp in the hall, turned night into day. Ranged around the circumference of the hall were the booths of the exhibitors, all finished in uniform style and with no glaring signs to mar the effect. Sixty-nine manufacturers were represented, and the unique display included almost every electrical device known to the electrical world.

## CHANGING ALTERNATING CURRENT TO DIRECT

BY H. L. TRANSTROM.

As an alternating current cannot be put to all the purposes for which direct current can be used, it becomes necessary to use a device to change it as near to direct current

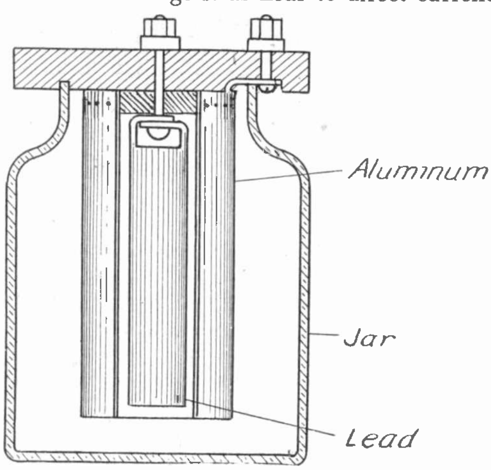



FIG. 1. CHEMICAL RECTIFIER

as possible. The devices that can do this are the motor generator, the mercury arc rectifier and the chemical rectifier.

The motor generator of course gives the best results, but for the amateur experimenter it means a considerable outlay of money and the mercury arc rectifier has the same drawback. Although a chemical

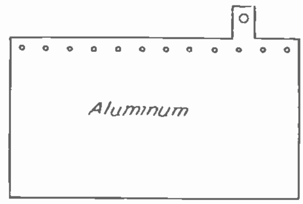



FIG. 2.

rectifier cannot change the alternating current to a direct current suitable for running large motors, yet for charging storage batteries and other uses where it is not absolutely necessary to have a smooth direct current a chemical rectifier fills the require-

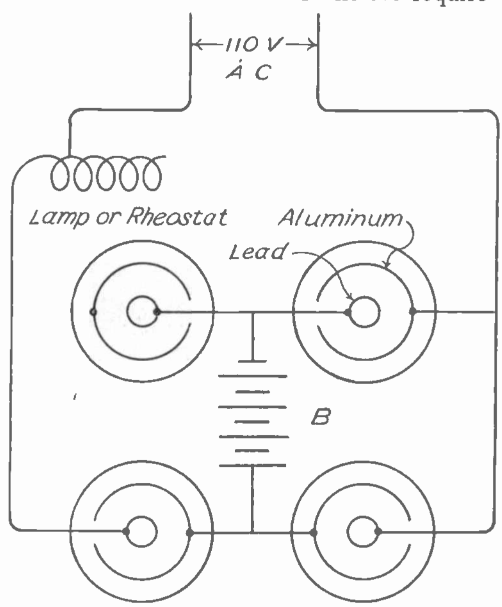



FIG. 3. CONNECTIONS OF RECTIFIER

ments admirably, and it can be made for about $3.00.

Procure four glass jars, those used for ordinary wet cell batteries are well adapted for this purpose, although any glass, rubber or porcelain jar will do. Cut four disks of dry birch to fit loosely in the tops of the jars, and four more disks four inches in diameter by ½ inch thick. Screw the latter fast to the smaller disks to form covers for the jars.

Cut a one-inch lead water pipe into four six-inch lengths and cut out of each with a hack saw enough to be able to bend the top together in such a manner that a long machine screw can be passed through it to a binding post on top of the cover (see Fig. 1).

Cut four rectangles of soft aluminum six by five inches by $\frac{1}{8}$ inch thick, with a projection $\frac{3}{4}$ inches long and $\frac{1}{2}$ inch wide, as shown in Fig. 2, which is bent over at right angles. Screw these plates fast to the $\frac{1}{2}$ inch disk, concentrically with the lead pipe, and countersink the projection into the wood so that it is flush with the under side of the four-inch disk. Bore a hole through the projection and the disk and fasten a machine screw through it to the binding post.

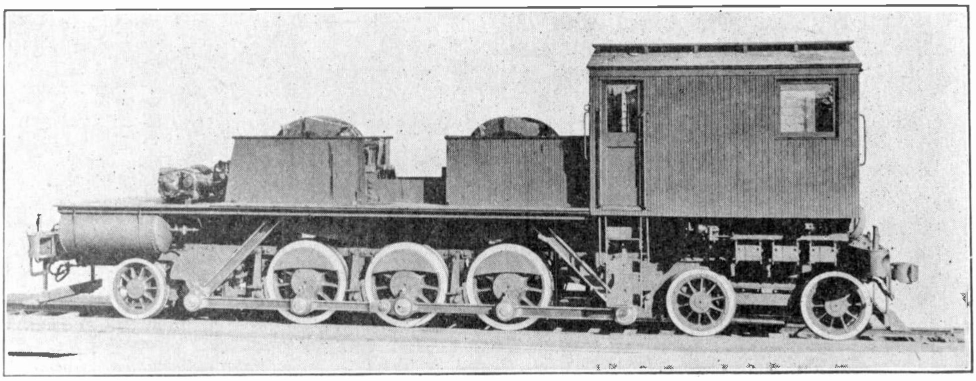
When the four jars are complete fill a larger jar with enough cold water to fill the smaller jars about three-quarters full. Into the cold water pour one pound of pure ammonium phosphate and stir until it is all dissolved.

Do not mix the solutions separately, as they are likely to be of different strengths.

The rectifier is now complete, but it remains to be connected up properly as shown in Fig. 3. A rheostat should be used in series with the alternating current and the rectifier. For purposes requiring little current a 16 candlepower lamp can be used as a rheostat.

In Fig. 3 the rectifier is shown as charging a small battery (B). The battery may, however, be replaced by any small current consuming device requiring direct current. With 110 volts alternating current sent into the rectifier direct current of about 80 or 90 volts is obtained.

# A NOVEL ELECTRIC LOCOMOTIVE



ELECTRIC LOCOMOTIVE WITH SIDE ROD DRIVE

When the electric locomotive first came into use it apparently possessed a great advantage over the steam locomotive in one important particular, namely, there were no massive connecting rods for the propulsion of the drive wheels, the motors driving the wheels direct. This obviated the loss of power due to rapidly reciprocating these heavy masses of steel. But in developing new ideas there is often a tendency to revert to old and tried methods, so after a time designers began to wonder if the old side rod principle might not possess advantages in electrical operation. So they tried the scheme and the locomotive shown in the picture is the result. Its practical value will of course need to be demonstrated by much experiment and many hard knocks.

The advantages claimed for the new type are as follows: Since the motor need not be mounted on the axle, more space is available and it may be built of large diameter and embody other features which will give it greater efficiency. It may also be supported by springs, reducing the jar and rendering it longer lived. Two such motors on a locomotive may be made to do the work of four necessary on other types, securing economy of construction and reducing the cost of the locomotive. The motors in such a locomotive can be located so as to concentrate a greater proportion of the weight near the center of the machine with the attendant advantage that the "moment of inertia" of the locomotive around its vertical axis will be as small as possible. This will reduce the rail pressures at the leading and trailing wheels and, consequently, the flange and rail-head wear. The location of the motors in the cab facilitates inspection and repairs and the renewal of brushes. The maintenance charges for the motors will also be greatly reduced as practically all road dust and other injurious foreign material can be kept out of the motors.

# EVERY MAN AN ELECTRIC RUNABOUT

BY AGNES DEANS CAMERON

You are your own voltaic battery. Every man is an electric runabout. So says Dr. Andrew McConnell, president of the Society of Universal Science, who is himself electrifying New York and Boston with the basic theory that the life principle of man is no mystic fluid, but electricity pure and simple.

Discrediting the idea that we live and move and have our being through some mysterious life force breathed into us at birth and withdrawn at death, Dr. McConnell, a southern scientist, declares that the life energy is electricity generated within our bodies, applied and controlled by our wills.

DR. ANDREW MCCONNELL

What great advantage would there be in finding this true? It would bring all the laws of life under the workings of the well-known laws of electricity. Every man becomes at the same time his electric motor, his own electrical engineer.

For over a decade Dr. McConnell has devoted himself to medical-electro experimental research, with the result that he builds up these three hypotheses:

1. Life power is electricity and is therefore directed and controlled by the laws of electricity.

2. The amount of electricity in each man is the measure of that man's health and working power.

3. This life electricity can be increased at will and to any extent by the individual, and so health and long life are easily within the reach of every human being.

These contentions open up a fascinating field of thought. Especially in the realm of electricity does the wise man hesitate to say, "This is impossible," "That is absurd." The Unknown of today is the Known of tomorrow. A Franklin told us that there is electricity in the air, it took a Marconi to demonstrate that this air-electricity can carry wireless messages. A Galvani told us a century ago that there is electricity in every living creature. May it not be an Andrew McConnell who shall establish the fact that we can at once make, control, and apply that life-stream?

If Andrew McConnell can teach us how to turn on the electric current and charge our batteries—we already know that electricity can decompose anything — it would appear that all we will have to do, to keep our bodily organs at their highest efficiency, will be to make proper application of this dormant force.

Dr. McConnell disclaims having discovered much that is original, but to have assembled a mass of proof from the experiments of others and linked his findings together in a chain of scientific reasoning to substantiate his theory. Here are some of his reasonings:

Every schoolboy knows of the experiment by means of which Galvani touched a dead frog to an electric machine and saw the muscles move as in life. Since Galvani's time numerous experiments have demonstrated that electricity contracts muscles. It is the electrical contraction of muscles which produces all movements of the body.

Acids and alkalies cannot come together in a moist state without generating electricity. It is the union of the stomach acids and the alkalies of the saliva which makes the electricity that dissolves our food in the stomach; the stomach itself is a voltaic battery. When we say facetiously that certain hearts are reached through the stomach, we in a half-hearted way feebly state a psychological and electrical truth. Dr. McConnell maintains that we should be able to direct a current of bodily electricity to our stomach battery and so set the process of digestion merrily on its way. It is said that most of modern man's physical ailments proceed from faulty digestion. Make a man absolute monarch of his stomach and he can master his enemies and dominate his destiny. It is dyspepsia that makes suicides, curdles the milk of human kindness, and allows divorce-lawyers to buy big automobiles. Give the man with the undertaker face and the rabbit-skin chest-protector the secret of sending health-giving electric currents into his little digestive system and his dog will come out from hiding under the woodshed, his wife smile as she used to 20 years ago.

What part does the brain take in all this? Professor Munsterberg, of Harvard, demonstrates very clearly that the brain is an electric battery of the most potent and sensitive type; that it both receives and transmits electric thought-currents.

According to the fascinating McConnell theory each one of us is a moving voltaic battery, insulated by our skin, hair, nails, and the texture of our clothing; each organ within us is itself a complete electric battery, and all the life processes electrical. The expansion of the lungs and the separation of the oxygen from the air, the whole process of digestion, the heart action, the formation and chemical changes in the cells, the secretions of liver and kidneys, the five senses of smell, taste, sight, hearing, and touch, in fact every process essential to life is a simple electrical function.

Most men think themselves more vital than a fish, yet there are many varieties of fish which give electric shocks, give them when they want to, and direct them where they will. It is not a very up-to-date man who is willing to take second place to the thunder-fish of the Nile, the torpedo-fish of the Mediterranean, or the electric eel of South American rivers. A one-horse man is a poor specimen. An historic American in the midst of a hot political campaign was glowingly characterized as "a whole team and a dog under the wagon"; yet with the power of a few electric eels at his disposal, properly directed, he would be this and more.

It would be a poor-spirited "human," Dr. McConnell says, who would refuse to take hold and run the machine when a scientist tells him that, without knowing it, he is the owner of a great splendid touring-car more delicately adjusted, more potent than the shiny and expensive one that whizzes along the city boulevards.

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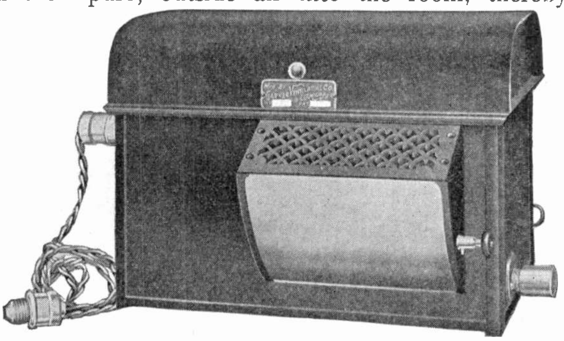
### VENTILATION.

Ideal ventilation can only be obtained by the use of some system which will draw the pure, outside air into the room, thereby forcing the vitiated air out, and at the same time not permitting the inflowing air to strike the occupants of the room directly. These conditions are not fulfilled by an open window, even if it be opened at the top, for the cold air in that case simply comes in at the top and drops, by reason of its greater density, upon the heads of the occupants.



NEW ELECTRICALLY OPERATED VENTILATOR

A very simple mechanical ventilator which gives the proper distribution of pure air in the room is shown herewith. It consists of a casing with an electric driven centrifugal fan located within. An air duct from the back of the casing is led out into the open air. In the front is a grating pointing upward. The rapidly moving fan inside draws in the pure air through the duct and then forces it out through the grating in a stream toward the ceiling, the force being sufficient to carry the air to all the upper portions of the room from whence it gradually settles, driving out the impure air at the bottom.

To take the chill from the incoming air, in the winter time, a system of steam radiating coils is placed in the casing which is fed from the pipes of the steam heating system.

## PROPER METHODS OF TYING AND SPLICING WIRES

As the sailor has his standard kinds of knots, which have been tied just so for generations back, so the electric lineman is supposed to make the ordinary ties and splices of the overhead wires in certain ways, specified by standard usage, if he does not want to call down upon his head the imprecations of the line foreman or the derision of his fellow workers. Some of the ties and splices which have become standard practice and which are approved by the National Electric Light Association, are shown in the diagrams.

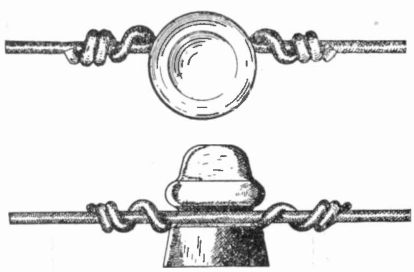


FIG. 1. SINGLE TIE

Fig. 1 shows the top and side views of an insulator to which the line wire is attached by what is known as the "single tie." It is made by taking a piece of wire about 12 inches long and bending it around the insulator under the line wire and making two or three wraps on each side. The ends of the tie wire should always be cut off close to the line wire.

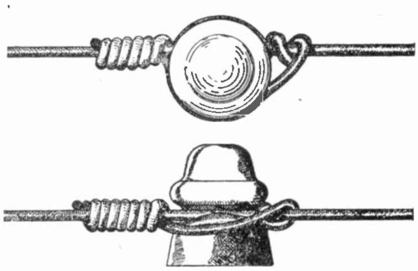


FIG. 2. BACK TIE

The "back tie" is shown in Fig. 2. A piece of wire about 18 inches long is bent around the insulator under the line wire, with four inches of tie on one side of the insulator and the remainder on the other. Then wrap the short end three times around the line wire, leaving a space equal to the diameter of the wire between each of the wraps. Then take the long end, wind it closely around the line wire two times, bring it back around the insulator and wrap three times around the line wire between the turns of the short end. Cut off close to the line wire.

FIG. 3. COMMON SPLICE

An ordinary splice for two wires is shown in Fig. 3. The two ends to be spliced are scraped perfectly clean and free from insulation. They are first given a complete long wrap and then the two ends are given four complete short wraps. The joint is then cleansed with standard soldering compound and well soldered with pure half-and-half solder. Finally the joint is taped.

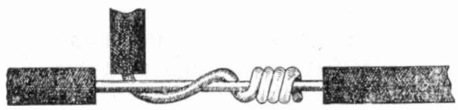


FIG. 4. TAP FROM MAIN LINE

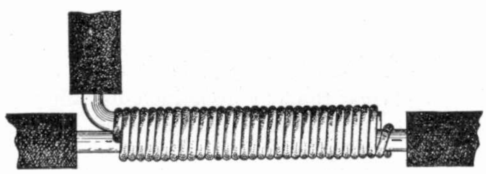


FIG. 5. TAP FOR HEAVY WIRES

A tap is taken off from a main wire as shown in Fig. 4, if the wires are comparatively small. For heavy wires the method shown in Fig. 5 is employed, in which the wires are bound together with a closely wrapped layer of No. 12 copper wire. In each case the joint is soldered and taped.

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During the last six months 195 new electric lighting companies have been formed in the United States and 20 in Canada and Mexico. The present total for the United States is 5264 companies and 5740 including Canada, Mexico and the West Indies. These figures show a total gain of 276 plants over the corresponding figures of a year ago.

# POPULAR ELECTRICITY WIRELESS CLUB

Membership in Popular Electricity Wireless Club is made up of readers of this magazine who have constructed or are operating wireless apparatus or systems. Membership blanks will be sent upon request. This department of the magazine is devoted to the interests of the Club and members are invited to assist in making it as valuable and interesting as possible, by sending in descriptions and photographs of their equipments.

# SPARK COIL CONSTRUCTION AND OPERATION

BY VICTOR H. LAUGHTER.

PART IV.

### DIMENSIONS OF VARIOUS COILS.

Dimensions of various sizes of spark coils are given below. If the amateur prefers to construct a larger or smaller coil than the four-inch size described in this series, he can take the dimensions from the table and proceed with the construction on the same general plan. However, if the coil in view is to be larger than the four-inch size slightly different rules should be observed in the construction.

DIMENSIONS OF COILS FROM 1 TO 20 INCHES

| A | 1 inch | 2 inch | 3 inch | 6 inch | 8 inch | 10 inch | 12 inch | 14 inch | 16 inch | 18 inch | 20 inch |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 7½ inch | 9½ inch | 11½ inch | 14 inch | 17 inch | 17 inch | 18 inch | 18 inch | 19 inch | 20 inch | 20 inch |
| B | 1 " | 1 " | 1¼ " | 1¼ " | 1½ " | 1½ " | 1⅝ " | 1⅝ " | 1¾ " | 2 " | 2 " |
| C | No. 18 | No. 16 | No. 14 | No. 12 | No. 12 | No. 12 | No. 12 | No. 12 | No. 12 | No 12 | No 12 |
| D | 1½ inch | 1 5-16 inch | 1¾ inch | 1¾ inch | 2 inch | 2 inch | 2⅛ inch | 2⅛ inch | 2¼ inch | 2½ inch | 2½ inch |
| E | 3½ " | 1¾ " | 2¼ " | 2¼ " | 2½ " | 2½ " | 2⅝ " | 2⅝ " | 2¾ " | 3¼ " | 3¼ " |
| F | 5½ " | 3½ " | 4 " | 4½ " | 6¼ " | 6¼ " | 6½ " | 7 " | 7 to 8 " | 8 to 9 " | 9 to 9½ " |
| G | 5½ " | 8 " | 9½ " | 10 " | 11 " | 11¼ " | 14 " | 14½ " | 15¾ " | 16 " | 16 " |
| H | 4 | 6 | 8 " | 30 | 36 | 40 | 40 " | 46 | 50 | 50 | 60 |
| I | 1 lb. | 2 lbs. | 3 lbs. | 7½ lbs. | 8 lbs. | 10½ lbs. | 12 lbs. | 14½ lbs. | 16 lbs. | 18 lbs. | 22 lbs. |
| J | 1000 | 2000 | 2400 | 4500 | 8300 | 8500 | 10,000 | 12,500 | 14,000 | 20,000 | 24,000 |

A—Length of core.
B—Diameter of core.
C—Gauge of primary wire.
D—Internal diameter of insulating tube.
E—External diameter of insulating tube.
F—Approximate diameter of secondary winding.
G—Distance between coil heads.
H—Number of sections in secondary.
I—Quantity of secondary wire.
J—Total number of square inches of foil.

From what has been previously learned, we know that the greatest difference of potential, or electrical pressure of an induction coil is between the ends of the secondary where the induced current flows up to the secondary terminals. Since the iron core is in near proximity to the point of the greatest difference of potential, being separated from it by only the insulating tube, and if the coil is of the larger size, a "breakdown" will sometimes occur due to the current breaking across to the ends of the iron core. The iron core offers a more conductive path than the leads to the secondary terminals. To obviate this difficulty the secondary in the larger sizes is wound with the greater portion of wire in the central sections. This is made clear by reference to Fig. 16. The central hole of the end sections is increased in diameter and the space between this central hole and insulating tube is filled with an insulating substance, usually paraffine wax. The exact proportion of the end sections to the central sections is of only minor consideration. This plan, as stated, need not be followed unless the coil is larger than the four-inch size.

An apparent discrepancy exists in the dimensions given below. As noted the dimensions for a three-inch coil gives the core as 11½ inches in length, while in the dimensions for the four-inch coil previously described the core length is 10 inches. This difference in length, however, is made up for in the general construction.

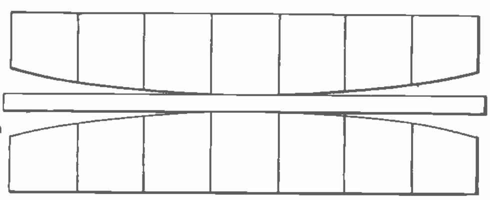

FIG. 16. METHOD OF WINDING SECTIONS OF LARGE COIL

### SPARK COIL EXPERIMENTS.

Experiments which can be carried out with the sparks coil are beautiful in effects

NOTE: In Chapter II, page 106, the first section of the coil should be wound with five ounces of wire instead of three ounces, as stated.

and surprising in results. No other electrical instrument offers as wide and varied a field for experimental work. With it X-Ray photographs can be made of the various portions of the body, bringing out in clear relief the interior parts which are concealed to the naked eye. It can be connected up for use in wireless telegraphy and messages sent through the ether, the distance dependent on the size of coil used. Among numerous other experiments may be mentioned the lighting up of Geissler tubes and the taking of electrical photographs, this last named showing the most beautiful application of the coil.

Operation of the coil will first be described connected up for use in a 20 mile wireless set. In making the statement, however, that this coil will work over a distance of 20 miles, it must be understood that it will do so under the best of conditions. In addition to the coil will be needed six one-pint Leyden jars, zinc spark gap, tuning helix and sufficient flexible conducting cord to make the various leads.

The Leyden jar can be purchased complete if so desired, but as the price is usually $1.00 or more the amateur may prefer to build it himself. The construction is simple. First, get six one-pint chemical beakers from any druggist or chemical supply house, and about one pound of tin foil. Cut the tin foil in strips of sufficient length to reach around one-half of the circumference of the jar, and three-fourths of the total height. Coat one side of the foil strip with library paste and place it down in the jar so that it clings neatly to the interior surface, and rub it down with a flannel rag until it adheres closely to the jar and all uneven places have been rubbed out. The opposite half is covered in this manner.

A disk is next cut of a size corresponding to the size of the inside of the bottom of the jar. Then carefully coat one side of this disk with the paste and drop in the bottom of the jar, rubbing it down the same as for the sides, and using care to make the edges of the foil come in contact with the side pieces. The outside of the jar is then coated in the same manner.

The exposed glass portion of the jar should be well coated with shellac to prevent leakage of the current.

A contact is now provided to make connection with the inner coating of the foil. A very simple method is to cut a 1-16-inch brass rod of sufficient length to clear the top of the jar two inches when resting on the bottom. On the end of this rod is preferably soldered a small round brass ball such as used for the hammer of an electric bell. This ball, owing to its shape, will prevent leakage of the stored charge, and unless it is used, there will always be a certain amount of leakage from the end points. To hold the rod in the jar cut two pasteboard disks, one to rest about one inch clear of the bottom, and the other about one inch from the top. Holes are punched in the center of the disks for the insertion of the rods. On the inside bottom of the jar a few scrap pieces of tin foil should be placed, so that the rod will make good contact and not scratch the foil surface. When the rod has been placed in the upper disk, the latter should be well coated with shellac, which will hold it in place better, and give more perfect insulation. This completes work on the Leyden jar and it is evident that the remaining five are constructed in the same manner. It is not essential, however, that chemical beakers be used for any other type of thin, high grade glass jar will answer. The jars are then connected to the other apparatus as shown in Fig. 17.

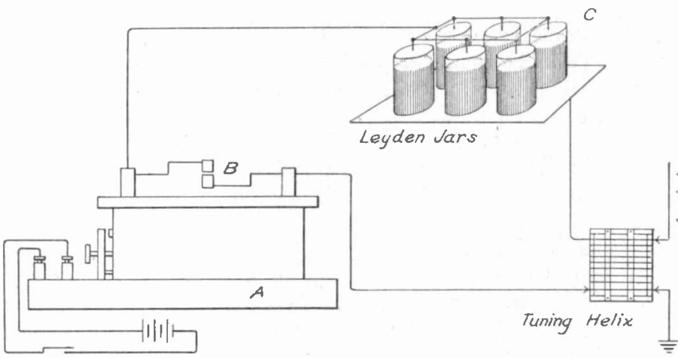


FIG. 17. CONNECTIONS OF THE LEYDEN JARS

The complete spark gap (B) of Fig. 17 is illustrated in detail in Fig. 18. It consists of the hard rubber base (F) with the binding posts (AA) mounted on it, and through the binding posts is run the brass arms (CC) with the zincs (DD) mounted on the ends, and on the opposite ends are mounted ebonite handles (EE).

The hard rubber base measures four inches long, two inches wide and $\frac{3}{8}$ inch thick. Holes are drilled and countersunk in the center one inch from each end. The

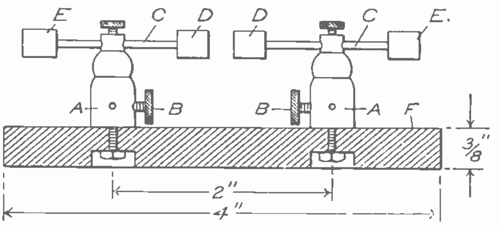


FIG. 18. COMPLETE SPARK GAP

binding posts are illustrated at (AA). These binding posts should be of sufficient height to hold the spark gap at least one inch above the base when mounted. The exact style of binding posts to use makes no difference, but it is best to select a type with a second lead as shown at (B), so that connection can be made with the secondary terminals of the coil, and to the leads to the condenser and helix.

The zincs can be cut from the rounded end of a battery zinc. Cut $\frac{1}{2}$ inch long and drill a 1-16-inch hole $\frac{1}{4}$ inch deep in the end of each. The brass rods (CC) should measure approximately 1-16 inch in diameter and two inches long. The ebonite handles (EE) come in stock sizes and can be bought at any electrical supply house. Shove the ends of the rods in the zincs and mount as shown. The faces of the zincs should be well polished with emery cloth before mounting. This completes work on the spark gap. The constructor can of course improve on the type of gap shown here, if he so desires, but this type will meet the requirements in view.

The parts which go to make up the helix are as follows: Two oak disks $\frac{1}{2}$ inch thick and six inches in diameter; eight wood standards one inch square and six inches high; 10 feet of No. 8 bare copper wire. The edges of the disks are countersunk, at equal distances around the entire circumference with one-inch squares as shown in Fig. 19. The wood standards are now cut with V-shaped notches $\frac{1}{4}$ inch deep and one inch apart all the way down. Holes are drilled at each end. The completed piece is shown at (A) in Fig. 19. The wood standards are now screwed to the disks in the countersunk slots.

The frame is now given several coats of shellac, and when dry the No. 8 wire is wound on. Begin by first screwing a binding post to one of the pieces near the top The hole in this binding post should be drilled out large enough to allow the insertion of a No. 8 wire. Lock the upper end of the wire in the binding post and wind around the frame, placing the wire in the notch of each piece and coming one notch lower at each turn. The lower end of the winding should be locked in a binding post the same as for the upper end. The completed helix is shown in Fig 20.

The various parts are now complete and the set is ready to be connected up for use.

The spark gap can be mounted on top of the coil case between the secondary ter-

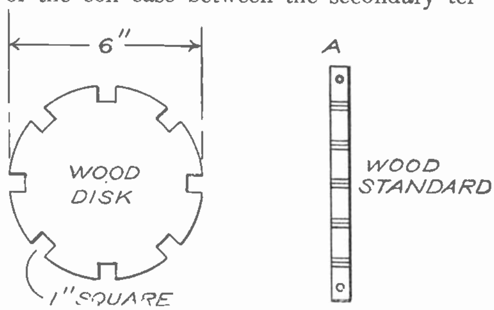


FIG. 19. SENDING HELIX PARTS

minals as shown at (B) Fig. 17. Although some experimenters prefer to mount the gap at other points, this is only a matter of choice. The Leyden jars are best mounted by first placing down a pane of glass, and

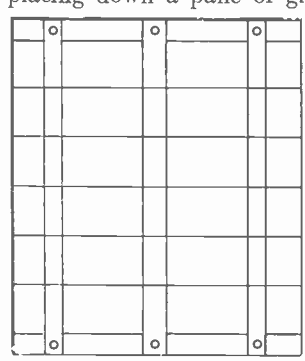

FIG. 20. COMPLETE HELIX

on this a thin copper sheet; the jars are set on the sheet so that it will make a contact with the outside coating of each jar.

The rods which make connections with the inside coating of the jars are now soldered together by one common wire, and a leap made of flexible lamp cord is carried back to one of the secondary terminals.

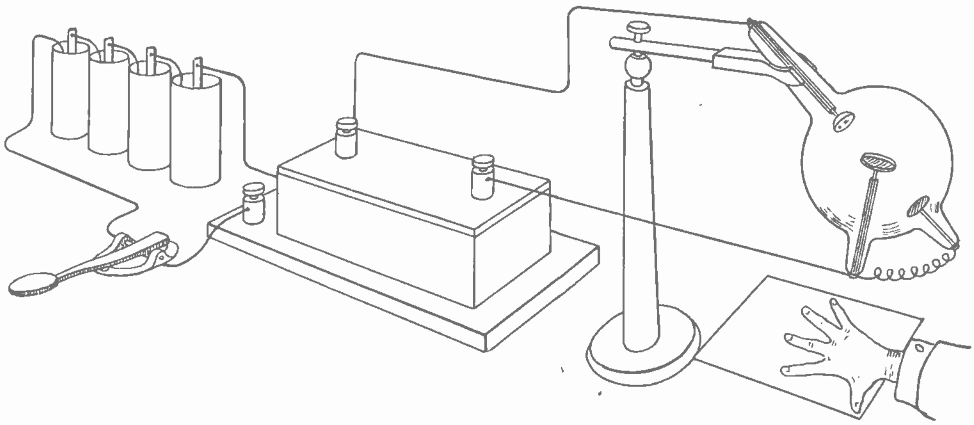

FIG. 21. USING COIL FOR TAKING X-RAY PICTURES

A second flexible lead is soldered to the copper sheet, with a metallic clip soldered to the opposite end, so that connection can be made instantly with the different turns of the helix. The next lead runs from the remaining secondary terminal over to the helix as shown.

The ground wire may be soldered onto the lower turn of the helix, but the aerial should be a variable contact.

It is evident that the amateur can add improvements to the general constructional plan as described here, as the various parts have been described in as simple manner as possible, so that the uninitiated will have no difficulty in following the principles of the construction.

RADIOGRAPHS.

Radiographs or X-Ray photographs can be very easily and successfully made with this coil. In buying the X-ray tube the constructor should state the size coil he is using, as tubes vary to a large extent for use in connection with different size coils. The average price of such tubes ranges from six to eight dollars, depending on the quality. It is also advisable to purchase a fluoroscope, as with it, the bones of the hand, the interior of a purse and other objects will be made visible to the naked eye. Without the fluoroscope it will be necessary to take the image on a photographic plate, and develop the plate to bring the object to view. This latter method has the advantage, however, of retaining the photograph for future use. To view an object when the fluoroscope is used, it is only necessary to hold the desired object between the X-ray tube and the fluoroscope. The making of radiographs, however, is a more difficult operation.

The complete X-ray set connected up for use is shown in Fig. 21. An ordinary photographic plate is placed below the tube at a distance from three to six inches with the sensitive side upwards. Place the hand on the plate, considering that a radiograph of the hand is to be made, and start the coil in operation by closing the battery switch. If the tube lights up with a greenish hue, it is working at full value and a clear radiograph should be the result. Make several exposures with different objects, at the same time varying the position of the tube and the distance of the object from the tube. In this manner the experimenter will soon be able to determine the exact position necessary for the best results. This must of course be done in a dark room or with the photograph plate carefully wrapped in black paper.

ELECTRICAL PHOTOGRAPHS.

The making of electrical photographs is a simple operation and does not require a large size coil. The photographs shown herewith were all made with a one-inch coil, and with the larger size much more elaborate effects can be obtained.

Considering that the coil is at hand the only other requisites needed are a can of talcum powder, a copper or brass sheet measuring about six inches square, and a number of photographic dry plates.

Connect one of the terminals of the spark coil to the metal sheet and solder the other terminal to a needle.

One of the plates is now taken from the box and laid on the metal sheet with the sensitive film surface upward. The plates should only be taken out of the box in a well darkened room, and preferably the photographs should be made at night, for this will lessen the danger of any stray beams of light affecting the sensitive film. A small photographer's ruby lamp should be in the room so that sufficient light will be had to show which side of the plate the film is on. The film side can be easily recognized as it has a dull, rough finish.

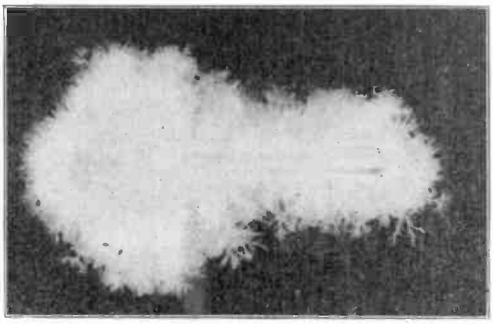

FIG. 22. PHOTOGRAPH OF KEY

Lay the plate on the metal sheet as before mentioned and place the second contact with the needle point in the center. A thin film of talcum powder is next sifted over the surface.

The key of the coil is now pressed for about a second. This will cause a spark to appear at the needle contact and spread over the surface of the plate. The plate is now taken up and wiped carefully with cotton batting and placed in a box and is later on developed, which brings out clearly the features of the sparks. Photographs of metal objects can be made by placing

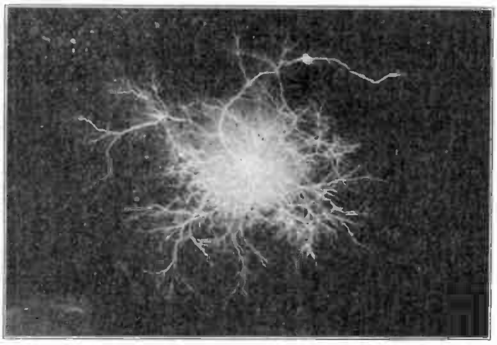

FIG. 23. PHOTOGRAPH WITH NEEDLE POINT ON PLATE

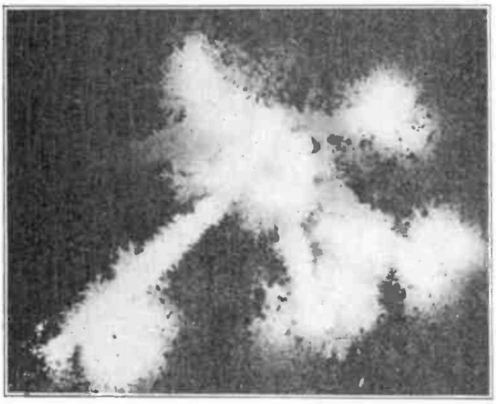

FIG. 25. PHOTOGRAPH OF BUNCH OF KEYS

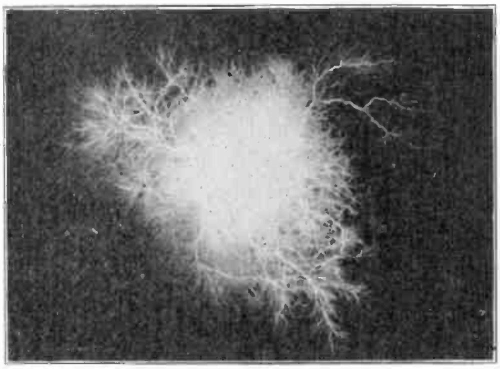

FIG. 24. POSITIVE POLE CONNECTED TO NEEDLE

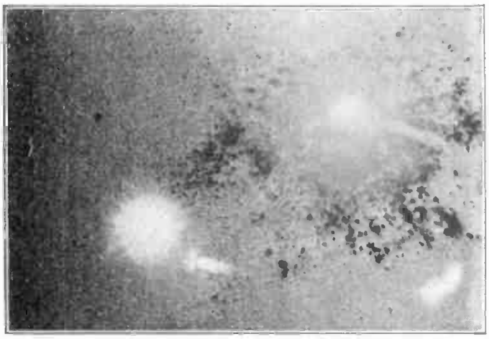

FIG. 26. PHOTOGRAPH WITH THE SECONDARY LEADS ON PLATE

the object on the plate and making contact with the needle point.

In Fig. 22 is shown the photograph of a Yale key made in this manner. In Fig. 23 is shown a photograph made with the needle point resting on the plate. The needle point was in this instance connected to the negative pole. Fig. 24 is from a photograph made with the positive pole connected to the needle. As noted the positive pole gives a flaming spark resembling a fire ball. Fig. 25 was made by laying a bunch of keys on the plate. The photograph in Fig. 26 shows a very curious effect. This was made by placing the two secondary leads on the plate. By close examination it will be seen that the film of talcum powder was driven from the right to the left hand side.

The experimenter can of course vary the range of his experiments a hundred fold and produce various effects.

(The End.)

### ELECTROLYTIC INTERRUPTER

The question is often asked: How can I operate my spark coil from the ordinary lighting current? The solution of the problem is to use an electrolytic interrupter. Such an interrupter is shown in Fig. 1, and it may be connected in series with any ordinary spark coil and the 110 or 220 volt direct or alternating current lighting circuit. No resistance or condenser is used, the vibrator of the coil must also be screwed up tight as it should not vibrate when the interrupter is in the circuit, as the latter does the making and breaking.

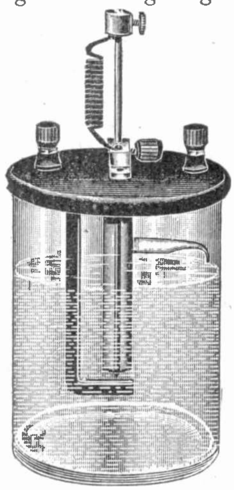

FIG. 1. ELECTROLYTIC INTERRUPTER

The interrupter starts with 50 volts. A metal rod of especial alloy goes through the cover, down into the glass tube. This tube at its lower end has a peculiar aperture in which the point of the rod fits. The tube at the upper end has a screw top which screws in the cover. This tube is made of special material and will not crack even if the interrupter is worked steadily. In operation the metal rod wears itself away to a point. The rod itself is fed down by gravity. This action is entirely controlled by the weight attached to the top of the rod. In fact the entire success of this interrupter lies in the right weight of the metal.

FIG. 2.

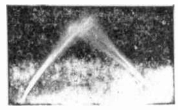

FIG. 3.

Too much weight gives no spark at all, too little gives an uneven and unsteady spark. Very little metal is used up; it takes about 60 hours' constant work to consume one inch of the rod. The rod can be left constantly in the solution without harm.

Use of the interrupter also increases the power of the spark, and with a one-inch coil connected to the proper condenser, and a zinc spark gap properly adjusted, you will get a crash that will almost take your breath away. To illustrate this Figs. 2 and 3 show two discharges from the same coil, using 110 volt current. In Fig. 2 the interrupter was not used and the spark is stringy. In Fig. 3 it was used and the spark was much better. As will be noted, the flame shoots upward due to the great amount of heat raised.

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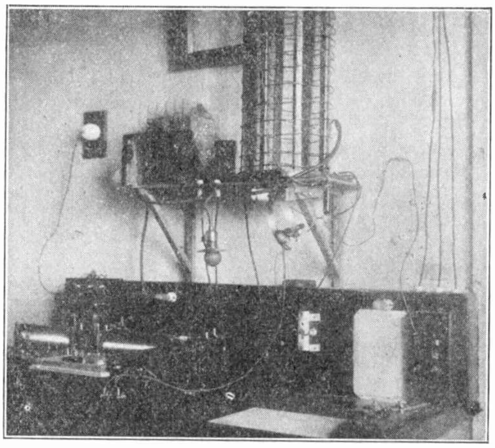
The opinion recently expressed by a French naval surgeon that the electric waves used in radio-telegraphy endangered the eyes of operators is pronounced unfounded by Mr. Marconi. He says that no case of this kind has occurred among the employees of his company, and no others have come to his notice. Besides, Mr. Marconi has had a particularly good chance to test the matter himself at his stations for trans-Atlantic service. At these places much more powerful apparatus is used than on shipboard, and he has worked with it for hours at a time, repeatedly, without the slightest ill effect.

### WHAT A CLUB MEMBER IS DOING

One of the members of Popular Electricity Wireless Club has designed and built almost entirely by his own efforts a wireless station in which he takes considerable just pride. George D. Henderson is his name, and he lives at 2827 Southport Ave., North Edgewater, Chicago. He sends us a photograph of his equipment which we reproduce herewith as an inspiration to other members of the club who are building wireless equipments for another purpose than to simply hear the sparks crackle. With this equipment he is able to send and receive messages to and from the steamers on Lake Michigan and the numerous wireless stations in the city.



INTERESTING AMATEUR EQUIPMENT

The sending apparatus consists of a one-quarter kilowatt transformer, operated from the electric light current; sending helix, consisting of a wooden frame 14 inches by 12 inches wound with 25 feet of No. 8 bare copper wire; a spark gap of brass rods with zinc tips, and a large condenser of six plates 8 by 10 inches with tinfoil five by six inches. The sending instruments are connected up according to De Forest's plan.

The receiving apparatus consists of a tuning coil having 372 meters wave length; 300 ohm potentiometer; five detectors, silicon, electrolytic, microphone, carborundum, and molybdenite, a variable condenser; fixed condenser; 1000 ohm receiver and battery, and also a five-point switch by which any of the five detectors can be thrown in circuit. These instruments were all home made except the silicon detector, telephone, sending key and switches.

A filings coherer is also used in connection with a 100 ohm relay and tapper, for signaling.

The aerial consists of six No. 15 bare copper wires, each 40 feet long, spread a foot apart on spreaders five feet long. The height is 45 feet.

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### THE WIRELESS MANIA

A most horrible state of affairs exists in Philadelphia, a city in which brotherly love is supposed to predominate. One of its citizens seems to think so at least, and it is all on account of wireless. So he wrote to a prominent wireless telegraph engineer for expert advice; and here is his letter:

In our city here, unfortunately for the welfare of some of our citizens, a tower exists about 525 feet high above the street level; a very fine place to send out deadly electric waves from the wireless telephone or the wireless telegraph apparatus; the latter of which they are now installing to work from our City Hall tower. Now I have been bothered for months, night and day, by deadly electric waves being trained on me and my home, and also on my mother, who is a woman over seventy years of age.

"I have been shocked almost to death several times by wireless electric waves and have had other dirty work done on me unfit to write. This wireless apparatus is trained on me now while I am writing this letter, and has been trained on me all day. I am almost positive that this dirty work is done on me from our City Hall, by the Republican Party that is in power in this city. We have a bad administration here and they have been denounced as thieves in public print here.

I am a steam engineer and have had some electric experience with dynamos up to 2,500 volts and have been reading up wireless now and then for the last six months.

My house is only a two-story affair, about 23 feet from the ground to the roof, not much height for wireless.

As I believe that you are well versed on wireless, what would you think best for a fellow to do in such a case? I went to a couple of lawyers, but that did not stop it. I reported the case to the United States Government at Washington and still it is trained on the house.

A fellow has a job to get any rest with a machine like that buzzing on your ears and vibrating on your brains all night.

The wireless telegraph engineer felt that he ought to answer this appeal, but as the technical points involved were too deep even for a brain steeped in wireless knowledge, he decided to put his answer in the form of a sort of fairy story, better tuned, as he thought, to the receiving apparatus of his Philadelphia correspondent. So he answered as follows:

Your highly interesting letter received today. It is indeed a great shame that the wireless station has been placed so near your house. This is contrary to the Jeffersonian Democracy and the Declaration of Independence, and you, as a free born American citizen, should fight it from beginning to end.

In my long experience in the wireless field, and voting the democratic ticket, I have never known of such a case of republican extortion. They are trying to force you to vote their ticket. Don't do it. Insulate your body as I will explain to you later on, and then you can bask in the deadly electric waves with impunity. In fact, the waves will give you a vigor and feeling that you have never had before.

Ah! if you could only do as the cannibals of the Bazoo Islands did to a naval wireless expert some time ago. The navy erected a high power station on the Isle of Bazoo. This island was dry and sandy and the natives, owing to the non-conductive influence of the ultra violet rays would often feel a faint tingling sensation. They instantly knew what it was. It was caused by the naval expert pressing the key which turned loose several million volts on their island. All the vegetation was shrinking up and drying. But the climax came.

One day the ill-fated King Cephas of Bazoo was walking down the beach when a flash of lightning from the top of the wire that sticks up in the air, sprang down, hit him between the shoulders, and he fell over stone dead.

The natives knew the reason. They instantly made soup out of the wireless expert and are now wearing the Leyden jars for watch charms.

This was caused by the enormous voltage becoming stored up in the air and ground and making a discharge like lightning. This will always happen around a high power wireless station. The Philadelphia station will no doubt have a like discharge at an early date which will tear down buildings and possibly injure a few people.

The best way to protect yourself would be to wear a feather duster, which are worn by all wireless operators. I will tell the secret of how it is made to you, but be sure to keep it confidential, for only a few of us know. First take a common linen duster and soak it in LaPage's glue. Now put the duster on and cut open a feather bed and roll in it for about fifteen minutes. Be sure that feathers adhere to all parts of the duster.

The above duster is a practical guarantee against the wireless waves. You need have no fear while wearing it.

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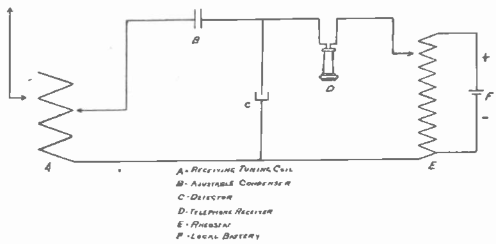
## CONSTRUCTION AND ADJUSTMENT OF THE TUNING COIL

So many questions are received regarding the construction of the tuning coil and how to connect it to the circuit that it is deemed advisable to repeat the description contained in Mr. Laughter's article on "Wireless Telegraphy Made Simple," which explains a simple form of coil easily made by any amateur.

Such a coil consists of an insulating cylindrical frame wound with 115 turns of No. 18 bare tinned copper wire, the turns being 3-32 of an inch apart. Slide wire contacts are provided which work up the frame and make contact with the various turns of the wire. The scale is provided in order that the operator may note the number of turns to use, with a station of a certain wave length. The connections of the receiving tuning coil are shown in the diagram.

Considering that all the instruments have been connected at both sending and receiving end, we may begin the tuning. The opera-




CONNECTIONS OF TUNING COIL

tor at the sending end sends out a certain letter at certain intervals, of, say, one minute each, he continues to send and regulate the movable contact over his tuning coil, noting at what points the adjustments are made. At the receiving end the operator moves the slide wire contacts of his receiving coil synchronously with the sending end. When the point is reached where the clearest indications are heard, note is made of the time and compared with the operator at the sending end. It will be well, however, to go over this operation several times so that the best point will be found.

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# WIRELESS QUERIES

ANSWERED BY V. H. LAUGHTER

### Condenser Operation

*Questions.*—(A) Kindly explain how a condenser bridged around the interrupter on a spark coil prevents sparking at contact points? (B) How is a circuit made through a condenser when the positive and negative coatings are separated by a glass plate? (C) Does the installing of a new telephone in a subscriber's house necessitate the erection of a new wire from the exchange to the subscriber?—H. G. N., New York, N. Y.

*Answers.*—(A) Refer to the article "Spark Coil Construction and Operation" in the May issue.

(B) See answer to A. R. W. in this issue.

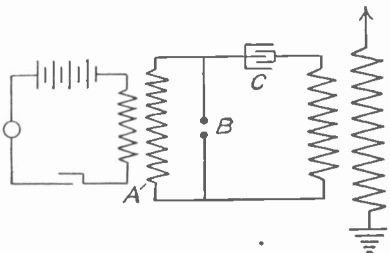
(C) Several telephones can be worked on one line by the addition of some special selective signalling arrangement. We would refer you to the telephone manufacturers for more extended information.

### Spark Coil; Condenser Operation

*Questions.*—(A) What is the approximate spark length of the following coil: Core 6½ inches long, ½ inch in diameter; distance between coil heads, 5 inches; diameter of coil, 3½ inches; primary two layers of number 18 B. & S. cotton covered wire; secondary 12 ounces of number 32 B. & S. cotton covered wire; condenser 70 sheets of tinfoil, 3 by 6 inches; vibrator, usual type. (B) Please show by diagram how to bridge a spark gap with Leyden jars? (C) Can Leyden jars be used for a condenser in above coil? If so, are they connected in the same way as ordinary type of condenser? (D) Please explain the passage of an electric current through a condenser.—A. R. W., Buffalo. N. Y.

*Answers.*—(A) The coil would give ⅜ to ½ inch spark.

(B) The usual method is shown in the diagram. (A) represents the secondary of




SPARK GAP BRIDGED WITH CONDENSER

the spark coil, (B) the spark gap and (C) the condenser.

(C) In answer to both your questions, yes.

(D) If two electrical conductors are insulated from each other and one is charged with electricity a charge of opposite sign or polarity is induced in the other conductor by a phenomenon which is known as induction. This principle is applied in the ordinary Leyden jar or condenser. The conductors in this case are separated by glass or other dielectric. If a condenser be included in an alternating circuit the conductor on one side of the plate becomes alternately positive and negative and by induction charges are produced on the conductor on the opposite side, also alternately positive and negative; therefore, if the circuit is closed, alternating current will flow through it, although there is actually an insulator in the circuit in the form of the glass plate. An alternating current wave comes along the conductor till it comes to the glass, induces a charge in the conductor on the other side which passes the wave along through the circuit. As an analogy, suppose we have a vertical, elastic wall (representing the glass plate). Now hang two pendulums so that the weights just touch the wall. Then draw back one pendulum weight and let it fall against the wall. Its force will be transmitted through the wall to the other pendulum which will be swung outward by the push exerted by the wall surface, although there has been no direct contact between the two pendulums. The motion of the pendulum corresponds to the rise and fall of an alternating current wave, the wave on one side of the wall inducing a like wave on the other. Direct current on the other hand will not pass through a condenser because there is no phenomenon of induction present because there is no rise and fall in voltage. It is the same as if we let the two pendulums rest against the wall and then pushed steadily on one of them. There is no force exerted on the other and the two are perfectly "insulated," in a mechanical sense, from one another.

### Spark Coil

*Questions.*—(A) What size condenser would I need to cut the sparking down at the vibrator? The coil has a 6½-inch core. (B) Would linen or silk wrapped around the primary, to a thickness of 3-16 inch, be enough to insulate primary from secondary if boiled in paraffine? (C) How far would this coil send with delicate receiving instruments at the other end? (D) How many meters capacity was the tuning coil described in March issue? (E) Will you please give me instructions to make a condenser for receiving end?—R. P. G., Salisbury, N. C.

*Answers.*—(A) The coil you describe will give a fat spark and send to a good distance for wireless use, but we doubt very much if the spark will be one inch long. Approximately 1,000 square inches of foil should be used for the condenser.

(B) Yes.

(C) Possibly five or six miles.

(D) We do not know exact number of turns and therefore cannot give you a suitable answer.

(E) Condensers for the receiving end are of numerous types. To describe a variable condenser would take up too much space for this department. A fixed type which is often used can be made by building up with alternate tin foil sheets three by four inches in size, on paraffine paper. Six such sheets would answer. By referring to the article on "Spark Coil Construction and Operation," Part I, you will find a more complete description of how to build up a condenser.

### Transformer

*Questions.*—(A) I have a closed type of transformer operating on the 110 volt A. C. current. I use no interrupter or condenser and obtain a quarter inch spark. About how far can I send with such a spark? Would an interrupter and condenser improve spark and if so, what type of interrupter shall I use? Should the key be placed in the primary or secondary circuit? (B) By using a chemical rectifier, as was described in the March number, could I successfully operate the closed core transformer, using either a make and break interrupter or electrolytic interrupter? (C) By using lamp resistance, would the current from the rectifier operate a wireless spark coil?—G. A. L., Springfield, Ill.

*Answers.*—(A) You should be able to send up to 50 miles under good working conditions with this transformer. The interrupter or condenser would prove of no advantage. However, in the secondary circuit a battery of condensers should be included. The key should be placed in the primary circuit.

(B and C) Transformers are not used with interrupters. The transformer will give good results if operated direct on the 110 a. c. circuit. By using a lamp resistance, as you state, the current would operate a spark coil.

### Coil Operation with Interrupter

*Questions.*—(A) Will it injure an induction coil of the following dimensions to use it on 110 volt alternating current with a Wehnelt interrupter: core 1 inch in diameter, 8 inches long, wound with three layers of No. 12 D. C. C. wire; insulating tube between primary and secondary 1/8 inch; secondary wound with 4½ pounds No. 34 D. C. C. copper wire in 40 sections with paper insulation between each; section 4 inches in diameter boiled in paraffine wax? (B) What size spark ought I get with this coil? How long may I leave the current on without injury? (C) How much resistance ought to be interposed and should the lights be connected in parallel? (D) Are Leyden jars bridged across the spark gap necessary? (E) Is it necessary to use a condenser on the receiving set and of what use is it?—R. S. K., Owensboro, Ky.

*Answers.*—(A) The coil can be used on the a. c. circuit, but it would be advisable to connect an ordinary lamp in series.

(B) The spark would be very short. If you get a 1/8-inch spark you can consider the results to be excellent. By using the lamp resistance the coil can be used indefinitely without injury.

(C) You can determine the exact amount of resistance best by actual experiments.

(D) The set would not operate at all unless the Leyden jars were used.

(E) Not unless the receiving set is of the tuned circuit type. The condenser serves to cut down the static currents and is a necessary part of the tuned receiving set.

### Wave Length; Detector; Antenna

*Questions.*—(A) About what wave length do most of the large wireless stations use? (B) Will it damage copper wire to burn the insulation off? I want to use it in my antenna. (C) Can the platinum wire out of an electric light globe be used in making an electrolytic detector?—L. L. K.

*Answers.*—(A) Four hundred and twenty-five meters is the wave length in use by the majority of the commercial stations.

(B) Not unless the insulation is too heavy.

(C) A very simple detector can be made by breaking the top of an incandescent lamp and removing the filament, leaving the platinum wires exposed. A solution of nitric acid is now poured into the bulb, and the connection made the same as for usual type of self-restoring detector. Such a detector, however, is not very sensitive.

### Spark Coil; Receiving Set

*Questions.*—(A) Would a six-inch spark coil send messages fifty miles? (B) Would the amateur receiving apparatus described in the February number receive up to the above named distance? (C) What amount of battery and what kind would be needed to operate a six-inch spark coil?—L. T., Minneapolis, Kan.

*Answers.*—(A) For sending up to 50 miles we would by all means recommend a 400-watt transformer.

(B) Yes, if connected to an aerial of about 100 feet in height.

(C) Six to eight common dry cells would operate the six-inch coil.

### Spark and Tuning Coil

*Questions.*—(A) Can the jump spark coil that is used for gas-engine ignition be used for a ⅛-mile wireless set? (B) If not, what size induction coil should be used? (C) Please explain the use of the tuning coil. (D) Is it necessary to use a tuning coil?—J. H. K., Cleveland, Ohio.

*Answers.*—(A) No.

(B) One-fourth or one-half inch.

(C) To regulate the wave length.

(D) No, not for ordinary experimental purposes.

# ELECTRICAL MEN OF THE TIMES

## FRANK W. FRUEAUFF

A new president has just been chosen for the National Electric Light Association, the great national organization of representative electric central station men. His name is Frank W. Frueauff, and he hails from Denver—City of Lights. He said on one occasion, "You can tell the whole electrical fraternity that we believe in sensationalism, out in Denver, in the matter of electric central station advertising," and that is the keynote of his success—to tell all the people, all the time, by every conceivable method, of the advantages derived from the use of electricity.

Although only 35 years of age, Mr. Frueauff has been identified with the lighting companies of Denver for nearly 18 years. It is a long climb from meter-reader to vice-president and general manager, but he made it in 13 years and has held the latter position with the Denver Gas and Electric Company since 1904.

But the guiding of the destinies of this large plant—in itself enough for almost any man—is not his only work. He is also a partner of Henry L. Doherty & Co., owners and operators of a score of large lighting plants scattered throughout various states from Colorado to the Atlantic, and familiarly known as the "Doherty interests." Consequently he holds executive positions in a large number of these individual companies which are controlled from the central head—the Doherty company. He is vice-president of the companies at Lincoln, Neb., Pueblo, Colo., Lebanon, Pa., and of the Doherty operating company. In addition he is secretary of the Lacombe Electric Co. in Denver, treasurer of the Summit County Power Co. in Colorado and director of the Massillon (Ohio) Electric and Gas Company.

Mr. Frueauff holds memberships in the National Electric Light Association, the National Commercial Gas Association, of which he is past president and in the Colorado Light, Power and Railway Association. He is well known in these associations, and this, together with his approachable, likeable and interesting qualities, has won him a host of friends from 'Frisco to New York City.

Out of the dreams that busied the young mind in the days when Leadville spelled the boundaries of Frueauff's life has come a career which has made the electrical world pause and take heed. The tribute which one of the largest newspapers in the city of his activities pays to him shows the general esteem in which he is held.

"It is just another little story of the self-made man, another illustration of the limitless possibilities for the boy of courage and nerve and persistence who stands strong against the winds of adversity.

"All great men did not begin their careers on the street corner in the company of the veriest gamins, but many great men did. And if they did not, they like to talk as if they had.

"When the National Electric Light Association, in session at Atlantic City, N. J., tendered its highest office to Frank W. Frueauff, a note of encouragement to struggling young manhood was flashed across the country and reverberated through the mountain fastnesses of Colorado, where Frank Frueauff used to dream of success and make his plans for a future which reckoned on no compromise with the little word 'Fail'."

# ELECTRICITY IN THE HOUSEHOLD

## MISSION DESIGNS IN LIGHTING FIXTURES

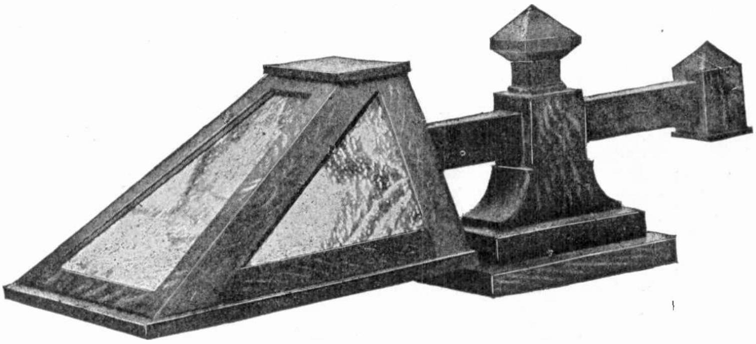
From the old Spanish regime in California, with its memory of Franciscan friars, we have adopted what is known as the Mission style of furniture and interior decorative finishings. Symmetrical and plain, this style lends a quiet elegance to a room which must not be marred by the harsh glare of metallic fixtures. A room so finished should therefore have Mission lighting fixtures, of which there are various types now available. They are made almost entirely of wood and stained art glass, the same stern lines and massive structure prevailing as in the furniture.

A few noticeably artistic designs of electric fixtures here shown will meet the approval of those who contemplate following the Mission style. The fixtures are made up complete, ready for use, even to the sockets for the incandescent bulbs. The material is carefully selected oak, weathered finish, hand rubbed and waxed. It is hard to imagine a more artistic hanging fixture than the six-light piece for lofty rooms or for a high ceiling reception hall. The four pendants are about four inches square by thirteen inches high, wired for one light each. The upper ceiling piece, from which the four pendants are hung, is also illuminated by two lamps, either plain glass or art glass being used. Manifestly a simpler adaptation of this style would be to use a single one of the pendant lights for den or vestibule.

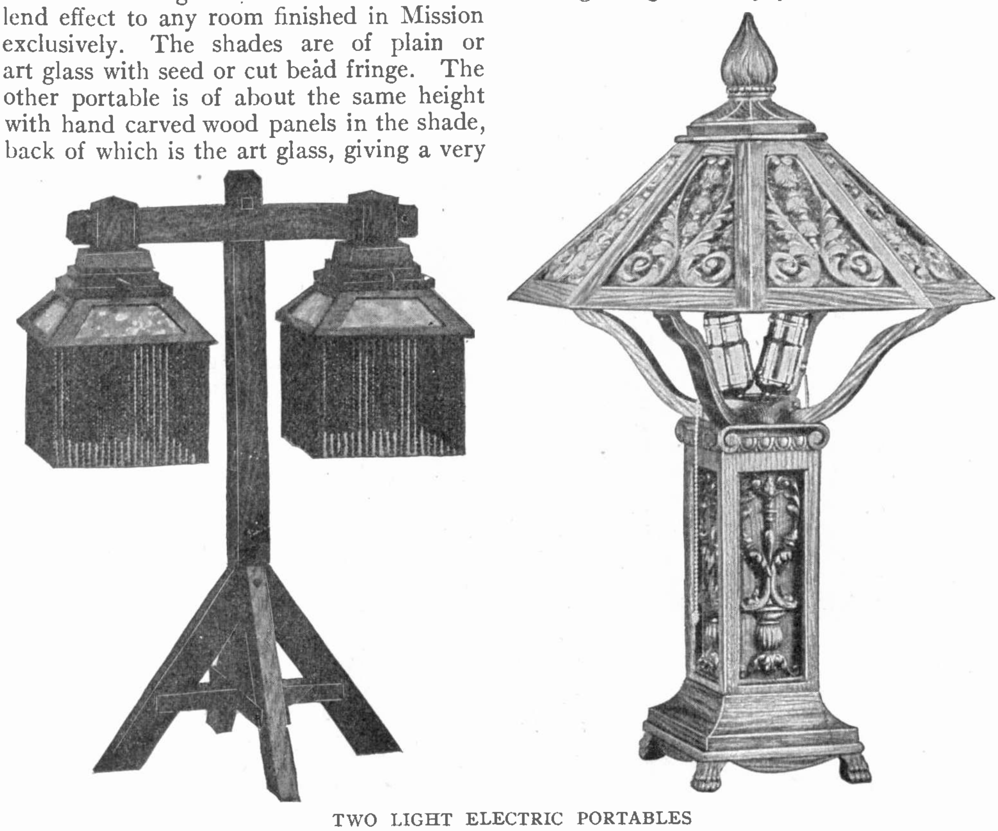
SIX LIGHT CEILING FIXTURE

Appearance of the piano or desk may be greatly improved by a lamp fixture made especially for the purpose, and at the same time a soft light may be thrown directly on the desk or on the music and piano keys. The combined desk and piano lamp shown in one of the illustrations is adjustable, the arm holding the lamp and shade being slidably mounted in a base piece sufficiently heavy to maintain the equilibrium of the unit. Two styles of electric portables are also shown, being designed for two lights each. The one at the left stands 24 inches high with a spread of 18 inches. It is strictly Mission in design and will harmonize and lend effect to any room finished in Mission exclusively. The shades are of plain or art glass with seed or cut bead fringe. The other portable is of about the same height with hand carved wood panels in the shade, back of which is the art glass, giving a very pretty effect. The base is also hand carved, with carved inserted panels. This latter makes an especially elegant portable for the parlor. Both are furnished, of course, with the necessary cords and plugs for attachment to the lamp socket.

The above are only a few examples of the many beautiful designs which may be worked out in the quaint style which had its beginning so many years ago when the old friars were their own architects and builders and their materials hewn timbers from the forest trees surrounding the mission houses in the wilderness.



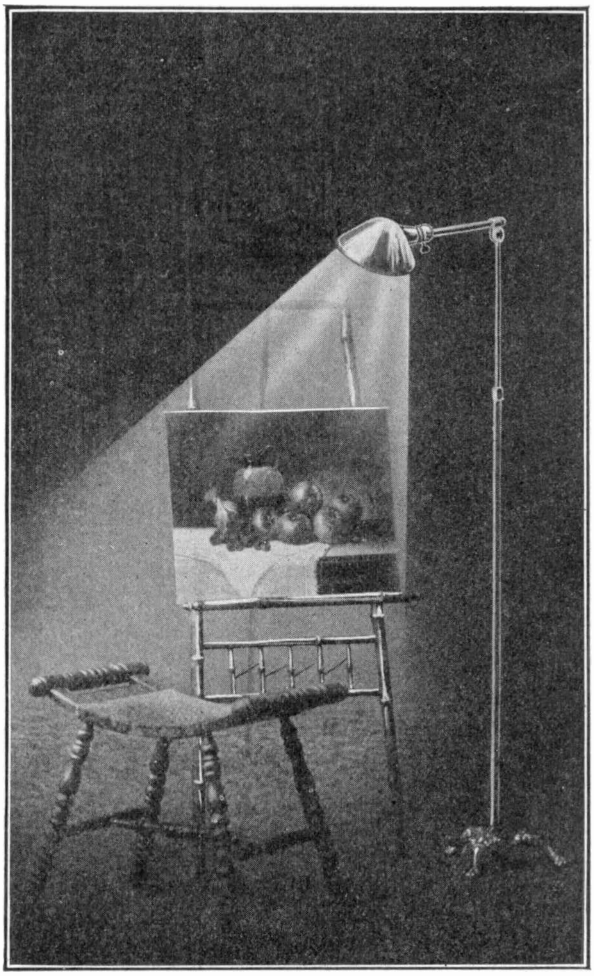
PIANO OR DESK LAMP



TWO LIGHT ELECTRIC PORTABLES

## PORTABLE FLOOR LAMP

A portable floor lamp is a welcome addition to the electrical equipment in any home, and is just the thing for a card game in the evening, when a table light is in the way, or for the piano, or to read by when you wish to be at ease in the Morris chair



PORTABLE FLOOR LAMP

in any part of the room. Such a lamp is shown in the picture illuminating an easel and painting. The lamp is made with a black enamel iron base or stand on which is a six-foot upright of old brass finish. At the top is a one or two-foot arm for carrying the lamp and shade, which can be swung in any direction. The lamp can be adjusted to any height without the annoyance of thumb screws.

## PERFECTING THE ELECTRIC IRON

No source of heat is so well adapted for ironing work as electricity, which is always ready in an instant and ceases to be, the very moment it is dismissed. Ironing by electricity banishes the hot, dirty and bothersome stove and the oppressive, heated atmosphere of the laundry. It saves countless steps and precious energy. It saves about half the time and permits the ironing or pressing to be done at any time or in any place from the ladies' boudoir to the back porch. The cost of operating is very slight, in fact, less than any other method.

The electric flatiron, the inventors found, could not be perfected as it ought to be until a different and better heating unit was discovered. The heat in an electric flatiron is the result of the electric energy "working" to get over a certain resistance. This resistance in the old irons was in the form of coils of German silver wire which heated nearly red hot when the electricity flowed through. It was to improve this "heating source" that a small army of scientists and inventors went to work in their laboratories testing all the common and rare metals and experimenting with the different alloys.

The result of all this laboratory research was the discovery of "calorite," a new high resistance alloy for a heating element that has 70 times the resistance of copper and three times that of German silver. This new metal is capable of withstanding oxidation to a point several hundred degrees hotter than any metal previously used for electric heating purposes as it melts only at the extreme temperature of 2,370 degrees Fahrenheit.

Nearly all of the experimental electric irons depended upon coils of German silver wire or kindred alloys for the necessary heat. But with the discovery of "calorite" it is now possible to stamp out a single flat grid or leaf shaped unit conforming to the face of the iron; this can be clamped firmly in the body of the iron insuring an even distribution of heat over the working surface and supplying the energy where it is most needed, along the toe, heel and side of the iron. The new leaf unit is as durable as the iron itself.

With an indestructible heating unit and good substantial plug and cord connections there is nothing to wear out about an electric iron and nothing to get out of order. There is no reason why such an iron should not wear a lifetime.

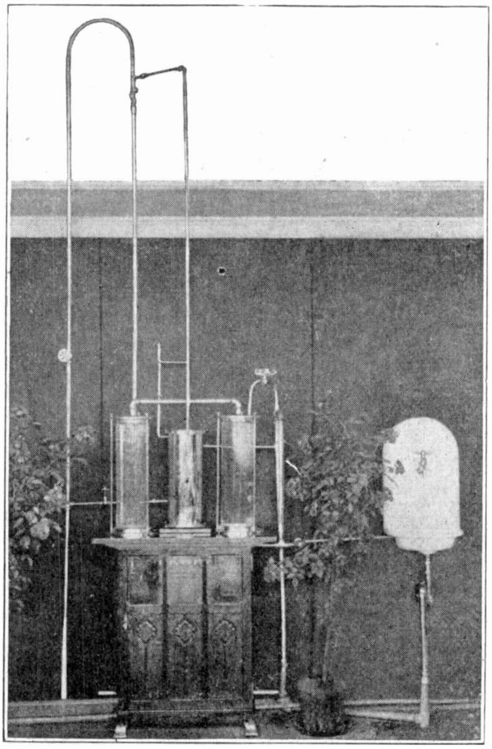
### OZONIZING WATER

Ozone is a form of oxygen which chemists represent by the formula $O_3$. It is made up of molecules containing three atoms of oxygen instead of two as in the ordinary form of oxygen as it exists in our atmosphere. But the ozone molecule is very "unstable" and will not exist as such for any great length of time. The bond which holds its atoms together is very weak, and one of the atoms is bound very soon to tear itself away and combine with an atom of some other element for which it has a stronger affinity—for instance, carbon. Now the solid matter of ordinary germ life consists largely of carbon, so the ozone readily parts with some of its oxygen atoms to combine with the carbon of the germs, thereby "oxidizing" the carbon, which amounts really to burning. Thus germ life is destroyed by ozone.

This principle is applied in various ways for purposes of sanitation, particularly to the purification of water. The city of Paris, after many years' experience with sand filtration, has recently adopted a process of purifying its water supply, derived from Marne River, by means of electrically produced ozone. This decision has been reached after ten years of careful experiments in which ozonization has been placed in competition with filtration in all its forms.

But the ozone process is not alone applicable to work on a large scale, for apparatus is now made for purifying small quantities of water to be used in the home. A small installation of this kind is shown in the picture.

An electric switch is turned and two or three valves are opened and the operation needs no further attention. Alternating current, which is most commonly used for lighting purposes, is stepped up in voltage, by a transformer in the cabinet, to an electrical pressure of 10,000 volts. This high pressure causes the electricity to jump across an open space between hundreds of little discharge points, causing what is known to electricians as a silent discharge. This silent discharge changes the oxygen of the air into ozone. The suction of the water flowing through the system of tubes and jars above draws the ozone from the point where it is generated and at the same



WATER OZONIZER

time causes a continuous supply of atmospheric air to pass over the discharge points. The ozone is then drawn into the pipes and mingles with the water, sterilizing it.

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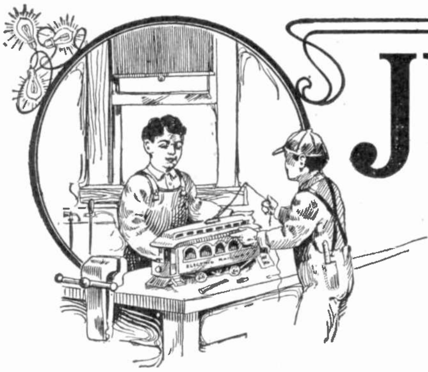
Our sweeping and dusting are already electrified: exit the broom and enter the electric pneumatic cleaner. It almost seems as though we would soon have an "electric cook and housemaid," completely automatic, capable of doing the work for a large family in a couple of hours' use per day, and started and stopped at the turn of a switch.



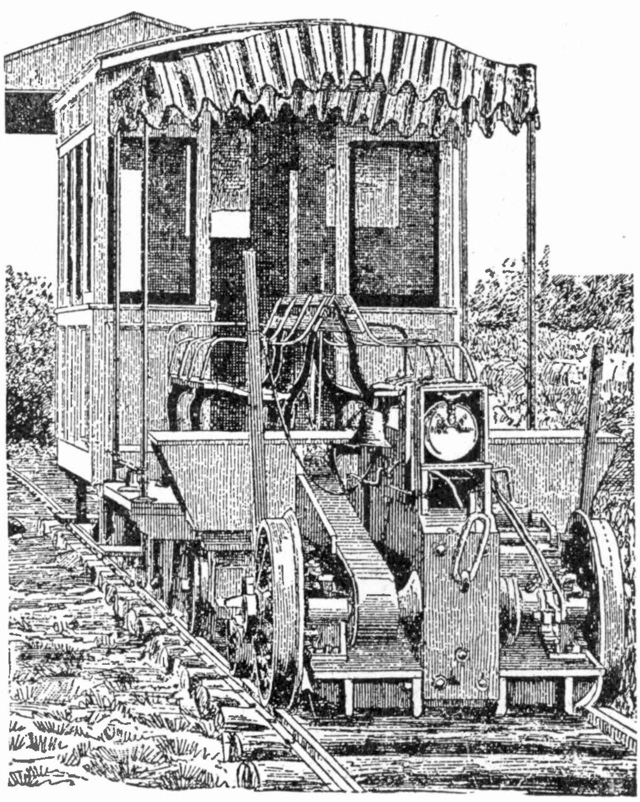
# JUNIOR SECTION

## EDISON'S EARLY ELECTRIC LOCOMOTIVE

Every boy who is ambitious to make a name for himself in the electrical profession of course has Thomas A. Edison as his model—Edison who invented the incandescent lamp, the phonograph and a hundred other things, and who started out in life as a telegraph operator up in Michigan. During his career Edison has had a hand in almost everything electrical and among other things he was one of the pioneer inventors in the electric railway field. In the early part of 1880 he constructed an electric railway some 90 rods in length at Menlo Park, N. Y., over which he operated one of the queerest looking locomotives that could be imagined. Some of the junior readers have doubtless never heard of this achievement of their hero, so the accompanying picture is reproduced to show this odd forerunner of the electric car.

Right in front is the electric motor, belted to the axle, and it isn't the kind of motor that is used nowadays. It is the old Edison motor—for Edison had been working on motors some time before he applied one to a locomotive. The motorman did not pound a foot gong as he does now. He rang a bell, as does the engineer on a steam locomotive. There was also an odd looking searchlight, and in the picture it appears to be a suspended incandescent lamp.

Odd as this locomotive may look today, it was nevertheless thought to be a very wonderful and perfect affair some 29 years ago.



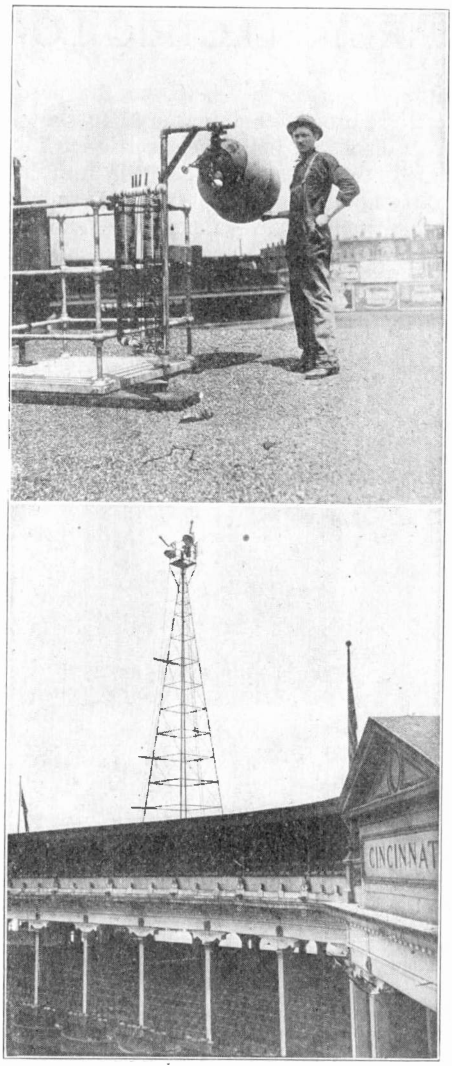
EDISON'S EARLY ELECTRIC LOCOMOTIVE

# PLAYING BASE BALL AT NIGHT

BY J. R. SCHMIDT

The first real base ball game ever played after dark took place on the night of June 17th at the National League base ball park in Cincinnati. Dating from that time, throughout the summer and fall months, there will be base ball games at night (the regulation game with regulation ball and bat), track meets and other outdoor sports. All this is made possible by one of the most wonderful electric searchlight equipments ever installed. The night baseball scheme is backed by a regularly financed company of which Mr. August Herman, well known base ball magnate, is president and manager. And it is said that over $5,000 was spent on the lighting equipment alone, in order that the Cincinnati "fans" might enjoy their favorite game after working hours.

Mr. George F. Cahill, an electrical engineer, inventor of the system of illumination, says no instrument has been found as yet that will measure the intensity of the light thrown upon the field by the searchlights, but he claims that the illumination from a single lamp is many times stronger than that from any other known electric light. It is evident that the light must be strong and steady to permit of playing the game with any degree of accuracy. The two pictures on the next page are from photographs taken at night with no other source of illumination than the searchlight, and although there are naturally defects in the negatives they give a good idea of the almost daylight brightness which prevails upon the field.

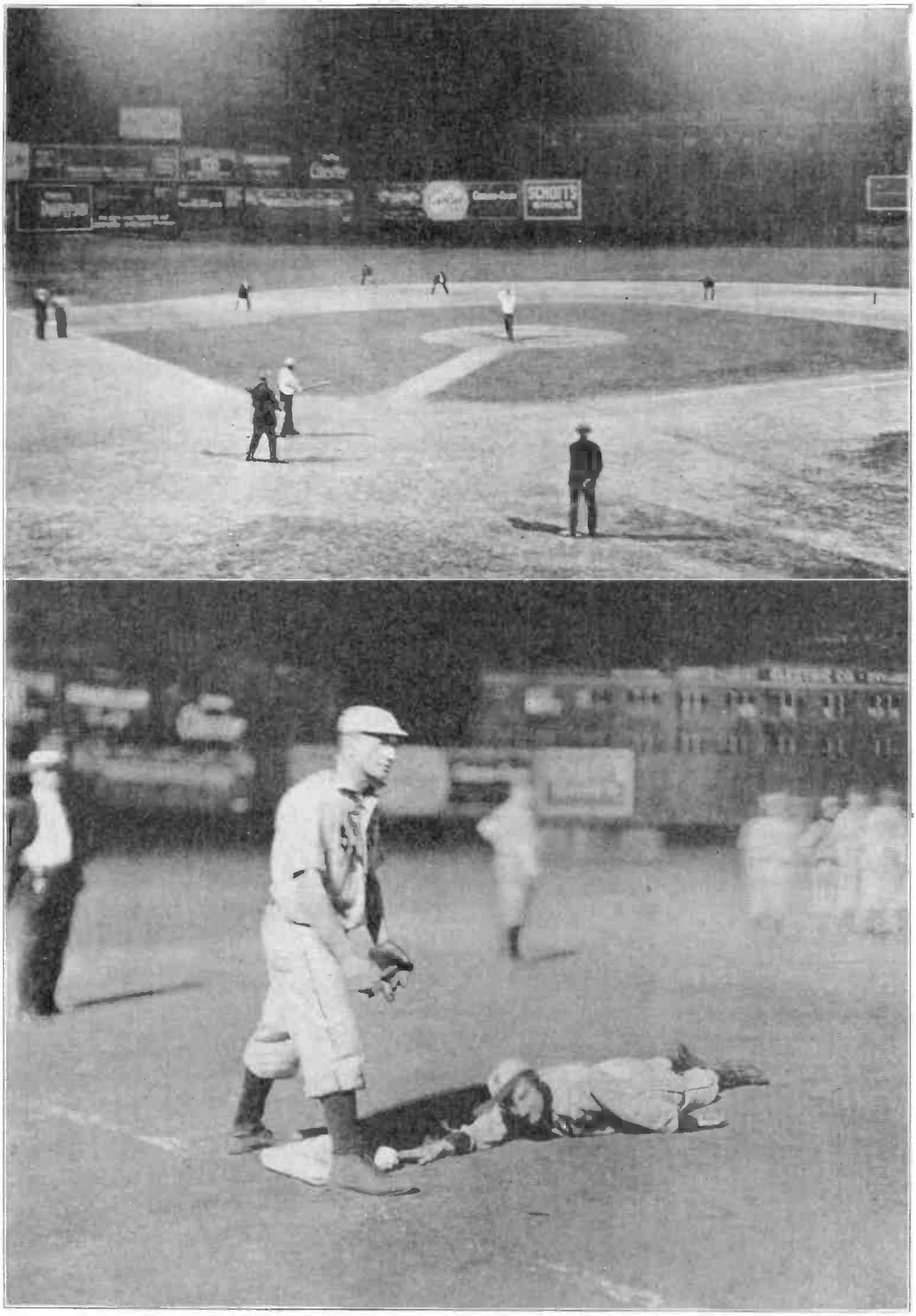



SEARCHLIGHT AND TOWER

The construction of the lamps is original and simple enough. There is a large galvanized iron hood, bell shaped, in which burn specially constructed carbons $1\frac{3}{8}$ inches in diameter. These lamps take current at 110 volts. No lenses are used to concentrate the rays but the hood directs them upon that part of the base ball field where they are most needed. The current supplying these lamps is manufactured upon the grounds by an alternating current dynamo of 235 volts, 250 horsepower. There are 14 lamps in all and the excess current developed is taken care of by large wire rheostats as shown in the detail picture of the lamp.

These unique lamps are located at convenient points encircling the big field. Ten of them are mounted on steel towers 100 feet in height. They are arranged in pairs and their illumination is so intense that every corner of the field is almost as bright as daylight.

The towers are so situated that there are lamps behind each fielder while others are mounted upon the roof of the covered bleachers and the grand stand, but situated so that their rays will not blind the players.



PLAYING BASE-BALL AT NIGHT ON THE ELECTRICALLY ILLUMINATED FIELD IN CINCINNATI

## SELF EXCITED ALTERNATOR

BY FRED R. FURNAS

There are a great many interesting experiments possible with alternating current, which the average student of electricity cannot perform on account of not having this form of current available.

The device illustrated in this article shows how any small shunt wound, two-pole direct current dynamo may be converted into what is known as a "self-excited" alternator. If your dynamo is series wound, that is, with the two field coils connected in series with the armature, you cannot use this device unless you "excite" or energize the field from dry batteries in a separate circuit. The field coils of all dynamos, whether alternating or direct, must be supplied with direct current, as alternating current reverses its direction of flow many times per second, and the magnetism set up through the armature would reverse just as often, preventing the dynamo from generating current.

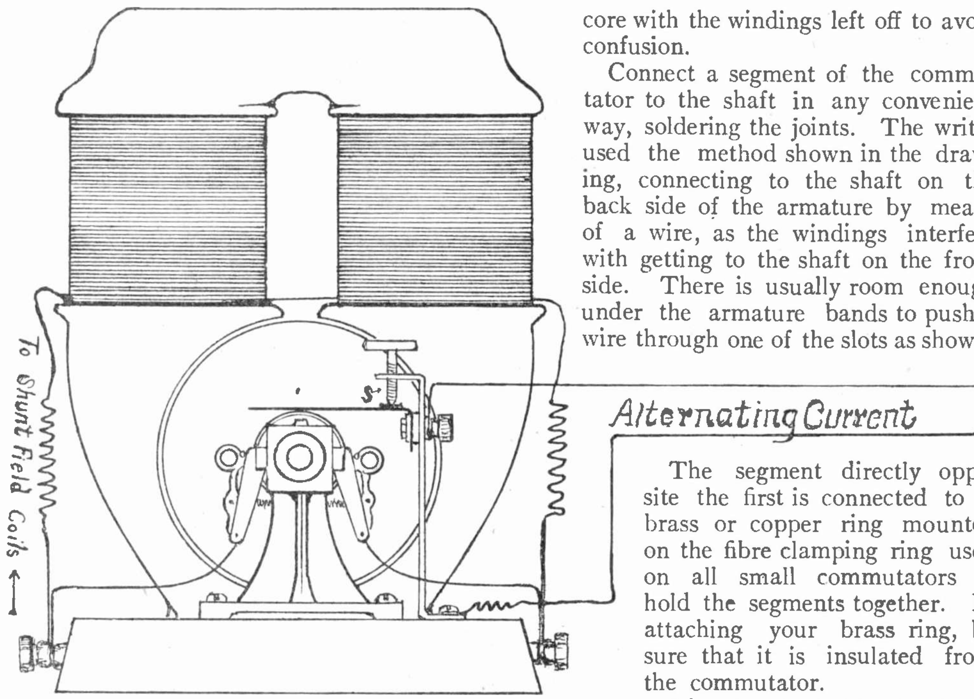



FIG. I SELF EXCITED ALTERNATOR

In large alternators the necessary direct current for the field is generally obtained from a small direct current generator, under which arrangement the machine is said to be "separately excited." In some machines, however, a commutator is used to change part of the armature's output to direct current for exciting the fields. The machine is then "self-exciting," and to this class Fig. 1 belongs. Fig. 2 shows the armature core with the windings left off to avoid confusion.

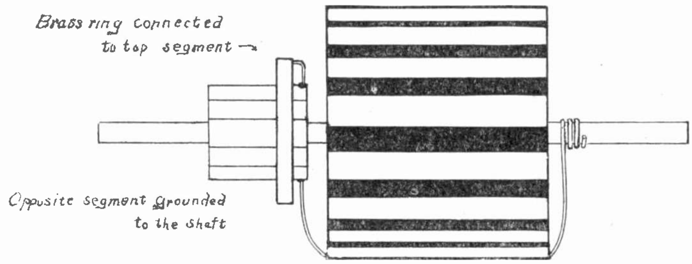



FIG. 2. METHOD OF CONNECTING

Connect a segment of the commutator to the shaft in any convenient way, soldering the joints. The writer used the method shown in the drawing, connecting to the shaft on the back side of the armature by means of a wire, as the windings interfere with getting to the shaft on the front side. There is usually room enough under the armature bands to push a wire through one of the slots as shown.

The segment directly opposite the first is connected to a brass or copper ring mounted on the fibre clamping ring used on all small commutators to hold the segments together. In attaching your brass ring, be sure that it is insulated from the commutator.

The brush holder is rigged as shown in Fig. 1, with a rather stiff strip of spring brass for a brush to rub on the ring. The binding post bolted through the upright iron support must be well insulated from the latter, and a small flake of mica must be pasted under the point of the adjusting screw (s).

The binding post attached to the brush

is one terminal for the alternating current. The other terminal for the alternating current may be connected to any convenient place on the iron frame of the dynamo, where it is handy to attach a wire. Wipe the oil from the bearings, and use graphite instead, although this is not strictly necessary. Only just enough direct current will be taken from the armature to magnetize the field, when alternating current is being delivered, but if so desired, alternating current and direct current may both be taken out at the same time, the direct current being taken off from the commutator brushes in the usual way.

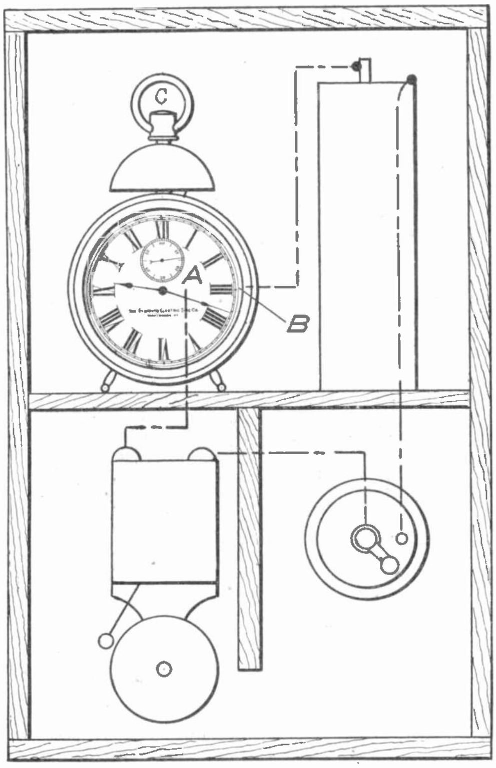
## ELECTRIC ALARM CLOCK

The accompanying diagram indicates an easy way to rig up an electric alarm and is practically self explanatory, (A) and (B) being the points of contact and the dotted lines being the connections made at the back of the board on which the apparatus is mounted.

The board is about 10 by 12 inches and has an ordinary bracket shelf about four inches wide. The battery (one dry cell) stands on this shelf, also the clock, which is an ordinary alarm clock of cheap grade. Under the shelf or in any part of the room or in another room is fixed a $2\frac{1}{2}$ inch call bell with an ordinary one-point switch.

Contact points (A) and (B) are merely two screws standing out about $\frac{3}{8}$ inch from the board and $\frac{3}{8}$ inch apart, to which the wires are attached, and (C) is a small screw hook on which to suspend the clock.

Simply wind the clock and set the alarm at whatever time you wish, placing the key on the back of the clock which winds the alarm perpendicularly between (A) and (B). The switch is then put on the connecting point. When the alarm goes off the key at the back of the clock turns, connecting points (A) and (B)., which completes the circuit and rings the bell, until the switch is turned off.




ELECTRIC ALARM CLOCK

## SIMPLE ELECTRIC HEATER

BY PHILIP M. EAMES.

It is a simple matter to build a small electric heater, which, although it may not be quite as efficient as the ones turned out by the big companies who have spent years in experimenting on the subject, nevertheless will be found to work quite satisfactorily and will at the same time afford the builder a new type of apparatus on which to demonstrate his constructive ability.

The material needed (and cost of same) to build an electric heater are as follows:

| | |
|---|---|
| 3 feet No. 14 asbestos covered wire | .10 |
| 2 pieces of sheet copper 14" x 6" x 1-32" | .35 |
| 2 pieces of sheet asbestos 14" x $3\frac{3}{4}$" x $\frac{1}{4}$" | .10 |
| 1 piece of sheet asbestos 12" x 2" x $\frac{1}{4}$" | .05 |
| 50 feet No. 14 bare german silver wire | .20 |
| Total | .80 |

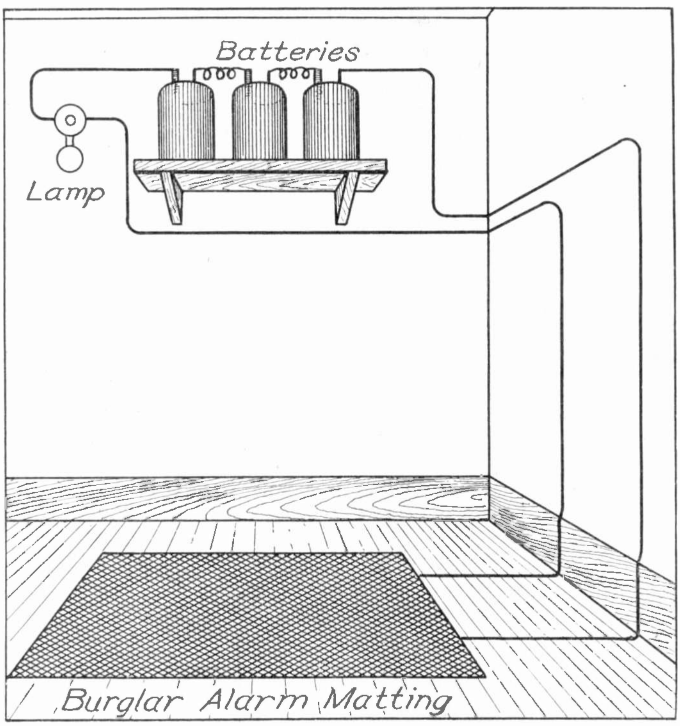
Proceed to wind 108 turns of the German silver wire around the small piece of asbestos, seeing that they do not touch at any place. Put the two loose ends of the wire through the asbestos to hold them firmly.

Place this piece of asbestos (the one with the wire on it) between the two larger pieces and bolt them together with some binding posts (the ones that come off the carbon in dry batteries will do). Connect the asbestor covered wires with the ends of the resistance wire, and run them out of one side of the heater. Put the whole between the copper sheets and rivet them together.

This heater will be suitable for 110 volt alternating or direct current.

### AUTOMATIC BEDROOM LIGHT

A very convenient bedroom light may be fitted up by using what is called "burgla alarm matting," obtained at electrical supplyr stores. This matting is made especially for the purpose and is so interwoven with wires that merely stepping on the mat at any point will close a circuit connected to two terminals supplied at the edge of the mat. To arrange a bedroom light connect up as shown in the diagram.




AUTOMATIC BED ROOM LIGHT

Use a miniature six-volt lamp and three or four dry cells in series as shown. Connect one side of the battery to one terminal of the mat. From the other terminal of the mat run a wire to the lamp, and then connect the other terminal of the lamp with the other side of the battery.

Everything is now complete. In the night step out on the mat, trusty revolver in hand, and, Presto! the lamp lights up, enabling you to shoot the burglar exactly in the center of the heart. Or, if there is no burglar there, you can easily convince yourself that you only got up to see what time it was anyway.

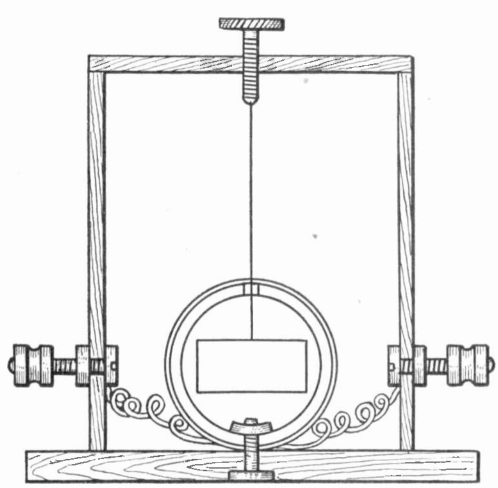
Manifestly another use for the matting would be to place it in front of the door and connected to an alarm bell instead of a lamp. In that case any one entering the door and stepping on the mat would cause the bell to ring.

### PRACTICAL GALVANOMETER

BY GORDON PHILIP.

As an amateur experimenter, I have often felt the need of a delicate galvanometer, and here is the description of one I made after some experimenting. The cost is but trifling, and when well made the instrument is as delicate as could be wished.

The material used in its construction can be found around any workshop or in the scrap heap. For the core a piece of iron or steel tubing about two inches in length and the same in diameter, is needed. Drill two holes through the tube in the middle and on opposite sides as shown in the diagram. Now wind on several layers of fine wire, the more the better. Take care in winding not to let any of the turns pass over the holes. Mount the coil



PRACTICAL GALVANOMETER

thus formed on a suitable base and give the whole a heavy coating of shellac. A long battery binding post can be used in fastening the coil, the screw passing through one of the holes drilled in the tube.

The needle, or in this instance it is a vane, is an ordinary safety razor blade magnetized by rubbing it with a bar magnet. Suspend it by means of a long silk fibre. Place it in the centre of the coil and pass the thread up through the hole. The upper end of this thread is attached to the top of the case in which the instrument is to be kept. A tall box with a glass front will do for the case. The ends of the coil are fastened to two binding posts taken from old batteries.

To use the instrument have the strands of wire parallel to the needle, which will point north and south if not close to a magnetic body. As the needle does not come quickly to rest some patience may be needed in using it. A brass pin set in the coil will prevent the needle from whirling around when the current is first applied.

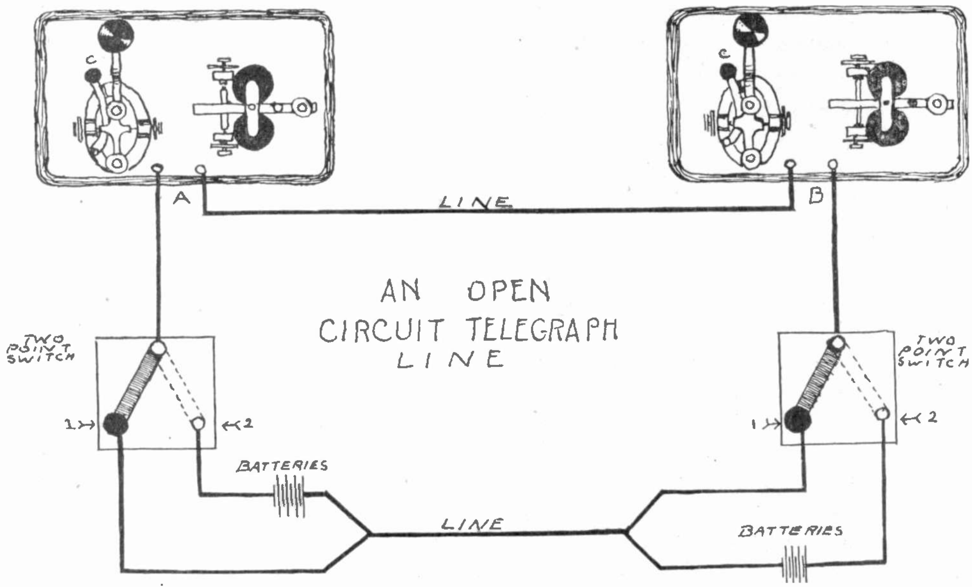
With such an instrument the current given by a small motor, when the armature is whirled in the fingers, can easily be detected by the deflection of the suspended blade, and with five or six cells the current that passes through a person's finger can be registered if a little care is taken.

# AN OPEN CIRCUIT TELEGRAPH

BY GLEN M. ROYSTON

The plan for an open circuit telegraph system shown in the diagram differs materially from the one shown in the March issue of Popular Electricity, and no doubt some of the junior readers will find pleasure and experience in building and operating such an equipment. The diagram shows very plainly how all the parts are connected, and when properly put together the mode of operation is as follows:

When the line is not in use, the switch is kept on (1) in the two point switch and the circuit breaker (c) is closed. This applies to both ends of the line.




OPEN CIRCUIT TELEGRAPH

Now suppose (A) wishes to talk to (B). He puts his switch over on point (2), which brings his batteries into the circuit. Then (A) calls in the usual way. The batteries at each end must be strong enough to run both instruments on one set of batteries.

# QUESTIONS AND ANSWERS

**Readers of Popular Electricity are invited to make free use of this department. Knowledge on any subject is gained by asking questions, and nearly every one has some question he would like to ask concerning electricity. These questions and answers will be of interest and benefit to many besides the one directly concerned. No consideration will be given to communications that do not contain the full name and address of the writer.**

### Magnetic Release Locks

*Question.*—I wish to install some electric door locks in my home and do not know just how to arrange them. I want to operate them with dry batteries. Will you give me some idea by drawings how these locks operate, how they are installed, and the best way to connect them.—E. F. S., Chicago, Ill.

Answer.—In Figs. 1 and 2, the interior parts of a magnetic release lock are shown. Similar parts are lettered alike in all figures.

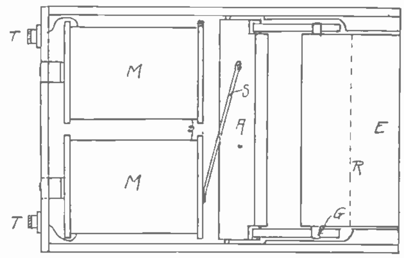



FIG. 1. MAGNETIC RELEASE LOCK—SIDE VIEW

Two dry cells connected as illustrated in Fig. 4, through a push button, (PB) are sufficient for operation. From (T) the circuit leads through the coils, (MM), in series. Closing the circuit through the button,

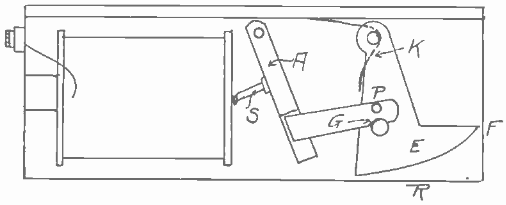



FIG. 2. MAGNETIC RELEASE LOCK—PLAN

(PB), energizes the core of the magnets, (MM), attracting the soft iron armature, (A). This pull is just strong enough to overcome the tension of the spring, (S). Referring to Fig. 2, (G) is released, and (E) may be pushed back against the force exerted by spring, (K), the release arm (A) being pivoted at (P). In Fig. 3 is shown a spring plunger, (SP). As soon as (E) is released by operating the push button (PB), the spring plunger (SP) pushes the door (E) back along (D), allowing one to pull the door open. These locks are made with the catch (E) extending, as in Fig. 3, or as in Fig. 2, flush with the edge (F) and open

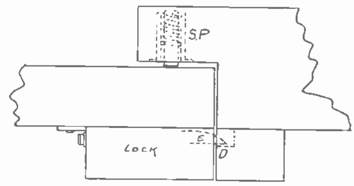



FIG. 3. SPRING PUSH

under (E) at (R). This lock can be operated only by current through the coils, no other means, as a key, being provided for.

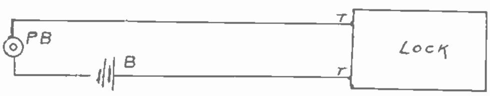



FIG. 4. CONNECTIONS

If the lock is placed on the door, Fig. 3, and the wires concealed in the woodwork, two sliding contacts should be placed at the upper hinged corner of the door.

### Making an Electromagnet

*Question.*—Will you tell me how to determine the pull of an electromagnet?—H. McN., Corocal. Canal Zone, Panama.

Answer.—Knowing the kind of metal of which the magnet is made, look up in tables compiled for this purpose the number of lines per square inch this metal carries at the saturation point, and also the number of ampere turns necessary to cause this flux density. Having a given voltage to work with use the wire whose resistance is such that by ohm's law, $(C=\frac{E}{R})$, C is what is required. Then from formula

$$B=1316.6\sqrt{\frac{\text{Pull in pounds}}{A}}$$

where B=lines per square inch of magnet, and A=lifting area of magnet in square inches, by substituting, the pull in pounds may be determined.

**Magnetos; Edison Three Wire System**

*Questions.*—(A) What is the voltage ordinarily obtained from a telephone magneto-generator? (B) May a magneto armature be wound with heavier wire for lower voltage and equipped with a commutator for direct current? (C) Can a magneto be run continuously without weakening the field? (D) Is blue vitriol the only necessary chemical to make a gravity battery? (E) Explain the Edison three-wire system.—O. M., Wayland, Mich.

Answers.—(A) The voltage given by a magneto generator depends upon the speed of the armature, the number of turns of wire on the armature, the strength of the magnetic field and the spacing between the armature and the field faces. One thousand revolutions per minute is the usual speed of hand driven magnetos. The voltage varies from 40 to 80 volts.

(B) Yes, both field coils and armature may be wound this way to reduce the voltage and increase the current output. The voltage, it must be remembered, however, is directly proportional to the number of conductors on the armature. The armature may be equipped with a commutator to furnish direct current.

(C) Yes, if not subject to vibration or shock, for as you know this tends to lessen permanent magnetization. A permanent bar magnet may be demagnetized by several sharp taps from a hammer.

(D) Yes.

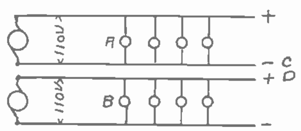



FIG. 1.

(E) Briefly, to step up to the principle of the three-wire system, let Fig. 1 represent two two-wire circuits, each operated by 110-volt dynamos. Assume lamps (A) and

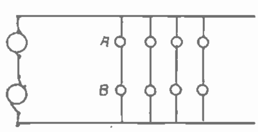



FIG. 2.

(B) placed as shown. It is plain that they may be connected in series as in Fig. 2, which does away with two wires (C) and (D): but, in case one lamp burns out or is turned off the other goes out also. For this reason a third wire (E), Fig. 3, is extended from the middle point of the two dynamos. By this arrangement any lamp may be put out without affecting the others. This middle wire is called the neutral (±), because it is negative as to one conductor

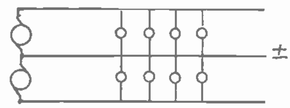



FIG. 3.

and positive as to the other outside wire. In Fig. 3 the system is balanced, that is, there are as many lamps on one side of the neutral as upon the other. If, however, as in Fig. 4, the load is not equally dis-

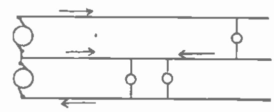


FIG. 4.

tributed, the neutral supplies the difference as indicated by the arrows. If the lamps are burning on one side only, the dynamo on the other side will do no work, while the neutral wire will act as positive or negative main according as the working dynamo is connected to the positive or negative main wire. The less the load is balanced the larger must be the neutral wire. This wire is seldom made less than one-half the size of the outside wires, and is often of the same size. One of the points favoring the system is the saving in copper wire. The outside wires need be only one-fourth the size required for the same power delivered by means of the two wire 110-volt system. With the neutral as large as the outside wire the total amount of copper is only $\frac{1}{4}+\frac{1}{8}$, or $\frac{3}{8}$ of that required for the two-wire 110-volt system.

---

**Condenser Capacity; Bell Operated by a Solenoid**

*Questions.*—(A) Please inform me how I can make the following condensers: one of one-half microfarad capacity and one of two microfarads. (B) Can a bell be made to operate on the principle of the solenoid, this being the hammer, and use alternating current?—W. H. F., Denver, Colo.

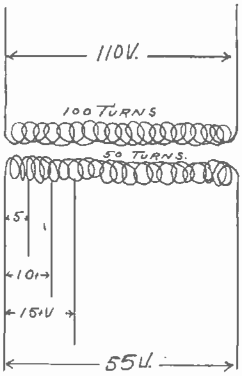
Answers.—(A) See page 35 of May, 1909, issue. A condenser of one microfarad capacity contains about 3,600 square inches of tinfoil.

(B) Such a bell could be made, the solenoid being so arranged as to open the coil circuit as it was drawn up.

### Transformer Taps for Various Voltages

*Question.*—How may a transformer be arranged so that with its primary connected to 110-volt mains, 5, 10, 15 and 50 volts may be taken off the secondary winding?—R. H. W., North Abington, Mass.

Answer.—The diagram shows the manner of connecting taps on the secondary to secure the required voltage. Slightly more than 5,




METHOD OF CONNECTING TRANSFORMER TAPS

10, 15 and 50 volts will be obtained as 1-10 of 50 turns is included between the 5-volt taps, 2-10 of 50 turns between the 10-volt taps and so on, the ratio of the transformer being 2 to 1.

### Open and Closed Core Transformers; Induction Coil on Alternating Current

*Questions.*—(A) What is the difference between open and closed core transformers? (B) Which is the more efficient? (C) Give dimensions of 500 watt transformer fulfilling answer to (B). (D) Can an induction coil be used on alternating current, 110 volts, 133 cycles, 5 amperes? If so, how?—F. H., Alden, Ia.

Answers.—(A) In the open core transformers the iron core forms the part on

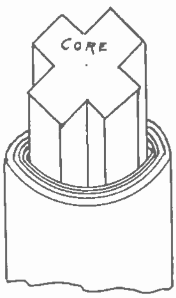



FIG. 1. OPEN CORE TYPE

which the coils are wound. Fig. 1 illustrates this type. In shell or closed core transformers the iron surrounds the coils. Fig. 2 shows the arrangement in the ordinary closed core type.

(B) One important point to observe in transformer construction is to so place the coils with reference to each other that all the

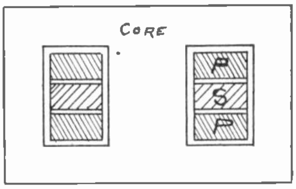



FIG. 2. CLOSED CORE TYPE

magnetic lines passing through one, must pass through the other, thus avoiding what is called magnetic leakage. We do not know that one type is more efficient than the other as leading manufacturers employ both types.

(C) Consider a core type transformer, provide a circular bundle of wire 12 inches in length by three inches in diameter, or a mass of laminated iron of the same length and cross section.

(D) Yes, by using the chemical rectifier described on page 235 of this issue, with resistance in series. See also Electrolytic Interrupter, page 245.

### Six Volt Lamps

*Questions.*—(A) I have a 6-volt, 40 ampere-hour storage battery with which I am lighting Tungsten 6-volt lamps. They are 6 candle-power apiece. How many amperes do they require? (B) How many hours service will there be if the battery is placed on one light? (C) How many lamps can I use at one time without overtaxing the battery? (D) What are the highest candle power 6-volt lamps obtainable and where?—M. W. S., Chicago.

Answer.—(A) If you refer to the Tungsten sign lamp, would say that this lamp is rated at 8 to 12 volts, 5 watts, and 4 candle power. Watts ÷volts gives current; therefore $\frac{5}{10\text{ (average)}} = 0.5$ ampere.

(B) A 40 ampere-hour battery should furnish 40 amperes for one hour or one light for 80 hours.

(C) That depends upon how long you wish to use the battery. The battery will give its rating. You can of course use up the 40-ampere-hour capacity quickly or by using little current make the battery last a longer time.

(D) The tungsten is the highest efficiency lamp now made. It may be purchased from any lamp dealer or electric supply house.

### Morse Relay; Recharging Dry Batteries; Telegraph Lightning Arrester

*Questions.*—(A) What size and how much wire should I use to wind a 20 ohm Morse telegraph relay? (B) Would the battery solution described in answer to F. C. S., June issue, do to recharge dry batteries? (C) Please give wiring diagram and plan for telegraph lightning arrester.—C. R R., Turner, Ore.

Answers.—(A) A Morse 20 ohm relay is wound with fourteen layers of No. 25 B. & S. gauge silk covered wire on each core.

(B) Yes.

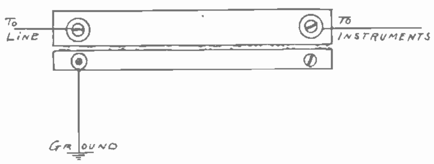



FIG. 1. SIMPLE LIGHTNING ARRESTER

(C) Fig. 1 shows connections for a lightning arrester and also the plan for same. Two strips of brass are used. The upper strip forms part of the line circuit. The lower strip is separated from the upper one by a small air space. When the line is struck by lightning the electricity jumps from the sharp points of the upper line strip, across the air gap to the grounded strip and into the earth.

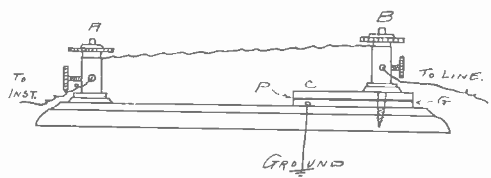



FIG. 2. COMBINED LIGHTNING ARRESTER AND FUSE

Fig. 2 shows a combination of fuse and ground plate arrester. Between binding posts (A) and (B) extends a piece of fuse wire, protecting the office apparatus in case of a cross with high voltage or lighting circuits. Two brass plates (C) and a ground plate (G) are separated by layers of paraffin paper, which, in case of a lightning discharge from the line to binding post (B), are punctured, the charge going to ground.

### Induction Motor

*Question.*—Please inform me how I can convert a 50-volt, 125 cycle induction motor into a 60 cycle 110 volt machine; also change a 125 cycle, 110 volt machine into a 60 cycle, 110 volt motor.—F. E. B., Riverdale, Md.

Answer.—See answer to J. E. D., Dec., 1908, issue. For a good book on the subject write any publishing house of scientific books for their catalogue in this line, and select from it such as you think will answer your purpose. If you state your need they will be glad to advise you.

### Condenser; Induction Motor; Volt Meter; Liquid Rheostat; German Silver Resistance

*Questions.*—(A) I have a one-fourth inch jump spark coil which will give a short spark and then stop for a moment. If it is the condenser, kindly tell me how to make one for the coil. (B) Will you give details of how to build an induction motor? (C) Is there any way to stop the pulsations of an alternating current? (D) Can a small voltmeter be easily constructed—one for about 90 volts direct current, that can be left on the line. (E) What liquid besides water would you advise for a liquid rheostat? (F) How much German silver wire would it take to reduce 110 volts to 10 volts?—W. J. S., Binghamton, N. Y.

Answers.—(A) Your trouble is probably in the condenser. For your coil the condenser should consist of 25, three by one and one-fourth inch sheets of tinfoil. See "Spark Coil Construction and Operation," May, 1909, issue, for details of condenser.

(B) This is a question requiring elaborate design and calculation and can hardly be answered in this department.

(C) See answer to S. N., June, 1909, issue.

(D) See "To Make a Voltmeter," April, 1909, issue. For one of higher range must refer you to standard instruments.

(E) Water and five per cent sulphuric acid.

(F) That depends on the size of the wire. 275 feet of No. 35, "30 per cent" wire will do the work.

### Reducing Speed of an Induction Motor

*Question.*—I have an induction, 60 cycle desk fan. Is there any way to reduce the speed to a low rate and not increase the wattage?—M. S., Pine Bluff, Ark.

Answer.—The speed of an induction motor may be reduced by increasing the number of poles, which is impracticable, or by lowering the frequency. The following formula applies:

$$S = \frac{2N}{P}$$

Where S=revolutions per second,
P=number of poles,
and N=frequency in cycles per second.

See answer to J. E. D., Dec., 1908, issue.

**Current Through Body; Bichromate Battery**

*Questions.*—(A) What is the strongest current that can be taken through the body without fatal results? (B) I made a bichromate battery using a quart fruit jar and put in four ounces of sulphuric acid. Was this too much? (C) Does it do any good or harm to add more bichromate of potash than the dilute sulphuric acid will dissolve?—C. V. S., Three Oaks, Mich.

Answers.—(A) We know that some persons are killed by contact with low voltage wires, while others come in contact with high voltage and live. To explain this we must remember that the current strength depends upon the voltage and also upon the resistance of the conductor which in your question is the body. The resistance of the body has been found to be variable. Men working in a place where acid vapors or a damp atmosphere prevail might have the resistance of the body so lowered as to get a fatal current through the body by contact with a 110-volt circuit. Cases are on record where in a bath persons with the body wet, and standing on grounded metal work have been killed by 110 volts. We cannot answer your question more definitely than by referring to Herr Hermann Zipp who has given this subject much study. He tells of placing one hand on a 1,000 volt transformer between the contact terminals. His system received a severe shock but no other ill effects. He says: "If, however, the contact had been made with both hands, a current equal to 100 milliamperes (.1 ampere) would have passed through my system even if the resistance had been as high a 10,000 ohms, and death would certainly have resulted." It is also believed that the current has a chemical action upon the body's liquids, and for this reason the portion of the body brought in contact with a circuit would determine how much current could be received without injury.

(B) No.

(C) We do not know that any detrimental effect would result. The usual proportions for such a cell are: potassium bichromate, 1 part; sulphuric acid, 3 parts; water, 9 parts.

---

**Storage Battery to Run Motor**

*Question.*—How can I make a storage battery that will run a $\frac{1}{8}$ H. P. motor for three hours and not be too heavy?—H. R., Muskogee, Okla.

Answer.—You do not state the voltage of the motor so we assume 80, that being common on automobiles. A battery giving 21 amperes for four hours would weigh about 42 pounds. See answer to E. F., March, 1909 issue, for construction of battery.

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**Hydrogen**

*Questions.*—(A) How is hydrogen gas produced? (B) What is its lifting power per cubic foot? (Can hydrogen be compressed? (D) By compressing same could the lifting power be increased?—R. L., Visalia, Cal.

Answers.—Hydrogen may be obtained by electrolysis as explained in the May, 1909, issue. A second way is to dissolve magnesium in dilute sulphuric acid. The hydrogen so obtained is very pure. The chemical action is: $H_2SO_4+Mg=MgSO_4+H_2$. For laboratory purposes zinc may be placed in dilute hydrochloric acid or sulphuric acid. The chemical changes are:

(1) $H_2SO_4+Zn=ZnSO_4+H_2$

(2) $2\ HCl+Zn=ZnCl2+H2$.

(B) Allowing the specific gravity of air to be represented by 1, hydrogen has a comparative weight of .069; that is, its weight as compared with an equal volume of air is only one-fourteenth as much. In the Soudan War balloons were much used. From their tests a volume of hydrogen occupying 4,150 feet was sufficient to lift a weight of about 150 pounds 3,000 feet up into the atmosphere. Its lifting power would also vary according to the density of the air.

(C) Yes. In the war above noted hydrogen gas was put up at the gas station and sent to the front, by compressing it in cylinders twelve feet long by one foot in diameter. Each cylinder, built of strong iron weighed with the contained gas, half a ton.

(D) You know the law concerning a body immersed in water. The body loses in weight the weight of the water displaced. Would you gain anything by compressing the immersed body into smaller space? Study your problem by assuming the water in a pail to represent the ocean of air around the earth, and a cork held at the bottom of the pail to be a balloon moored at the surface of the earth. Two men of equal weight go swimming. One is closely built and hard of muscle, the other is loosely framed and larger. Which one will have to exert the most energy to keep afloat. Why?

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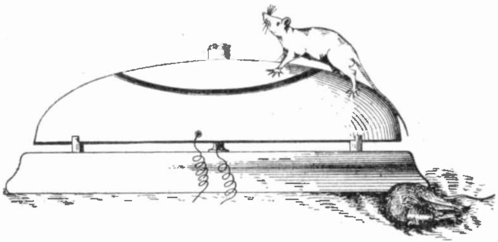
The legislature of North Carolina has passed a law requiring all the railroads within the state to equip their engines with electric headlights of not less than 1,200 candle-power.

# NEW ELECTRICAL INVENTIONS

## ELECTRIC RAT TRAP

A unique rat trap devised by Byron S. Ames of Williamsport, Pa., is shown in the sketch and is said to do the work every time. It looks something like the ordinary electric bell, only it is larger. The lower part of the metallic bell-shaped piece is connected to one side of an electric circuit.

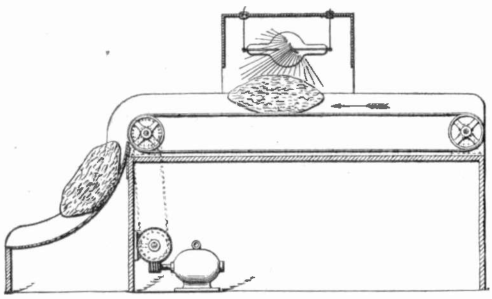


ELECTRIC RAT TRAP

The upper part, insulated from the lower part as shown by the heavy black line, is connected to the other side of the circuit. On top is placed the usual bit of cheese. When the rat goes to nibble at the cheese he steps across the two sections of the bell and receives a shock, and then it is his funeral.

## A NEW WAY OF TREATING TOBACCO

It is known among dealers in tobacco and the manufacturers of products from tobacco, that in the course of a year large quantities



TREATING TOBACCO WITH X-RAY

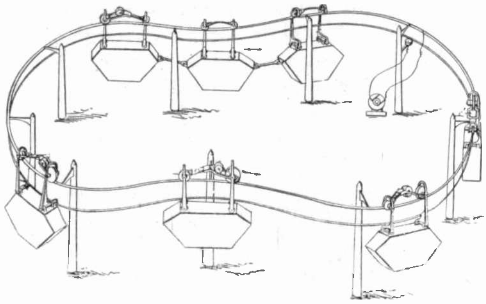
of the leaf are destroyed by small insects, the chief of which possibly is Lasiderma serricorna, commonly known as the cigarette beetle. In addition to this beetle, however, there are probably 150 other small insect creatures which prey upon tobacco and occasion its injury if not destruction. The result of the devastating action of these parasitic insects is the destruction of millions of dollars' worth of tobacco during each year.

It is the object of an invention by Franklin S. Smith of Philadelphia, Pa., to subject tobacco to a treatment which not only will destroy these insects but will also destroy their eggs, the larvæ, and the pupæ, and thus preserve the tobacco for an indefinite period. It is necessary that this treatment of the tobacco, for the purpose stated, shall itself have no deleterious or injurious effect upon tobacco.

He discovered the fact that tobacco may be subjected to the action and effect of X-rays, which occasion the destruction of the eggs, the larvæ, the pupæ and the adult insects, without injury or danger of causing deterioration of the tobacco.

## ELECTRIC TELPHER SYSTEM

The term telpherage is applied to small overhead track systems on which are suspended cars or carriers which are propelled along the tracks. Numerous forms of electric telpher systems have been devised

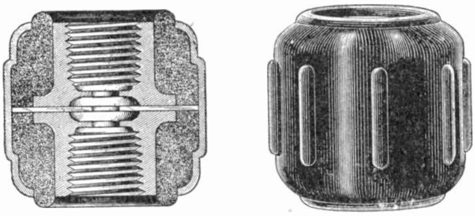


ELECTRIC TELPHER SYSTEM

which make use of electric motors for propelling the wheels of each individual car. Such a system is shown in the diagram and is the invention of Barnett W. Harris of Buffalo, N. Y. There is an upper cable which carries the weight of the cars and also forms one side of the electric circuit. Below this is a wire which forms the other side of the circuit. The special feature of the system is an arrangement whereby the cars or carriers may be operated in trains.

### A NEW INSULATING JOINT

In the installation of combination gas and electric fixtures it is required that the fixture support be insulated from the main piping system at the point where it is screwed into the gas outlet. A new insulating joint of this kind is shown in the cut, showing at the



NEW INSULATING JOINT

left a longitudinal sectional view. The screw threads, top and bottom, receive the outlet pipe and the fixture support respectively, and are insulated from each other by the horizontal strip or disk. The gray material on the outside is also insulating material molded and compressed over the threaded members. Outside of all is a drawn steel casing which gives strength and protection. The stone-like insulating material is a sort of artificial quartzite and has been given the name of Di-el-ite.

### ALUMINUM WELDING

Aluminum cannot be welded to aluminum by means of a blow torch, although it can be welded to other metals in this manner. Uniting aluminum to aluminum by means of solders of various kinds has also been more or less unsatisfactory, since the solder and the aluminum, being two different metals, form a sort of battery in the presence of water and the electrolytic action thus set up gradually corrodes or eats away the metals, resulting finally in a poor joint for electrical work.

The inability to make a good weld is due to the fact that at the high temperature which must necessarily be employed, a skin or film of oxide forms on the surface of the aluminum to be welded, and this film despite its extreme thinness prevents the fused edge or surface of one piece from uniting with the fused edge or surface of the other piece.

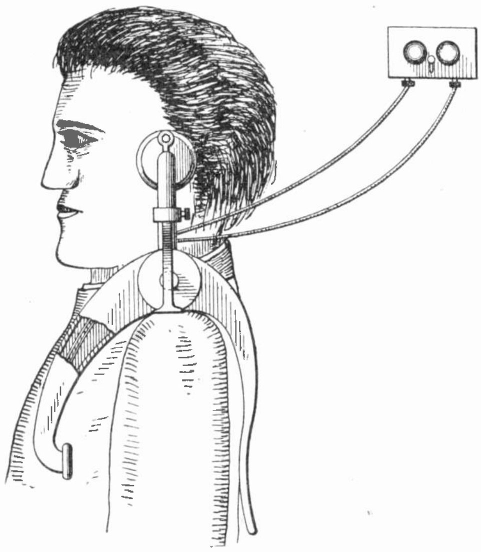
In order to make such a weld possible, a process has been patented by Max Ulrich Schoop of Bois Colombes, France, which employs a special flux which will reduce the layers of oxide which are formed, and using preferably the oxy-acetylene flame as a source of heat. This mixture consists of

| | |
|---|---|
| Potassium chloride ...... | 60 parts |
| Sodium chloride ....... | 12 parts |
| Potassium bisulphate .... | 4 parts |
| Lithium chloride ........ | 20 parts |

It is preferably fused in a platinum dish, then crushed in a mortar and sufficient water added to form a thin paste. If a blow pipe flame of lower temperature than that produced by the oxy-acetylene flame be employed, such, for instance, as that produced by oxygen and illuminating gas, or oxygen and hydrogen, it is desirable to increase the proportion of potassium bisulphate in order to lower the point of fusion of the mixture.

### UNIQUE TELEPHONE

Eugene Koehler of Philadelphia, Pa., is the inventor of a new type of telephone in which the vibrations of the speaker's body are made to affect the transmitter directly, rather than through the agency of air waves

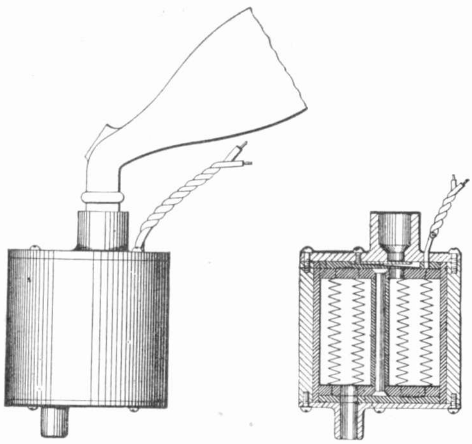


UNIQUE TELEPHONE

as in the ordinary telephone. This unusual apparatus consists of three members so arranged that when the whole device is placed upon the shoulder the receiver will be against the ear of the user, the transmitter, on a long curved arm, will rest on the breast and a clamping arm will slip down over the shoulder blade, holding the instrument in place.

### ELECTRIC AIR HEATER

An electric air heater designed for use in barber shops, hair dressing parlors, etc., is the invention of Louis A. Siebert of Columbus, Ohio. It is a simple device, consisting of a small cylindrical casing of a size suitable to be held in the hand with a connection leading into it for the attachment of the tube from a source of compressed



ELECTRIC WIRE HEATER

air. Another opening for the exit of the air is supplied with a funnel shaped nozzle for dispersing the air blast. Inside the casing are a number of coils of resistance wire through which electric current is made to flow during the operation. The passage of the current through these wires causes them to heat up almost to incandescence, warming the air blast.

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### AUTOMATIC STREET CAR SIGNAL

An ingenious device has been invented by C. W. Mallins, general manager of Liverpool Corporation Tramways in England. The device consists in the footboard of a car working on a hinge, so that when a passenger steps on it it gives slightly and presses on an electric contact which automatically switches on a lamp near the motorman in the front of the car. The motorman then slows up in response to the signal, and as soon as the passenger alights the lamp is extinguished.

It frequently happens in double-deck cars, which are extensively used in England, that a passenger riding below wishes to alight while the conductor is on top collecting fares. Mr. Mallins' invention will obviate the necessity of searching for the bell rope.

# BOOK REVIEWS

Operators, Wireless Telegraph and Telephone Handbook. By Victor H. Laughter. Chicago: Frederick J. Drake & Co. 1909. 180 pages with 87 illustrations. Price, $1.00.

A book to strike the happy medium between treatises too rudimentary on the one hand and those too technical on the other will be appreciated by a large class of experimenters in wireless telegraphy, of whom there are literally thousands in the country today. Such a book has been written by the able young wireless expert Mr. Victor H. Laughter, who is well known to the readers of Popular Electricity through his many valuable contributions to its pages. Mr. Laughter had been long impressed with the fact that a book was needed which would not only teach the amateur the principles upon which modern wireless systems depend but also one which would explain clearly how to go ahead with the construction of simple equipments, which are among the most interesting of all electrical experimental apparatus. In this he has succeeded admirably and the book stands as one of the best elementary treatises for amateur experimenters to date. In reading over the text we find, naturally, a little at the beginning upon the history of the art and something about the early methods employed. But this is cut very short and the reader is plunged almost immediately into the practical subject of how to build a simple wireless set.

Wireless telephony, now that it is a demonstrated success, is arousing much interest in the minds of those experimenters who cannot rest until they have built an equipment which will actually transmit articulate speech without the agency of wires, so a chapter of the book is devoted to this important subject, describing the De Forest system, the Bell radiophone, the speaking arc, etc.

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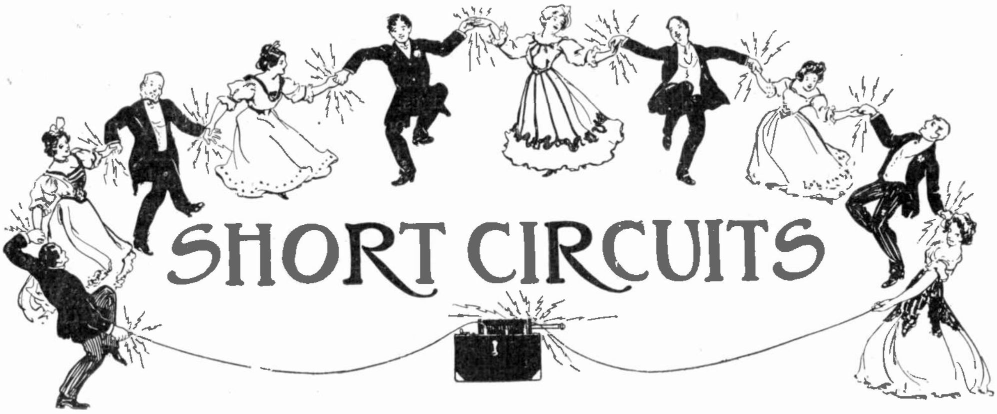
How Telegraphs and Telephones Work. By Charles R. Gibson. Philadelphia: J. B. Lippincott Company. 1909. 156 pages, with 15 illustrations. Price, 75 cents.

A small book written in simple nontechnical language, dealing with telegraphs and telephones, such as would be useful to those who are specially interested in those instruments. A chapter on wireless telephony, and a short discussion of the electron theory, bring the volume thoroughly up to date.



# SHORT CIRCUITS

Student (who is taking his girl out in his auto)—Fifty miles an hour! Are you game?
The girl (as she swallows another pint of dust)—Yes; I'm full of grit!

* * *

First Chauffeur—There's one thing I hate to run over, and that's a baby.
Second Chauffeur—So do I; them nursing bottles raise Cain with tires.

* * *

Mr. Martin—Mr. Miller is after findin' out why his cow went dry.
Miss Hogan—An' phwat was it?
Mr. Martin—His bye, Willie, milked the poor craytture wid wan of thim new-fangled, dust-suckin' machines!

* * *

"Colonel," asked the beautiful girl, "when was the most trying moment of your life?"
"It was when I went to my wife's father for the purpose of asking him to let me have her. He was very deaf and I had to explain the matter before twenty clerks."

* * *

Jack—It would please me very much to take you to the theater this evening.
Miss Heavyweight—Have you secured the seats?
Jack—Oh, come, now, you're not so heavy as all that.

* * *

As Jones wended his uncertain way homeward he pondered ways of concealing his condition from his wife. "I'll go home and read," he decided. "Whoever heard of a drunken man reading a book?"
Later Mrs. Jones heard a noise in the library. "What in the world are you doing in there?" she asked.
"Reading, my dear," Jones replied cheerfully.
"You old idiot!" she said scornfully, as she looked in at the library door, "shut up that valise and come to bed."

* * *

Magistrate—The man you ran down swears positively you were grinning like a fiend before the car hit him.
Trolley motorman—I was, your honor, but you will understand when I tell you, I was a chauffeur for three years before I got my present job and from force of habit I thought I could steer the car to avoid him after throwing the usual scare into him.

* * *

A new clerk in the Statistical Department asked the meaning of "deficit." "A deficit," answered Mac, "is what you've got when you haven't got as much as if you just hadn't nothing."

"Are you related to Barney O'Brien?" Thomas O'Brien was once asked.
"Very distantly," replied Thomas. "I was me mother's first child—Barney was th' sivinteenth."

* * *

Ruyters Kramp—You didn't even read this story that you turned down.
Magazine Editor—How do you know?
Ruyters Kramp—I pasted several of the pages together, and they weren't opened.
Magazine Editor—You don't have to eat the whole egg to know it is bad, do you?

* * *

There was a young man from the city
Who saw what he thought was a kitty
"Come here, little cat."
He said with a pat—! !
They burned all his clothes—what a pity.

* * *

One day the office boy went to the editor of a country paper and said:
"There is a tramp at the door, and he says he has had nothing to eat for six days."
"Fetch him in," said the "ed." "If we can find out how he does it we can run this paper another month."

* * *

The missing link scratched his—or its—head, in deep perplexity.
"I'm certainly close to the people," mused the creature—or phase of development—"but where are the people? I don't see any!"
Which was quite true, for the people, though they were next, as one may say, had not yet arrived.

* * *

An American contractor visiting in England was inspecting some new construction work in company with the British contractor, and the latter was boasting of the rapidity with which English workmen could put up a building in case of necessity. "Why, look at this building," he said, "yesterday morning there was nothing on the ground but the foundation stones and now they are finishing the second story." "That's nothing," said his companion, "it very often happens in the United States that we start work on a building in the afternoon and next morning have to begin ejecting tenants for non-payment of back rent."

* * *

"I observe that you never pull anybody's political chestnuts out of the fire."
"No," answered the party leader and reorganizer. "My specialty is firing political chestnuts out of the pull."


THE INFORMATION BUREAU

# ELECTRICAL DEFINITIONS

Below are defined a few of the most common electrical terms. They are reprinted from month to month and will be of assistance in understanding the magazine text.

**Accumulator.**—See secondary battery.

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

**Ammeter.**—An instrument for measuring electric current.

**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. The international ampere is the current which, under specified conditions, will deposit .001118 gram of silver per second when passed through a solution of nitrate of silver in water.

**Ampere Hour.**—Quantity of electricity passed by a current of one ampere flowing for one hour.

**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.

**Brush.**—The collector on a dynamo or motor which slides over the commutator or collector rings.

**Bus Bars.**—The heavy copper bars to which dynamo leads are connected and to which the outgoing lines, measuring instruments, etc., are connected.

**Buzzer.**—An electric alarm similar to an electric bell, except that the vibrating member makes a buzzing sound instead of ringing a bell.

**Candle Power.**—Amount of light given off by a standard candle. The legal English and standard American candle is a sperm candle burning two grains a minute.

**Capacity, Electric.**—Relative ability of a conductor or system to retain an electric charge.

**Charge.**—The quantity of electricity present on the surface of a body or conductor.

**Choking Coil.**—Coil of high self-inductance which retards the flow of alternating current. See self-inductance.

**Circuit.**—Conducting path for electric current.

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

**Collector Rings.**—The copper rings on an alternating current dynamo or motor which are connected to the armature wires and over which the brushes slide.

**Commutator.**—A device on a dynamo shaft for gathering the current from the various coils of the armature and sending it out over the line as direct current. On a motor it takes current from the line and passes it on to the armature coils.

**Condenser.**—Apparatus for storing up electrostatic charges.

**Cut-out.**—Appliance for removing any apparatus from a circuit.

**Cycle.**—Full period of alternation of an alternating current circuit.

**Dielectric.**—A non-conductor.

**Dimmer.**—Resistance device for regulating the intensity of illumination of electric incandescent lamps. Used largely in theaters.

**Direct Current.**—Current flowing continuously in one direction.

**Dry Battery.**—A form of open circuit battery in which the solutions are made practically solid by addition of glue jelly, gelatinous silica, etc.

**Electrode.**—Terminal of an open electric circuit.

**Electromotive Force.**—Potential difference causing current to flow.

**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.

**Farad.**—Unit of electric capacity.

**Feeder.**—A copper lead from a central station to some center of distribution.

**Field of Force.**—The space in the neighborhood of an attracting or repelling mass such as a magnet or a wire carrying current.

**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.

**Generator.**—A dynamo.

**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.

**Lightning Arrester.**—Device which will permit the high-voltage lightning current to pass to earth, but will not allow the low voltage current of the line to escape.

**Motor-dynamo.**—Motor and dynamo on the same shaft, for changing alternating current to direct and vice versa, or changing current of high voltage and low current strength to current of low voltage and high current strength and vice versa.

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

**Neutral Wire.**—Central wire in a three-wire distribution system.

**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 height.

**Parallel Circuits.**—Two or more conductors starting at a common point and ending at another common point.

**Polarization.**—The depriving of a voltaic cell of its proper electromotive force

**Potential.**—Voltage.

**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.

**Rheostat.**—Resistance device for regulating the strength of current.

**Rotary Converter.**—Machine for changing high-potential current to low potential or vice versa.

**Secondary Battery.**—A battery whose positive and negative electrodes are deposited by current from a separate source of electricity.

**Self-inductance.**—Tendency of current flowing in a single wire wound in the form of a spiral to react upon itself and produce a retarding effect similar to inertia in matter.

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

**Series Motor.**—Motor whose field windings are in series with the armature.

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

**Shunt Motor.**—Motor whose field windings are in parallel or shunt with the armature.

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

**Spark-gap.**—Open space between the two electrodes of a spark coil or resonator.

**Storage Battery.**—See secondary Battery

**Thermostat.**—Instrument which, when heated, closes 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.

**Volt Meter.**—Instrument for measuring voltage.

**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.

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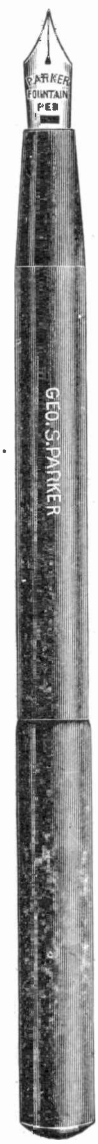


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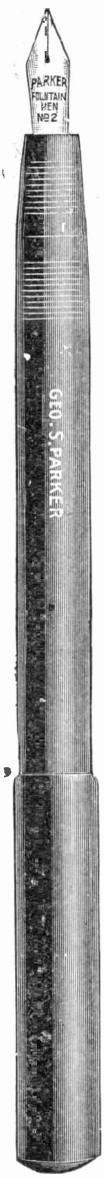


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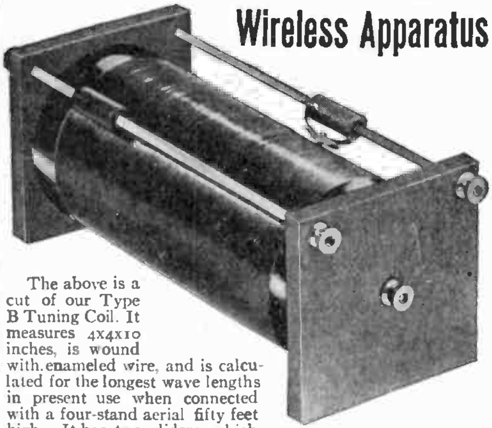

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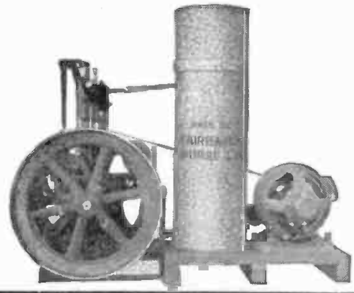

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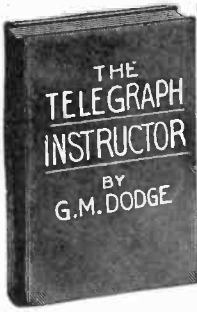


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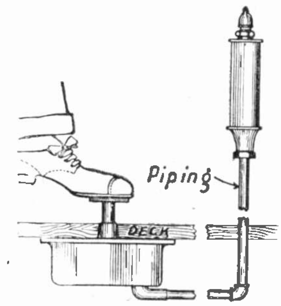


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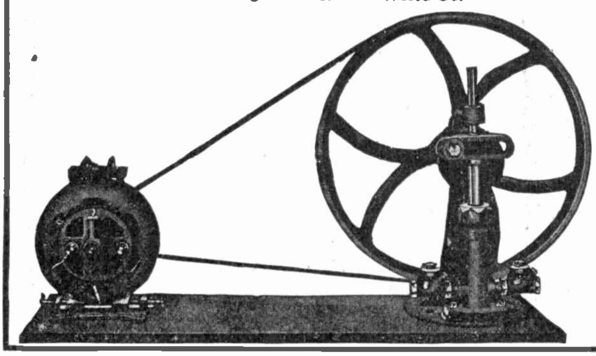

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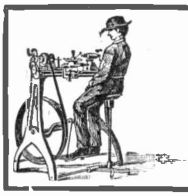

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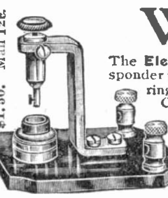

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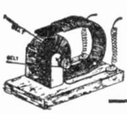

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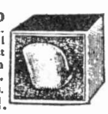

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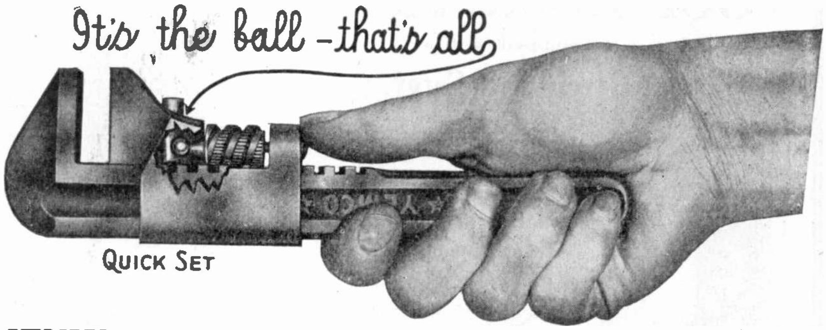


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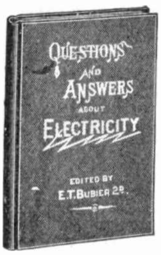


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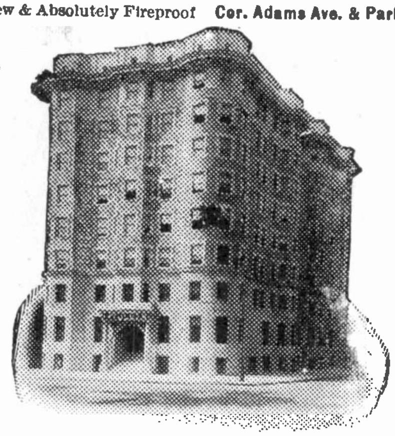

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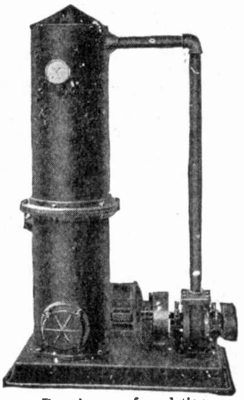
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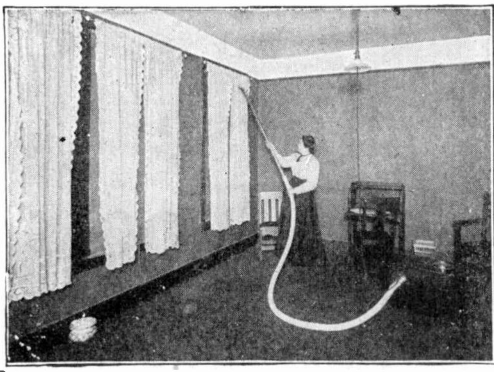

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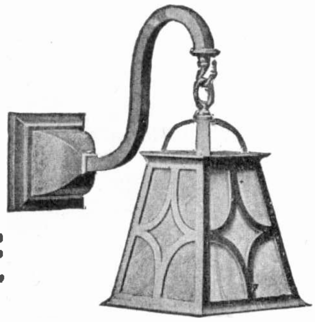

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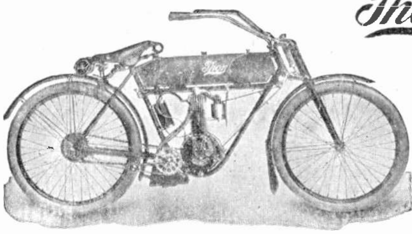

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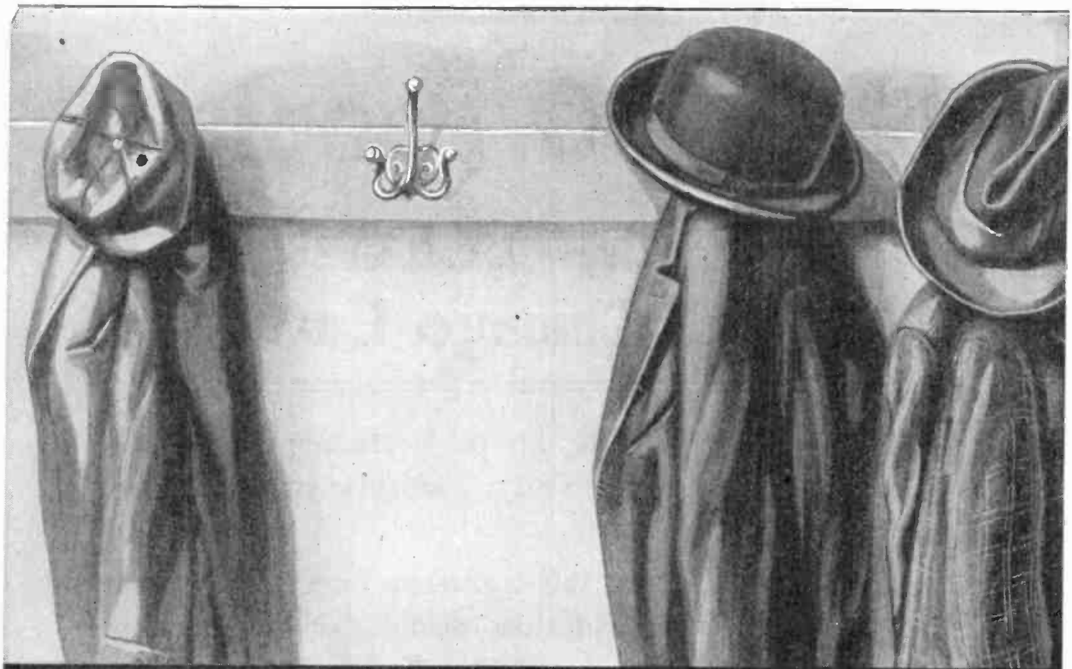

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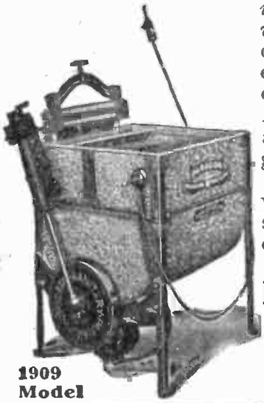

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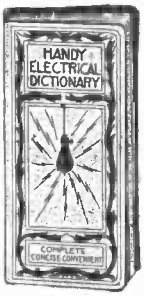


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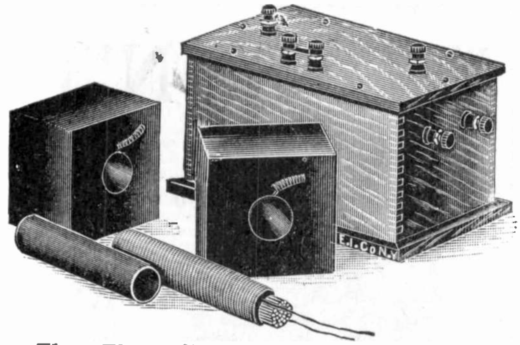


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