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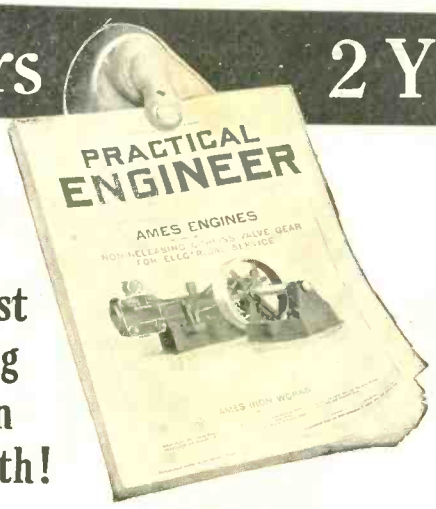

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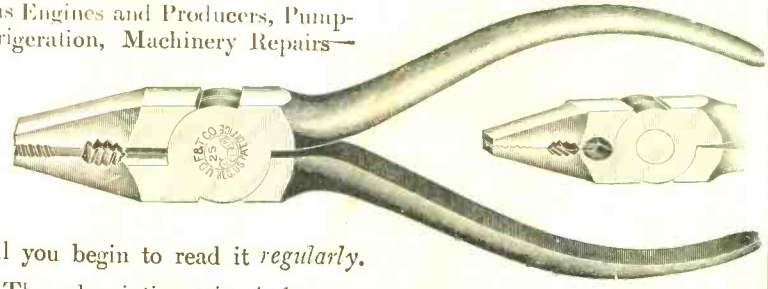

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POPULAR ELECTRICITY

IN PLAIN ENGLISH

HENRY WALTER YOUNG, Editor

Vol. II DECEMBER, 1909 No. 8

CONTENTS

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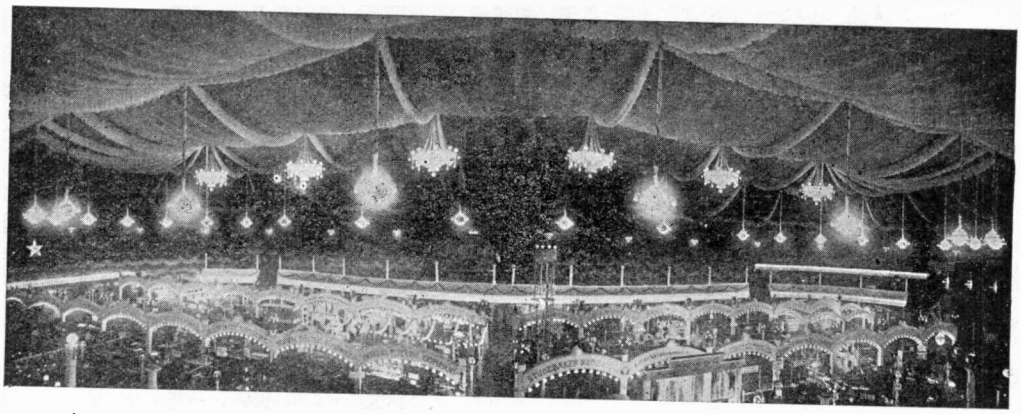

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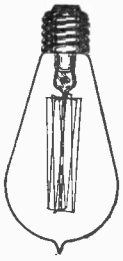

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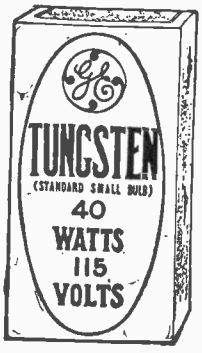

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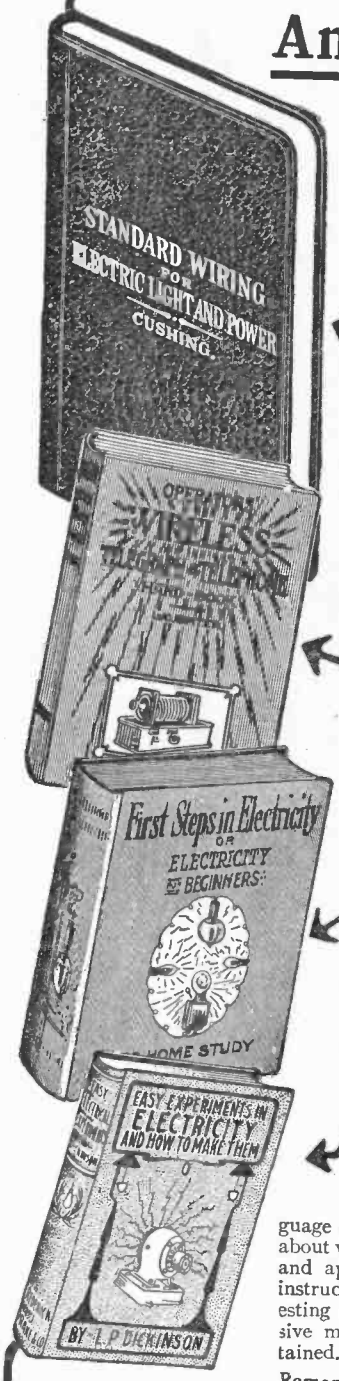

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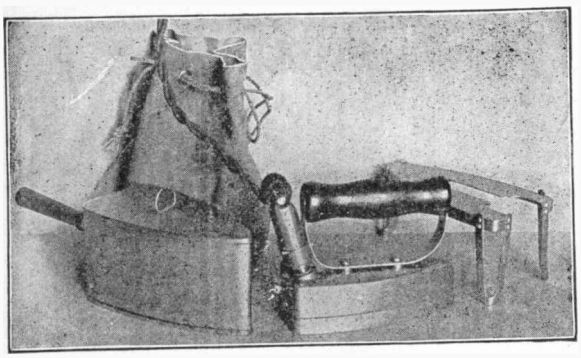
Iron, Dish and Stand packed in leather bag



The Aristocrat Among Electric Irons

HERE is an electric iron that is lighter, daintier, prettier, than any other. It is so built that it has wonderful ironing capacity, and will do more work than many irons weighing twice as much.

But the Utility outfit combines **Iron, Stove and Tong Heater.** When you unpack the nifty ooze leather bag, you find the following:

—a nickel-plated iron weighing 2½ lbs., with cooking stand.

—a nickel-plated copper cooking dish, with cover and ebonized handle.

—attachment for heating curling tongs.

—a switch plug with 8 feet of flexible cord and connecting plug.

Everything, bag included, weighs 3¼ lbs., and the package is less than 4 inches square and 6 inches high.

The Utility Iron is the newest member of the Hot Point family—we make the famous Hot Point Iron that has been sold for several years in all parts of the country. The Utility Iron is the refined expression of the experience which we have accumulated during the five years we have been manufacturing electric irons.

The Utility Iron is simple and sturdy and strong. It will iron all kinds of light work, and does such things as shirtwaists even better than a bigger, clumsier iron.

WITH electric lights in your home, you cannot afford to get along without a Hot Point Electric Iron.

For all kinds of domestic work, you should have a 6 lb. Standard Model. But even then you should have this new, light-model Utility, for your own personal use and for traveling.

Hot Point Irons attach to any light socket instantly; heat up so that you can begin ironing in a couple of minutes; cost very little to use and last for years.

Our Binding Guarantee

We guarantee every electric iron we make against mechanical and electrical defects, and troubles of any kind, not due to carelessness.

What the Utility Outfit Does

As an Iron, it does all sorts of ironing, except the heaviest household work.

As a Stove, it will boil two or three cups of water in a very few minutes, in the dish that is provided.

As a Curling Tong Heater, it will heat the tongs quickly at no expense for extra current.

How to Get a Utility Outfit

The Hot Point Iron is on sale by a great many dealers or lighting companies all over the United States. Go to your dealer or lighting company first. If they do not have it, order direct.

We are so anxious that you should examine this Utility Hot Point Iron that we will prepay the express charges ourselves from the factory to any town in the United States where it is not on sale.

Be sure to give voltage. If uncertain, call up the lighting company or look for the label on one of your lighting bulbs.

This is the Only Utility Iron

There is no other Utility iron that weighs so little and does so much work. No other iron with a dish and curling tong heater. No other iron packed in a dainty ooze-leather shopping bag.

No other iron has the Hot Point so that you can iron right up into the tucks and folds; nor cool handle so that you need never use a holder.

For these reasons, and many others, we urge you to accept no substitute. If you cannot get the Hot Point Iron (Standard or Automatic or Utility) in your town, use the below coupon.

PACIFIC ELECTRIC HEATING CO.

Main Office and Factory: Ontario, Cal.

Eastern Factory: Chicago, Ill. — 560 Washington Boulevard, Send order to nearest point.

Central Station Managers and Dealers

This is but one of the many advertisements we are running. We want to turn orders in your town to you. Order samples, subject to 30 days approval. State number you will be able to use and we will name special quantity price. Give voltage.

PACIFIC ELECTRIC HEATING CO.

ONTARIO, CAL. CHICAGO, ILL. (Address nearest office.)

Please send me further particulars about Hot Point Electric Irons.
Send me, charges prepaid, one Utility outfit, $6.00.
Enclosed is check in payment of same.

Name _____

Street _____ Voltage _____

City _____ State _____

I inquired about it of _____

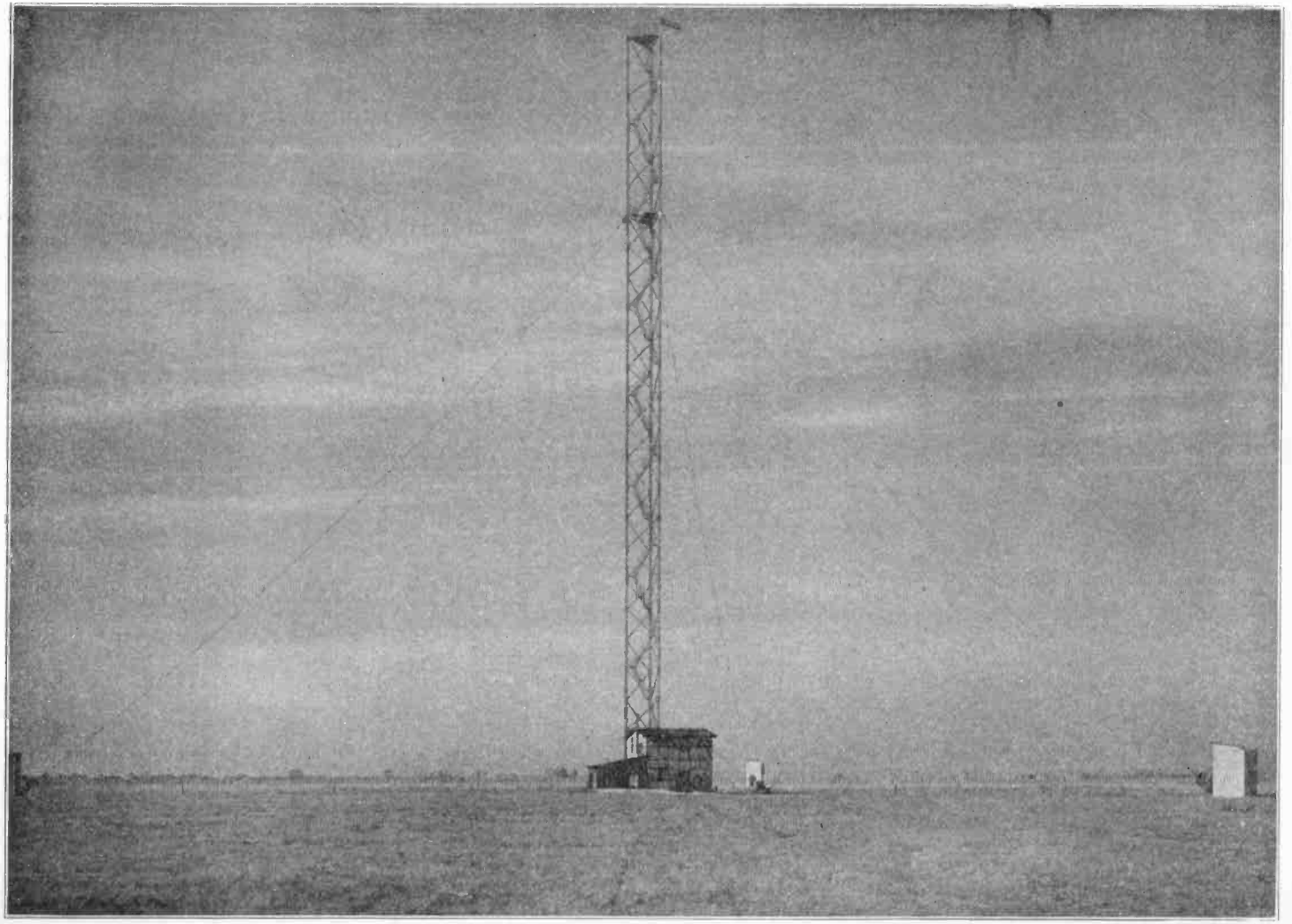
Pop. Elect.

Electricity

It sped with a power supernal that laughed at
the laggard Time,
It raced through the silence eternal, it throbbed
with the great star-chime,
It flashed through the desolate places where
dust of dead worlds is blown,
It leaped from the outermost spaces, past systems
and suns unknown.

Ho, out of the uttermost regions it leaped to the
waiting earth;
The strength of a legion of legions by it has
been given birth,
And no man may say why it lingers, and none
may its course pursue—
But you with a turn of your fingers are bidding
it work for you.

—Wilbur D. Nesbit



(See Page 522)

WIRELESS TELEGRAPH TOWER OF THE NAUEN HIGH POWER STATION IN GERMANY. HEIGHT 328 FEET.

POPULAR ELECTRICITY
IN PLAIN ENGLISH

VOL. II DECEMBER 1909 No. 8

Torpedo Controlled by Wireless

A French inventor, M. Gabet, has come forward after seven years of work and demonstrated that he has invented a marine torpedo which responds readily to the action of wireless electricity. Recently he made tests on the Seine at Paris which showed that he had succeeded in producing something more than a mere toy.

The contrivance when out of water has the appearance of being two torpedoes, one above the other and about six feet apart. The upper part is merely a floater, the lower section being the real torpedo. In it are a motor storage battery, an apparatus for receiving the Hertzian or wireless waves, and at the nose an explosive charge weighing 1,800 pounds. The ordinary torpedo contains but 200 pounds. When placed in the water the engine of destruction sinks to the upper floater, which carries two masts and antennae for receiving the wireless impulses. Upon the masts are electric lamps which are automatically lighted by the battery current as soon as the Hertzian waves reach the antennae; they are, however, directed aft so as to be invisible to the enemy.

In the experiments on the Seine the inventor made use of an instrument which somewhat resembled a piano. When he touched one of the keys, the torpedo, which was some distance away, responded at once. By sending a varying number of waves he moved the rudder of the contrivance to right or left as he pleased. It should be remembered, however, that the wireless waves do not themselves operate the screw or rudder, they simply control the apparatus.

Cathedral at Night in City of Mexico

Electrical illumination plays an important part in the annual celebration of Mexico's independence, in the City of Mexico. One of the attractive features of the event is the brilliant display of lights on the nights of September 15 and 16, upon the massive towers of the great cathedral edifice which fronts on the Zacolo Plaza, diagonally across from he National Palace. These towers reach to a height far above all other buildings in that quarter of the city and the electrical illumination may be seen from all points in the broad valley of Mexico. The lower part of the cathedral is shrouded in darkness, the faint lights upon the plaza being eclipsed by the brilliant illumination of the towers.

ILLUMINATED CATHEDRAL

Elementary Electricity

By PROF. EDWIN J. HOUSTON, PH. D. (Princeton)

CHAPTER XX.—ELECTRO-MAGNETS.

As shown in Chapter V, the passage of an electric current through any conductor is attended by the production of magnetism. There now remains to be explained the manner in which this property of an electric current is utilized in the production of working magnets.

Very early in his experiments, Oersted discovered that the magnetism produced by an electric current possesses a polarity which depends on the direction in which the current is flowing through the circuit. This is only another way of saying that the direction of the circular magnetic streamings, or lines of magnetic flux surrounding the conductor, changes with a change in the direction of the current. For example, if an electric current flows through a conducting wire (DD) Fig 41, in the direction indicated by the arrow from below the plane (BB); that is, upwards, the circular lines of magnetic flux produced will have a direction opposite to that of the hands of a clock; that is, will be counter clockwise. If, however, the direction of the electric current is changed so that it flows from above downwards, the magnetic flux will be clockwise or in the same direction as the hands of the clock.

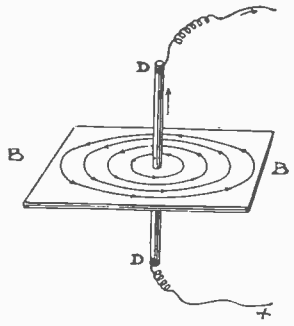


FIG. 41. ILLUSTRATING THE DIRECTION OF MAGNETIC FLUX

The magnetization of a bar of soft iron or steel by the passage of an electric current can be readily understood. Suppose, for example, that an electric source, such as the single voltaic cell, represented in Fig. 131, has its terminals connected as shown with a single coil of wire, so that the current flows from the positive pole (C), through the coil and returns to the cell at its negative pole (Z), then the circular lines of magnetic flux will pass downwards through the face of the coil of wire as indicated. If, now, a bar of soft iron (SN), be placed above the coil in the position shown, the lines of magnetic flux will pass through it, entering at the upper end and passing out at its lower end and thus magnetizing it. Since it has been agreed to call the north pole of a magnet the pole from which the magnetic streamings pass out and the south pole the pole at which they enter, it is evident that the lower end of the bar will have north polarity and the upper end south polarity.

If, however, the direction of the current through the coil is changed, as by changing the battery connections, the magnetic flux will thread through the face of the coil upwards, so that the end (N) of the bar nearest the coil will then have south polarity, and the furthest end or (S), north polarity. A bar of soft iron magnetized in this manner by the passage of an electric current is known as an electro-magnet.

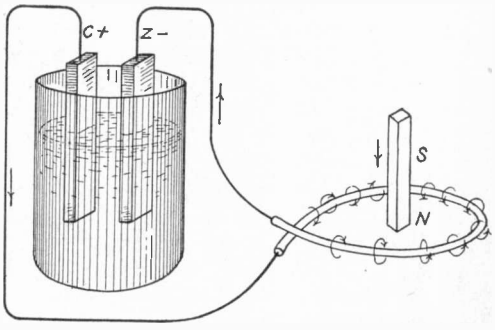
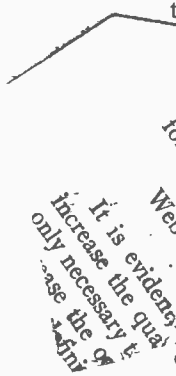


FIG. 131. MAGNETIZATION OF A BAR OF IRON BY CURRENT-CARRYING COIL

The strength of an electro-magnet depends on the quantity of magnetic flux pass-

ing through its circuit. When, therefore, it is desired to obtain a strong electro-magnet, the amount of magnetizing flux must in some way be increased. In order to understand how this can be done it is necessary to consider the peculiarities of the magnetic circuit.

There are many points of resemblance between electric and magnetic circuits. In the electric circuit, something called electricity, obtained from an electric source, passes through a conducting circuit, and entering an electro-receptive device produces in it one or another of the many effects electricity is capable of producing. Generally speaking, the greater the quantity of electricity passing the greater will be the amount of this effect. If the electro-receptive device be an electro-magnet, the greater the quantity of electricity flowing through the magnetizing coils, the greater will be the quantity of magnetic flux, and consequently the greater the strength of the magnetism.



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of the magnetism so produced will depend on the direction of the flux, since the parts at which the flux enters thereby acquire south magnetic polarity, and the parts at which it passes out, north magnetic polarity.

The quantity of flux passing through a magnetic circuit depends not only on the magnetic source producing the flux but also on the character of the medium forming the magnetic circuit through which the flux passes. In the electric circuit the strength of the electric flux of current passing is measured in units of electric current known as amperes. This strength depends on the quantity of electricity set in motion by a force known as the electro-motive force, or electricity-moving force, or E. M. F. In other words, it depends primarily on the number of units of electric pressure or volts the electric source is capable of producing. But the strength of the electric current produced by any source also depends on what is known as the elect
the circuit. The electric resi
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offer but little resistance to
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Copper is a much better electric
than iron, and iron much better

The quantity of electricity passin
a circuit increases with the increas
E. M. F. applied to the circuit and dec
with a decrease in the resistance. In o
words, the greater the E. M. F. and the smaller the resistance of a circuit, the greater the quantity of electricity that passes in a given time; that is, the greater the current strength. This fact is generally expressed by Ohm's law as follows:

$$\text{Amperes} = \frac{\text{Volts}}{\text{Ohms}} \text{ or } C = \frac{E}{R}$$

Now the same thing is true in the magnetic circuit. The quantity of magnetic flux or magnetism that passes through a magnetic circuit is measured in units of magnetic flux called webers. The force that produces the magnetic flux is called the magneto-motive-force, generally contracted M. M. F. The greater the magneto-motive-force the greater the amount of magnetic flux that is produced.

But the quantity of flux that passes through the magnetic circuit is also dependent on a quantity known as the magnetic reluctance; that is, a property which tends to resist the passage of magnetic flux.

Magneto-motive-force is measured in units of magneto-motive-force known as gilberts, while the magnetic reluctance, or, as it may also be called, the magnetic resistance, is measured in units of magnetic resistance known as the oersted.

Just as in the electric circuit the greater the E. M. F., and the smaller the resistance, the greater the electric current in amperes, so in the magnetic circuit the greater the M. M. F., or the gilberts, and the smaller the reluctance or the oersteds, the greater is the magnetic flux or webers passing per

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is one ohm by an E. M. F. of
.. In a similar manner a weber is
a passage of magnetic flux which is
uced in a magnetic circuit having a
reluctance of one oersted by a M. M. F. of one gilbert.

But since in the case of any electro-magnet, it is the electric current or the amperes, that is the coulombs-per-second, that produces the magnetic flux, it is possible to express the gilberts or the M. M. F. in the circuit of any electro-magnet by the electric current flowing through the magnetizing coils. If, for example, a current strength of one ampere passing through a coil of a given number of turns produces a certain quantity of magnetic flux and this current strength be doubled, the amount of magnetic flux will, approximately, be doubled. Or, if the number of turns in a magnetizing coil be

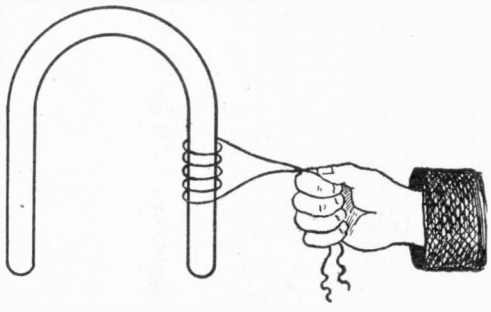


FIG. 132. STRENGTH OF MAGNETISM DEPENDS ON AMPERE-TURNS

doubled, the current strength remaining the same, the amount of magnetic flux produced will also be doubled. If a magnetizing coil of 250 turns produces a certain intensity of magnetic flux, a coil wound with 500 turns would produce twice the amount, assuming of course that the same current passes. For this reason the term ampere-turn is employed as a unit of magneto-motive-force, the ampere-turn being a single conducting loop through which a current

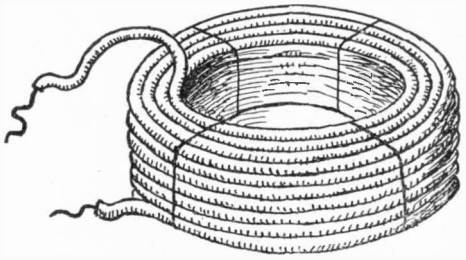


FIG. 133. TYPICAL MAGNETIZING COIL

of one ampere is passing. The ampere-turn is somewhat greater than a gilbert being equal to 1.26 gilberts.

But there is another way of increasing the quantity of magnetic flux that is passing through a circuit, and this is to decrease the magnetic reluctance of the circuit. Substances differ greatly in the resistance they offer to the passage of magnetic flux. Of all substances, soft iron or soft steel offers the least resistance to this passage. Air, on the contrary, possesses a much greater magnetic reluctance than iron. Consequently, the greater the amount of iron, or the smaller the amount of air in a circuit, the greater the number of webers that a given number of gilberts can produce; for, other things being equal, the smaller will be the number of oersteds.

The quantity of magnetic flux in a circuit, and hence the strength of the magnetism produced, can be readily varied by an increase in the number of ampere-turns. If, for example, as represented in Fig. 132, instead of a single turn, five turns of insulated wire are wrapped closely around one leg of a U-shaped core of soft iron, the quantity of flux, and hence the strength of magnetism, will be approximately five times what would have been produced by a single turn of wire.

The ampere-turns, instead of being applied to the soft iron core in a single series may be wound over one another as shown in Fig. 133. Here seven turns of wire are carefully laid one over the other in four separate layers; that is, there are 28 turns in all. If, therefore, a current of one ampere

be sent through such a magnetizing coil; that is, through its 28 turns, there would be, roughly speaking, 28 times the amount of magnetism (28 ampere turns) that would be produced by a magnetizing coil of a single ampere-turn.

Electro-magnets of the U-shaped form generally have the magnetizing coils placed on each leg. By this method the number

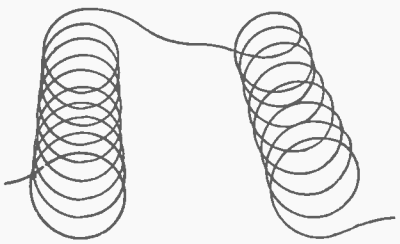


FIG. 134. THE WINDINGS MUST BE IN A CONTINUOUS DIRECTION

of ampere-turns is increased, and the quantity of magnetic flux, and, consequently, the magnetism, is increased.

When, as in the above case, the magnetizing coils or windings, are divided into two separate sets, if it is desired that the ends of the U-shaped core shall posses opposite polarity; that is, one shall possess a north polarity and the other a south polarity, it is necessary so to connect the coils that the electric current shall pass through both in the same direction. In order to do this the ends must be so connected that the same direction of winding be preserved in each, as represented in Fig, 134.

Various shapes are given to electro-magnets. Generally speaking, these shapes are capable of being divided into three general classes, according to the character of the material of which the circuit is composed i. e.:

(1) Magnets with aeric circuits, or those in which the magnetic flux passes through air only.

(2) Magnets with ferric or iron circuits, or those in which the flux passes through a circuit of iron only.

(3) Magnets with aero-ferric circuits, or those in which the flux passes through a circuit partly of air and partly of iron.

An example of a magnet with an aeric circuit would be to pass an electric current through a hollow coil of insulated wire wrapped in a close hollow ring-shaped spiral by connecting the terminals of an electric source to the two terminals of the wire. As the current flows through the magnetizing coil, the circular magnetic flux is produced around the wire so as to thread or pass through the air space within the magnetizing coils.

Another form of a magnet with an aeric circuit is represented in Fig. 135, where a hollow solenoid, helix or spiral (ab) is suspended with the ends of its circuit dipping in mercury cups at (pp), so that it can have an electric current sent through it from the source and yet be free to move. Under these circumstances the magnetic flux produced by the ampere-turns will thread through the air core within the coil and passing out at one of its ends thus producing a north pole, will pass through the air on the outside of the coil, and re-entering the core at the other end, will produce a south pole. Consequently, the solenoid becomes a magnet, and, being free to move, will come to

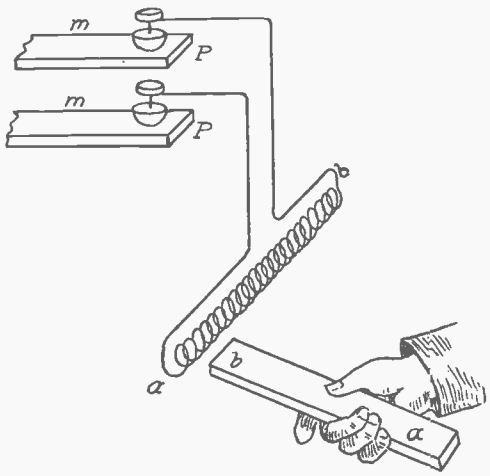


FIG. 135. A HOLLOW SOLENOID ACTS AS A MAGNET

rest like a magnetic needle when pointing, approximately, to the earth's north geographical pole. At the same time, like a magnetic needle, such a suspended magnet would be attracted or repelled by the approach of a bar magnet as shown.

A magnet with a ferric circuit or one in which the magnetic flux passes entirely through iron would be produced if the magnetizing coil represented in the preceding figure be wrapped around a core of soft iron or steel. If the number of ampere-

turns is the same and the diameter of the iron and air core are the same, it can be shown that the amount of magnetic flux that passes through the iron core will be something in the neighborhood of 1,000 times greater than the flux which passes through the air core.

Since the magnetic reluctance of iron is much greater than that of air it was believed at one time that the increase in the quantity

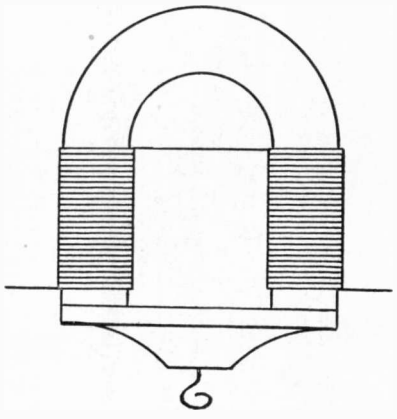


FIG. 136. HORSE-SHOE TYPE OF ELECTRO-MAGNET

of magnetic flux passing through an iron core was due to the decreased reluctance of the iron circuit. Indeed, this decrease of magnetic resistance would be capable of explaining some of this increase. It was not long, however, before it began to be evident that the decrease in the magnetic reluctance of the circuit should not be regarded as the sole cause. Were this the case then, necessarily in such a magnet, when the magnetizing current is cut off by the opening of the circuit, all magnetic flux would instantly disappear. Now this is not the case. On the opening of the circuit there always remains a certain amount of magnetism known as a residual magnetism. Evidently, therefore, there is a source of magneto-motive-force, other than that of the magnetizing current, and this is now correctly traced to the ultimate particles or molecules of the iron that are naturally and originally magnetized or have tiny streams of magnetic flux passing through them.

It may be asked if such is the case why a bar of iron does not always manifest this magnetism? The reason is evident. The small molecular magnets, instead of being definitely directed, point in practically all directions, and, therefore, neutralize each other's magnetic effects. When, however, a magnetizing current produces a flux that passes through the molecules of iron all the molecular magnets are aligned or turned in the same direction, so that they add their flux to the flux produced by the magnetizing current.

There are, therefore, in the case of a magnet with iron in its circuit, two sources of magneto-motive-force, i. e.:

(1) The prime magneto-motive-force, or that produced by the ampere-turns, and,

(2) The aligned or structural magneto-motive-force, possessed by the bar whether the magnetizing current is passing or not. This is caused to add its magnetic flux to the circuit by the aligning of the molecular magnets.

As an example of an aero-ferric magnet, or one in which the magnetic flux passes through both air and iron, we might take the case where a portion of a circular iron core, before being wound, has a section or segment cut out. On the passage of the magnetizing current the magnetic flux is passed through the iron core, but at the air gap, instead of being limited to the space directly between the cut parts, also passes through the surrounding air, thus producing what is known as magnetic leakage.

Where the dimensions of this air gap are increased, the leakage is still more pronounced.

As can be readily seen, the simple horse-shoe magnet, represented in Fig. 136, is of the aero-ferric type, since the flux produced passes both through the core of the magnet and the air gaps at its poles. It can be understood, therefore, that when a mass of soft iron called the armature, shaped as shown, is placed in contact with the free magnet poles, a marked increase is produced in the strength of the magnetic force, not only by reason of the decrease in the reluctance of the circuit, but especially by the increase in the magneto-motive-force due to the aligned or structural magneto-motive-force that is thus added to the circuit.

(To be Continued.)

Modern Ways of Applying X-Rays

One of the important functions of the X-ray is to aid the physician in making a diagnosis. As is generally known it discloses pins, needles, bullets, etc., embedded in the bodily tissues and as the bones are shown more or less distinctly it makes fractures and dislocations evident.

There are two ways of using the apparatus. One is to employ a fluoroscope, holding the member to be examined between the fluoroscope and the X-ray tube, and then look into the former as you would into an ordinary stereoscope. The rays penetrate the flesh easily but not the bone or metallic substances which cast a clearly defined shadow on the screen which forms the front of the fluoroscope.

The other way to take an X-ray picture is by means of a sensitized photographic plate which is affected by these rays as by ordinary light rays, and then examine the picture at leisure.

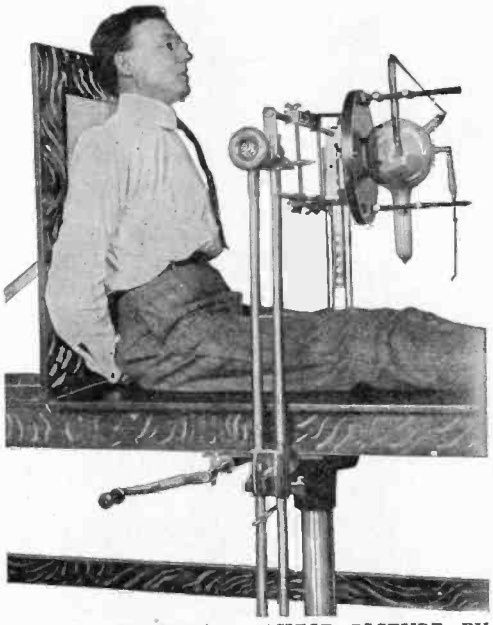
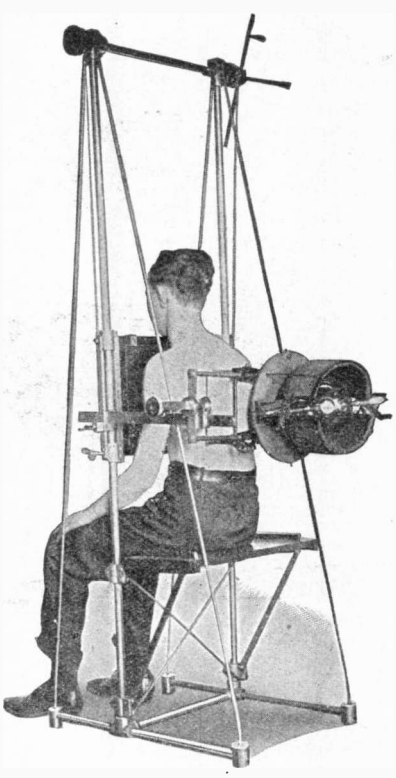
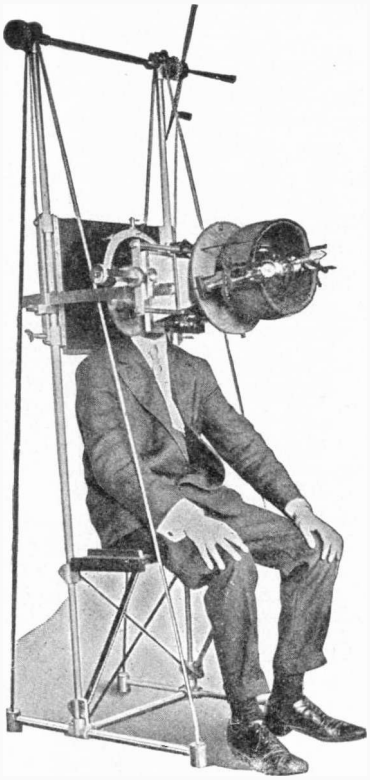


FIG. 1. MAKING A CHEST PICTURE BY X-RAYS

FIG. 2. MAKING A FLUOROSCOPE EXAMINATION WITH X-RAYS





FIGS. 3 AND 4. APPLICATIONS OF THE LANGE CHAIR

Some unique devices are nowadays employed to apply the X-rays for such purposes, as shown by the illustrations.

Fig. 1 shows how chest pictures are made. The subject is placed in a sitting posture. In front of him is the X-ray tube with adjusting devices. At his back you will see the location of the sensitive photograph plate. This is carefully wrapped in black paper to keep out the sunlight. The X-rays, however, pass right through the clothing and body and through the black paper as if nothing were there, only that the bones or foreign metallic bodies will show up as a shadow on the plate, for the rays cannot pass through them.

Fig. 2 shows the use of a fluoroscope in connection with the X-rays. The operator is there examining the bones of the subject's arm by looking into the fluoroscope. No photograph is taken in this case. You will note also that the operator protects his hands by gloves which are opaque to the rays. This is because the latter are very harmful if allowed to fall on the flesh for continued periods, as would happen in the case of the operator examining many subjects. Over exposure to the rays causes very deep seated and serious burns which are almost impossible to heal.

The Lange chair was designed by Dr. Sidney Lange especially for making fluoroscopic examinations and skiagraphs (X-ray photographs) of the chest, esophagus and stomach, with the patient in the erect posture, as shown in Figs. 3 and 4. The patient may either sit or stand; facing forward or backwards.

The plate-holder and fluoroscopic screen are interchangeable and the tube with its support and shield moves in unison with the plate-holder or screen.

Electricity Supply a Great Manufacturing Proposition

Electric current is brought into our homes through a pair of insignificant wires, carefully concealed; it is brought into factories, stores and other places of business through cables a little larger, but again carefully concealed; occasionally we see a small group of men putting in the underground conduits, a lineman here and there working on the few over head wires that are visible, and very rarely, indeed, do a comparative few have occasion to visit the immense power plants where the current is generated. It is significant therefore, that in a great city like Chicago the magnitude of one of the most dominant of all the forces which contribute to the welfare of its citizens is by them little comprehended. Few people, as a consequence, have any conception, of the importance of the business of making and distributing current in a great city.

Mr. Samuel Insull, president of the Commonwealth Edison Company of Chicago, recently spoke at a luncheon of the Chicago Electric Club upon the sale and distribution of electric energy in that city, and the facts and figures which he set forth will be astonishing to many who are accustomed to pay little attention to the affairs of an electricity supply company except at the time when their monthly bills are to be paid.

Within the corporate limits of the city of Chicago there is at present about $60,000,000 invested in the generation and distribution of electric energy. To pay 6 percent on the money invested takes about $400 an hour, 24 hours a day, 365 days in the year. For the privilege of earning that interest the company pays, with pleasure, to the city and state an amount in taxes and compensation which exceeds $100 an hour.

To produce the energy which the Commonwealth company sells requires, on the average, 100 tons of coal an hour, 8,760 hours a year. At certain times in the winter coal must be burned at the rate of 200 to 250 tons an hour. "Fancy," said Mr. Insull, "the engineering brainwork that must have been centered in that one proposition—how to get through the grates 250 tons of coal in an hour."

The company must stand ready to deal with large and small consumers as they come along, at all hours of the day. This is known as "Readiness to Serve." To do this there has been installed, principally at two points, electric generating equipment to the capacity of 240,000 horsepower. This generating capacity, enormous as it is, must, however, be increased and new steam turbine generators added to the constantly growing stations, for even if the city were not to grow in population it is conservatively estimated that the amount of current now supplied is only one-third of the amount which could be used for electric light and power purposes.

Fifty-four stations and substations are needed to meet the requirements of the various classes of business from the smallest lighting installation to the operation of a railway system. The current that passes through them is conveyed by a total of 1,255 miles of cable, 4,000 miles of overhead wires and a conduit mileage of 2,200. All of this development has taken place in less than 30 years, and in order to take care of the growth of the business the company is spending about $6,000,000 a year or nearly $2,000 for every working day of the year. This gives an idea of the investment side of the electricity supply business in Chicago.

But in spite of the enormous expenditures required the price of current to consumers has been constantly on the downward trend. This has been due to the increased efficiency of modern apparatus and methods and the decreased cost of manufacturing electricity on a large scale, as in the case of any other manufactured product.

In 1909 the kilowatt hours of electricity sold was 40 times the amount sold in 1896, and it is due to this enormous growth that the company is now able to make a fair percentage of profit upon an income which is only 25 percent per unit (kilowatt hour) sold of the income received in 1896.

To illustrate what this great volume of business represents Mr. Insull made the striking statement that if his company could make a reduction in operating cost of one one-thousandth of a cent per kilowatt hour produced it would mean a saving of $4,500 in a year.

Taking the whole schedule of rates through, it is believed that electricity is sold cheaper in Chicago than any where else on either side of the Atlantic where steam driven plants are used, and even including those water power plants established as commercial propositions. This has an effect on the present agitation for the electrification

of the steam railroad terminals. With the present equipment the company is prepared to furnish current for the operation of the terminals of any two railroads entering the city. With equipment to be installed by January, 1911, two more could be supplied. Furthermore the current for this purpose could be bought in Chicago considerably cheaper than it is now being produced by the two great traffic lines which are now engaged in electrifying their terminals in New York City.

How An Arc Lamp Works

By ALBERT WALTON

Next time you are in a department store or on the street where arc lamps are used for illumination watch a lamp for a few moments and you may see it flicker, or "wink," the lamp going nearly out for an instant but as quickly returning to full brilliancy. If you are near enough you will

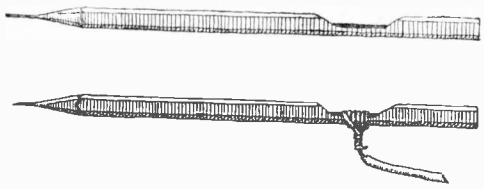


FIG I. LEAD PENCILS MAY BE USED FOR A MINIATURE ARC LAMP

hear a sharp click at the same time. Most of us have seen and heard this very often and many of us have been annoyed at what we considered an imperfection in the lamp mechanism. Usually "to understand all is to forgive all," and a thorough understanding of the causes of this flicker should prove no exception to the rule. One seldom appreciates the wonderful development of the modern arc lamp mechanism until he tries to do by hand what the arc lamp does automatically. This can be done on a simple scale by any one who has an incandescent lamp circuit with which to experiment.

An arc light is simply a flame caused by the incandescent vapor generated between two points of carbon, or similar material, which have been heated to the necessary temperature to produce this vapor by the passing of electricity from point to point. This will readily be seen if the experiment mentioned be tried. The "lead" in a lead pencil is really compressed carbon dust very similar in composition to the carbons of an arc lamp, though very much smaller. If two pencils are sharpened and cut as shown in the sketch (Fig. 1) they can be used as the carbons of a miniature lamp if the following instructions are carefully followed.

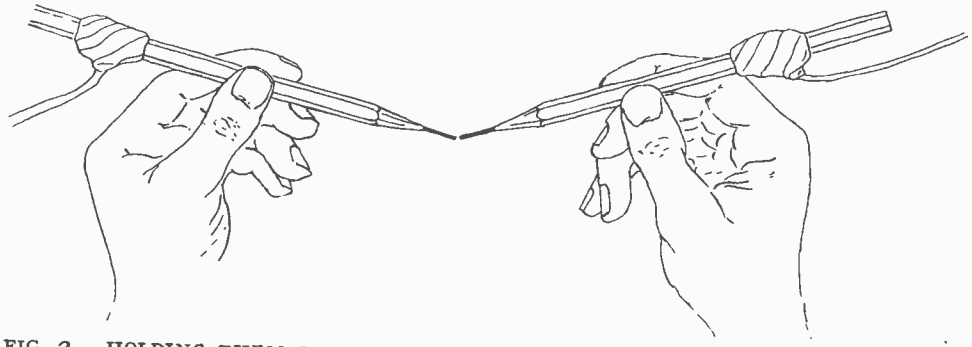


FIG. 2. HOLDING THEM BY THE WOOD, BRING THE TWO POINTS CAREFULLY INTO CONTACT

A "bank" of three or four ordinary 16 candle power incandescent lamps on the usual house or office circuit of 110 volts will provide just about the proper resistance

for the experiment. The pencil-arc is to be put in *series* with the incandescent lamps —that is, in the gap formed by cutting *one* of the two wires supplying the string of lamps. Thus all the current that can pass through your arc is that which the lamps

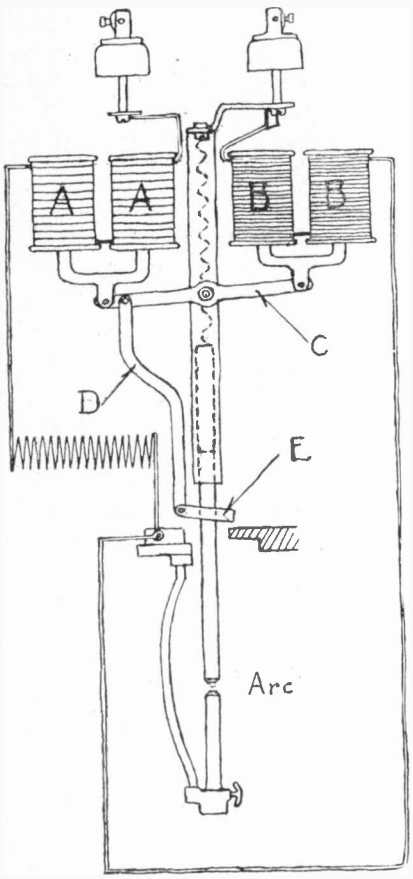


FIG. 3. THE VARIOUS ELEMENTS OF AN ARC LAMP

permit. To put the pencil-arc between the two wires without the lamps would cause a short circuit, as there is but little resistance in the pencils themselves.

Attach your flexible wire or lamp cord to the pencil by winding it around the notch so that is makes a good contact with the exposed lead, and wrap it up with tape or cloth, tap in the other ends in the gap made by opening one side of the circuit. Turn on the switch which controls the lamps. They will not light because of the gap at the pencils. Now take one pencil in each hand, being careful not to touch the bare lead at either end of the pencil. Holding them by the wood, bring the two points carefully into contact, which will immediately allow the current to flow and light the lamps. Very gently separate the two points. The small spark caused by the break will fuse the ends of the pencils and vaporize some of the carbon and, if the opening is not made too great, nor too quickly made, the vapor will carry the current from pencil to pencil and will be heated by it to a bright incandescence. By careful handling an arc can thus be held for several seconds which will brightly illuminate a small room. But before you have attained this proficiency in holding the arc you will have much greater respect for the mechanism of an arc lamp and more tolerance for its very occasional wink.

You will also, probably, be prompted to investigate the working of the device that can do this trick hour after hour in all manner of weather, swinging and swaying in the wind, working in summer heat and winter blizzards, on lofty towers, on street poles and in stores and mills without adjustment or attention. Although cooped up in a space no larger than a man's hat it will keep the lamp burning day and night for a week without being touched for so much as the removal of the carbons.

The various sketches show how this is done in the simplest of arc lamps and will serve as an explanation of all, since the others are but elaborations of these same principles. Fig. 3 shows the various ele-

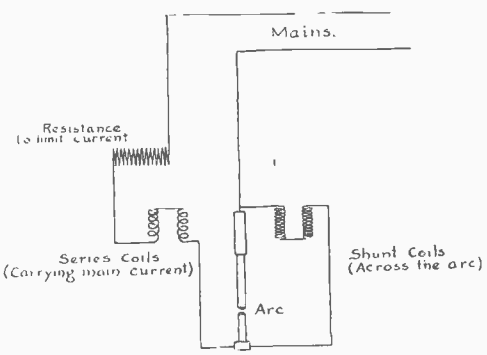


FIG. 4. CONNECTIONS OF AN ARC LAMP

ments in diagram form and from this sketch the operation may be described. The electrical elements without the mechanical parts are diagrammed in Fig. 4, the same reference letters being used in both. The parts

are very few and of simple construction. There are two pairs of electro-magnets, (A) and (B), with U-shaped cores, the bottoms of both cores being hinged to opposite ends of a rocker-bar (C), which is pivoted at its middle point. When current passes through these magnet coils the cores are drawn upward upon the well known principle of the electro-magnet, and the greater the current, of course, the greater the pull. At one side of the pivot of the bar (C) is hung a rod (D), on the lower end of which is the clutch (E), which holds or releases the carbon as may be required. If you trace out the diagram you will find that the pair of coils marked (A) must carry the whole current of the lamp whereas the ends of the wires from the other coils are attached, one above and the other below, the arc. The resistance of these "shunt" coils (B), is such that practically no current flows through them when the carbons are touching, the current preferring the low resistance path through the carbons. Let us assume the carbons in this position when the electricity is turned on. There is a rush of current through the carbons and, therefore, through the series coils (A) which instantly exert a strong upward pull on their U-shaped core. This raises their end of the arm (C), and with it the rod, (D), and the clutch (E). This raises the upper carbon and starts the arc, as was done by hand with the pencils. As the gap lengthens the resistance to the flow of current across it through the vapor increases and part of the current is then forced to go through the shunt magnets (B), which provide a parallel path through the lamp. This shunt-coil current, then, increases as the arc gap increases and this causes an increasing pull to be exerted on the other end of the rocker arm, (C), which tends to draw it back to the horizontal position. A balance is thus struck automatically, for the longer the arc gap the greater the pull tending to shorten it and vice versa.

Assume that this balance is reached when the carbons have separated a quarter of an inch. The lamp now burns steadily with no motion at either end of the bar. Gradually the carbons are burned away and the gap increases. But this increases the arc resistance and forces more current through the shunt coils which pull up on their core and lower the carbon again till the balance is restored. The constant burning of the carbons necessitates constant readjustment by lowering of the upper carbon till finally the rocker arm is tipped at quite an angle and the shunt coils have drawn up their core about as far as it is desirable to allow. This is when the "wink" occurs, for just before the arm has tipped to its limit the clutch touches a fixed stop which presses on it in such a way as to open it and allow the carbon to drop freely through until it strikes upon the lower carbon. The shunt coils (B) are instantly deprived of their current and the series coils (A) being strengthened by the rush instantly raise their end again and the arc is re-established and the entire process goes on as before. This is done so quickly that hardly a perceptible interval occurs and in many modern lamps the "wink" can be noticed only by close observation.

Concentration of Bacteria by Electricity

Electricity is being employed in one way and another in the destruction of bacteria, as, for instance, in water purification systems, sewage disposal and ozone air purification apparatus. The most recent experiments in this line reveal a new and interesting susceptibility of certain microbes to electric action, namely, a tendency to collect around one pole or electrode of an electric circuit terminating in a liquid containing them. It is therefore possible to gather evidence of the existence of suspected bacteria in a liquid by driving them to one pole where concentration makes their presence manifest.

The result of some elaborate experiments made by an English scientist, Dr. Charles Russ, was to show that in a liquid containing bacteria the micro-organisms under favorable conditions could be driven by the electric current to accumulate as a dense column, visible to the naked eye as a white cloud. In less favorable conditions Dr. Russ's method furnishes none the less a very delicate test of the presence of small numbers of bacteria when they exist in the body fluids.

The fluid under exmination is subjected to an electric current, and the bacilli (of tubercle, for example) will be found to aggregate at one electrode. This portion of the fluid can then be withdrawn and tested for them. The aggregation takes place, both with living and dead bacteria, and the difference of the behavior of various kinds of bacteria may be studied.

The World's Greatest Searchlights

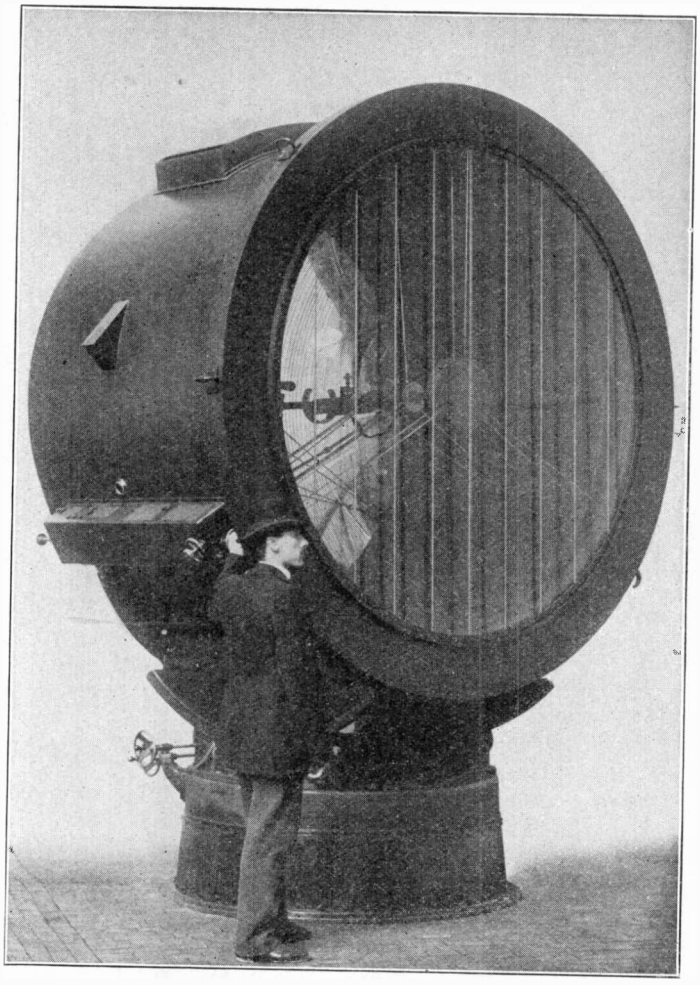
Thirty million candles! Just think of it. To use a slang expression, that is "some light." Yet this represents the power of electric searchlights of the Heligoland light house, which occupies a most important position at the mouth of the Elbe River in Germany. At that point there is great danger attendant on the course taken by mariners in the immediate neighborhood of the island. This called for a light of hitherto unequaled brilliancy and power for lighthouse service, equivalent to the intensity of 30 million candles.

THE FAMOUS HELIOGLANDE LIGHT

The Heligoland light is a combination of four projectors one of which is an auxiliary or reserve search light and is mounted at the top, while the three usually employed are mounted 120 degrees apart on a revolving platform. The rays from these lights are a most imposing spectacle at night as they shoot straight out in almost cylindrical beams from the parabolic mirrors. The demand was for a light having a minimum duration of one-tenth of a second, flash to succeed flash every five seconds.

The three electric projectors used on the revolving platform have parabolic mirrors 30 inches in diameter with a focal length of 10 inches, and each arc lamp takes 34 amperes. The platform revolves at a rate of four times per minute and the current for operating the electric motors driving this platform as well as for operating the searchlights is supplied by a dynamo plant in the government buildings equipped with duplicate generating apparatus.

But the Heligoland light, though remarkable, is not the largest. One far more



SEARCHLIGHT WITH AN EIGHTY INCH MIRROR

powerful was constructed by the Siemens-Schuckert Werke of Berlin and Nürnberg, Germany. This has a brass parabolic mirror 80 inches in diameter and an arc lamp with carbons $1\frac{3}{8}$ inches and $1\frac{7}{8}$ inches in diameter, respectively, for the negative and positive, and the consumption of current being 200 amperes.

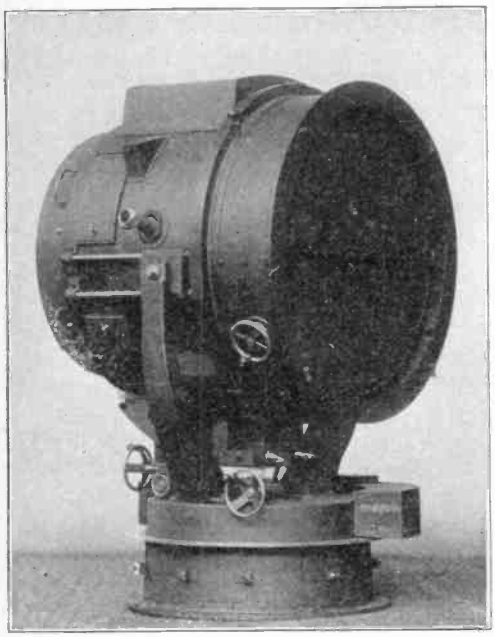
The mirror of this searchlight has a focal length of nearly 34 inches and when using current at the rate above mentioned the intensity of the light is said to be equal to 316 million candle power. One of the remarkable features of this searchlight is the operation by an electric motor of the Iris shutter, which when closed presents a perfectly opaque surface to the brilliant reflection of the polished mirror.

The modern searchlight is always of interest, and its wonderful development in recent years has made it almost indispensable on land and sea, both in time of war and peace. The armies of the world are now equipped with portable electric plants supplying current for electric searchlights mounted on auto cars and animal drawn trucks.

Light houses and the forts are equipped with great electric arc projectors whose beams of light search both land and sea from sunset to sunrise. The warships from the smallest torpedo boat to the greatest battleship are provided with electric searchlights as well as the great ocean liners and the steamers on lakes and rivers.

One of the accompanying illustrations shows a powerful German motor-controlled electric searchlight having a mirror three feet in diameter with a focal length of approximately 17 inches. The parabolic mirror of this searchlight is entirely of glass of uniform thickness, ground and polished to the greatest accuracy. Its parabolic form gives it the property of projecting a nearly parallel ray of light, entirely removing the spherical aberration of the spherical mirror, as well as the drawbacks of the separately built up lenses often used in lighthouse work. At the same time it gives better and more lasting results than the metallic mirror.

This searchlight requires a current of 90 to 150 amperes and is used to advantage on modern warships and forts to illuminate distant objects, it being automatically controlled, so that no manual effort is required of the observer in raising or lowering the beam of light or turning it to the right or left, a small lever of the electric controller being moved in the direction in



AUTOMATIC MOTOR CONTROLLED SEARCHLIGHT

which the beam of light is to travel, and the electric motors do the rest.

Blind Man Operates a Telephone Switchboard

Mr. Kirk S. Thompson is probably the only blind telephone operator in the country. The subscribers of the Crescent Telephone Company in Erie, Ill., many of them at least, are probably not aware that their calls are answered by a man who possibly never saw a telephone switchboard, for blindness came upon him many years ago.

The switchboard which Mr. Thompson operates is equipped with bells for the party lines, while the single lines terminate in drops or shutters on the switchboard. These drops are similar to those found on most switchboards in the smaller exchanges; that is, when the subscriber rings central a little shutter on the front of the board drops forward and discloses the number of the party calling. On the board operated by Mr. Thompson these numbers are raised. A buzzer also gives a signal when any drop falls.

When a call comes in the operator hears the buzzer and immediately runs his left hand lightly over the shutters till he finds the one which has fallen, and feeling of the raised characters he knows the number and is able to complete the connections. He is able also to distinguish the party line bells by their respective sounds. With the switchboard literally at his finger ends he is remarkably quick at completing connections.

Insulator to Withstand 150,000 Volts

This peculiar looking chain of inverted saucer-like objects is a high tension insulator. It is of a type recently chosen by the Hydroelectric Power Commission of Ontario for suspending the wires of its 110,000 volt transmission line. While the insulator as shown has eight units, six units would have been sufficient for the present needs, but the Commission expects later to use 150,000 volts and the eight unit type will withstand this enormous pressure safely.

150,000 VOLT INSULATOR

The insulator units are made of a special grade of porcelain the ingredients of which are selected, mixed and fired with the greatest care. There must not be a flaw or weak spot in all the structure, for current under a pressure of 150,000 volts is constantly striving with an almost inconceivable force to reach the earth.

The units of the insulator are connected by means of caps and forged steel studs. The eight sections complete make a string over four feet long. The insulator is hung from the cross arm and the current carrying wire is suspended from the lower end. Any stray current, to reach the earth, must climb this eight section ladder and pass down the tower.

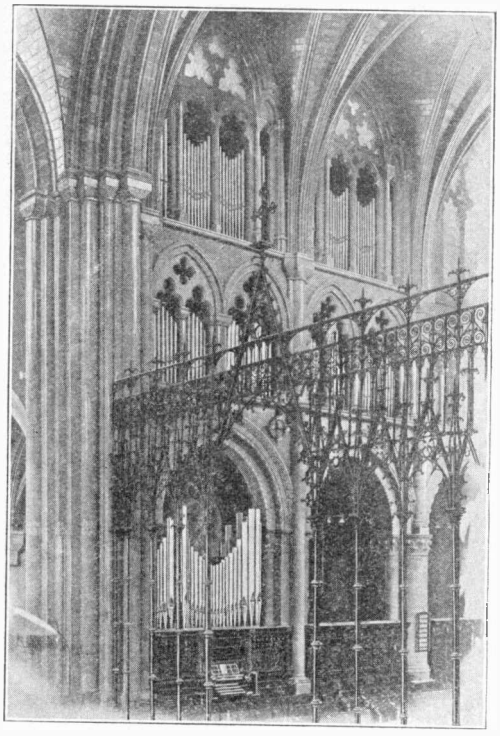
The Pipe Organ Revolutionized by Electrical Control

BY JOSEPH B. BAKER

The modern organ is a very impressive instance of scientific evolution in a musical instrument. It is a far cry from the early days, when the proposed installation of a "Kist O' Whustles" to accompany the hymns of Scotch worshippers threatened to disrupt the kirk, to the modern electric organ, with its forest of pipes, vast range of tone quality and special musical effects. And the difference is one of the many triumphs of that subtle agent, electricity.

All organs, large and small alike, were formerly operated by mechanical or pneumatic devices, connected to the keyboard by systems of levers. In large organs the complication and clumsiness of the mechanism was immense; long trains of levers and rods to sound the pipes, to couple the different stops or sets of pipes, to operate the swell organ, etc. The weight and friction were so great that the player, even when physically a strong man, could not move the keys when the full organ was coupled up; so that although the impressive equipment of pipes and stops was there, it was largely useless. The great organ in the old Boston Music Hall was practically unplayable for this reason.

The first large organ in which these difficulties were overcome was the electro-pneumatic organ at the Garden City, N. Y., cathedral, given by A. T. Stewart thirty years ago, and built by Hillborne Roosevelt, a cousin of the ex-President.



MODERN PIPE ORGAN WITH ELECTRO-PNEUMATIC ACTION

Since that time, the electro-pneumatic system has made great strides, and the latest large organ to be built on that principle, the magnificent organ for the Hotel Astor, New York City, is no less a great feat of electrical engineering than a marvelously flexible musical instrument of extraordinary delicacy and power.

In the modern electric organ, the entire action—sounding the pipes, operating the stops and other movements — is accomplished by electricity as the controlling agent, with the "wind" (compressed air) as the motive power. In many organs, "blowing up" the wind is also done by an electrically operated blower. It is in the electro-pneumatic organ action that the greatest improvement has been made. Instead of the clumsy keys, stops and levers of former days, moving ponderous mechanisms by main strength, the player now finds his console equipped with an orderly profusion of keys and buttons, that call forth perfect response to his lightest touch. Where formerly the player had to work like a steam engine, not only to make the rapid changes of stops, etc., in rendering difficult musical passages, but even to play on the keyboard when a massed tone was required, he now finds that he can make all necessary changes instantaneously with a touch of the finger, and can play the full organ with absolutely no more effort than that required to play with a single stop drawn.

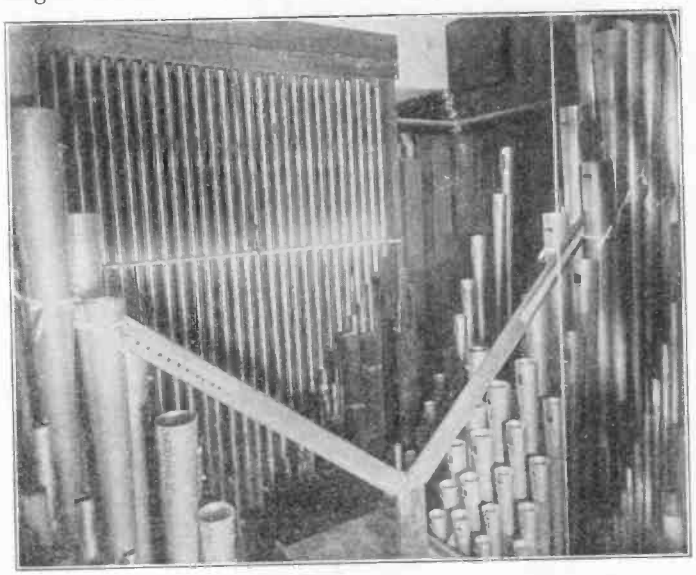
CONSOLE OF A MODERN PIPE ORGAN

The Hotel Astor organ, already mentioned, consists really of four separate organs or divisions of pipes, installed in different parts of the new ballroom, operated from any one of three separate consoles or keyboard arrangements. Each console has four keyboards or "manuals" and five groups of stop-keys for the swell, great, orchestra, pedal, and solo organs, all within easy reach. The organist can put down a number of stops at once during the execution of a difficult passage, by pressing a single "thumb-piston," of which there are several on the console adapted to the different combinations. Pressing a release key puts all the stops back to normal. Other push-keys are provided to connect and disconnect the other consoles, to put on the tremolo effect, etc. Owing to the electrical control, the action is so rapid and positive that the shortest staccato fingering on the keyboard calls out perfect response from the organ. Thus, feats that were impossible by mechanical or by tubular-pneumatic organs—such as flicking the keys with the fingers to get special tremolo effects—are easily executed on the electrically controlled organ.

The entire console contains nearly two hundred stop keys, pistons and combination pedals to be controlled by the organist in addition to the fingering of the keyboard. Truly he has his work cut out for him, to manage all this equipment! But the perfect electrical control encourages the rendering of the most brilliant passages, which were hitherto entirely out of the range of organ playing.

Any one of the separate divisions can be used as an "echo organ," and each is equipped with "swell blinds"—operated by an electrically controlled pneumatic engine inside the wind chest—to increase and decrease the loudness of the tone. An incidental advantage of electric operation is that the console need not be located in front of the organ proper; it can be placed anywhere in the auditorium, and connected to the organ by a cable of wires.

The "cathedral chimes" which forms a part of many modern organs, really consists of a set of metal tubes of different lengths, struck by felt covered hammers, electrically actuated from the keyboard. The tone emitted is a perfect imitation of distant church bells; and the organist is able to play practically a church-bell accompaniment to his theme. The responsiveness of the chimes to the pressing down of the keys is a trifle slower than the response of the



ALL THESE PIPES RESPOND TO THE LIGHTEST TOUCH

speaking pipes, on account of the inertia of the hammers.

One of the most impressive parts of this organ is the blowing machine. With the "bellows" formerly used, it was impossible to obtain the constant wind-pressure needed; because sounding the big pipes, or a large number of pipes at once, made the pressure fall off so as to balk the organist's best efforts. In the Astor organ, the main blower is a turbine fan arrangement, giving a sufficient wind pressure with plenty of volume of air, and operating almost noiselessly. The blower consists of a wind-tight casing containing a series of turbine fans, driven by a 20 horse-power electric motor, and with large "wind-ways" running from the basement, in which the blower is located, to the wind chest.

The wind chest is the principal part of the main organ division and serves not only to make the pipes "speak" when the contained wind is allowed to enter them, but as a location for the entire organ action. It is really a good sized room, and may be entered while the organ is being played, through double doors constituting an air lock without disturbing the music. Thus the mechanism may be inspected while it is being electrically operated on the console, and any necessary adjustments or repairs made under actual working conditions.

In the wind chest is an electric distributing board, to which the wires from the console are brought into systematic order, and from which run the wires to the many different electrically operated primary valves. When the organist presses down one of the notes on this keyboard, he thereby closes a platinum-iridium electric contact, causing a current to flow along one of the wires entering the wind chest and pass through a little electromagnet. The energizing of this magnet lifts a tiny disk valve, which, by allowing a little wind to escape through it, serves as a sort of "relay" to release a larger amount of wind. The feeble electric impulse coming from the key is thereby made to call into instant action the full pressure of the wind as a motive force to effect any desired mechanical movement. In the case mentioned, pressing down the notes makes the pipe speak as promptly as though directly connected to the key—but with no effort on the part of the organist beyond a light pressure of his finger. In the same electro-pneumatic way, the different stops are actuated, the swell blinds moved, etc.; the electricity serving only to control the real motive force, i. e., the wind pressure that sounds the pipes.

The making of the organ pipes is an art in itself. The pipes are made of metal or wood, various metals and alloys being used to obtain particular tone qualities, and there being a wide variety of sizes and shapes. The pipes in the Astor organ run all the way from a tiny pipe three-quarters of an inch long and three-sixteenths of an inch in diameter, giving a note of exceedingly high, shrill quality within three notes of the upper limit of human hearing, to a 32-foot height, large enough for a man to crawl in and giving a very deep note which is so near the lower limit of hearing that it shakes the ear drums and the whole building with its pulsations when sounded. The length of a pipe is measured from the mouth, where the sound is generated, to the adjustable "tuning-point" at or near the top end of the pipe. Some pipes have two openings, one on each side, giving improved quality and amplitude to the tone. Wood pipes, like the bodies of violins and other string instruments, are glued up, without using any nails or screws. The gluing requires special care, and is done in a hot room, to prevent any possibility of the glue becoming chilled.

In the modern organ, classic compositions may be rendered in a manner unheard of hitherto except from a full orchestra. Indeed, the organist seated at his keyboard is in the strategic position of the conductor of an orchestra. The organ stops are his players, each in his own proper gamut—sixty or one hundred of them or more, from piccolo to tuba, with a harpist and the chime of church-tower bells thrown in—all playing in perfect unison. Electrical control has made all this not only possible, but physically easy. It is safe to say that the application of electricity to organ operation has revolutionized this noblest and grandest of musical instruments.

Talks With the Judge

"What's the use of having two kinds of electric current and what's the difference anyway? They're always talking about direct current and alternating current, 110 volts a. c. and 110 volts d. c. and all that sort of thing. Electricity is hard enough to understand without having two kinds of it. Why don't they make just one kind and let it go at that?" The Judge was in a somewhat petulant mood and it almost made him angry—this question which has puzzled so many.

"To tell you all the reasons why direct current is used for some things and alternating current for others, the differences between them and how they are generated and utilized would be a greater task than I would care to undertake, Judge," I said. "But perhaps in a few words I can enlighten you sufficiently so that you will not lose any more sleep over the matter."

"As a general statement it may be said that direct current flows continuously through a circuit in one direction while alternating current reverses the direction of its flow many times per second. Of course this does not explain much more than the names imply, but electricity being a form of energy which cannot be sensed it must be assumed that there is a 'flow' of some kind in order that we may explain the action of the force of which we see only the effects.

"Electricity as generated by a dynamo is in reality all alternating in character. The coils of wire which go to make up the armature, as it revolves, have current generated in them in one direction as they sweep across in front of one magnet pole face. The next pole being of opposite polarity, when they pass in front of it they have current generated in them of opposite direction. The theory is that the current is generated by the wires 'cutting' the invisible 'lines of force' which flow from one pole to the next of opposite sign. You can readily see, therefore, that the current in the wires of the revolving armature reverses in direction a certain number of times per second, governed by the speed at which the armature revolves and the number of poles in the machine.

"As stated above, the current generated by an dynamo armature is alternating, and the common alternating current generator or alternator is the simplest type of dynamo. Strange as it may seem, however, in the very beginning of dynamo construction a more complex type was built and is used up to the present time; namely the direct current generator which gives unidirectional current. Such a machine is simply an alternator fitted with what is known as a commutator. The commutator consists of a number of copper segments insulated from each other and mounted on the armature shaft. The number of segments corresponds to the number of coils in the armature and to them the latter are connected. Brushes of carbon bear on the segments above and below and are connected to the external circuit. Being so arranged, one brush collects the current, from each of the passing segments, which is flowing in one direction, and as the segments pass on around and the current reverses the other brush is there to collect it, so each brush is constantly carrying current in one direction, therefore we have direct current flowing out over the line from one brush and back on the other side of the line to the other brush."

"Well, what's it all for?" said the Judge, "Why do they use the two kinds?"

"For a number of reasons," said I. "Where the current is to be transmitted any distance, say over half a mile, the alternating current is best. This is for the reason that it is more readily stepped up and down in voltage, by means of simple static transformers. Wires present a certain resistance to the flow of electric current, the same as water pipes do to the flow of water. To force the current through them for any great distance requires very high pressure or voltage—either that, or you must have very large wires, which are exceedingly costly. Therefore, where the current is to be sent a long way as to the outer portions of a large city, it is customary to make alternating current, step it up to high voltage by transformers, transmit it over a few small wires to substations located in the outer zones and there step it down in voltage

for use in the homes of else to feed other still smaller transformers where it is still further reduced in pressure for the use of the consumer at the usual 110 volts. But the current all the time remains alternating. That is why the current in your home in the residence district is alternating."

"Where does the direct current come in?" was the next question.

"Now-a-days for lighting and power service only in the most congested portions of our large cities. In a city like Chicago, for instance, in and about the "Loop District," current is used in such vast quantities within the radius of economical transmission by direct current that it is there largely used. It is brought there as alternating current from distant power stations and made over into direct current and fed into a great network of wires and cables all interconnected. This network is a very advantageous thing to have where the quantity of current used is sufficient to warrant it, as it is an easy matter to connect the motors and lamps to it anywhere at any time, and it being all interconnected if any substation or feeding point pouring current into it should break down, other substations carry the load. Such a network all over the city would, however, be out of the question owing to the great cost of copper.

"Direct current also has other specific fields. It is used almost entirely for electric railway work, owing to certain inherent advantages of direct current motors for street car service. For charging storage batteries, also, only direct current can be used.

"So, after all, you see direct and alternating current are not so very different. Alternating current plunging first one way and then the other, back and forth through the filament of an incandescent lamp will heat the filament white hot. So, too, will direct current which flows steadily on in one direction. The reversals of the alternating current being so rapid, commonly 120 reversals of 60 complete alternations (60 cycle current) per second, the heat in the filament does not have time to die down perceptibly between times so the lamp glows steadily. Motors of two kinds, direct and alternating current, are constructed to utilize these two kinds of current. Which kind of electric current it is best to use, as explained before, is determined largely by economic conditions."

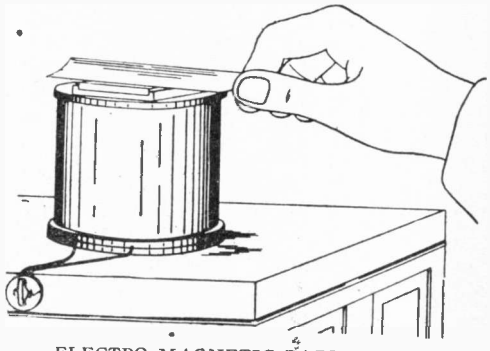
Lightning Conductors Used by the Ancients

The suggestion of Georg Ebers, made in a novel some years ago, that the Egyptians made use of lightning conductors, is sustained by a writer in the Elektrotechnische Anzeiger with many incidents to show that electrical action was not unknown to the ancients, and that Georg Ebers' suggestion is well founded.

The temples, he says, were protected by lightning rods. The Biblical descriptions of these temples show that the roof was provided with metallic points, held aloft by columns, and that these points, ending in chains, terminated in a great water tank. He adds: "All of which is vouched for in the First Book of Kings and the Second Book of Chronicles."

Electro-Magnetic Razor Hone

A very clever device that will be appreciated by every man who has tried to hone his own razor, is the electro-magnetic razor hone, invented by a Los Angeles barber. The idea is simplicity itself, as would of necessity be the case, for the inventor is no



ELECTRO-MAGNETIC RAZOR HONE

electrician. It consists of a coil of insulated copper wire (about four pounds), a core of Norway iron and directly above the latter a shallow groove which receives the stone; an ordinary hone.

The coil is connected with an electric light fixture and uses about as much power as an eight candle power incandescent bulb. When the current is turned on, this magnet holds the razor blade steadily to the grinding surface, overcoming the tendency of the thin, elastic edge to spring away from the hone.

Window Lighting Suggestions from Paris

By EMILE RUEGG

The photographer's ambition is always to produce a picture which will flatter the real object. The same is apt to be true of the window trimmer's ambition. He wants to give his objects an effect which will make them appear to the onlooker as if they are worth at least twice as much as they really are. This is what we call the art of creating a desire.

How may we arrive at the best results? There is at present much lack of originality in electric window lighting owing to the fact that the art is comparatively new. I am now alluding to the arrangements of the electric bulbs which, in many cases, are simply fixed all in a row, like a crown all around the frame of the window.

It is quite evident that the glaring lights are almost blinding the eyes of the passers-by. The storekeeper notices, also, that the objects are not properly illuminated and he goes to work and exchanges the 16 candle lamps for 32 candle ones. The result is, as may well be thought, far worse than if he had reduced his lamps to half.

Some one found out the true effects which such an arrangement produces and provided a reflector for each electric lamp, thus reducing the glaring effects considerably. This indirect or screened illumination is therefore now quite common.

But we are yet far off from artistic illumination. Now that we have found the true principle of artificial illumination, namely indirect illumination, we are prepared to enter into the real thing, i. e. the study of harmony in the colors. The French people are naturally of an aesthetic nature and in Paris especially have advancements been made in artistic window lighting.

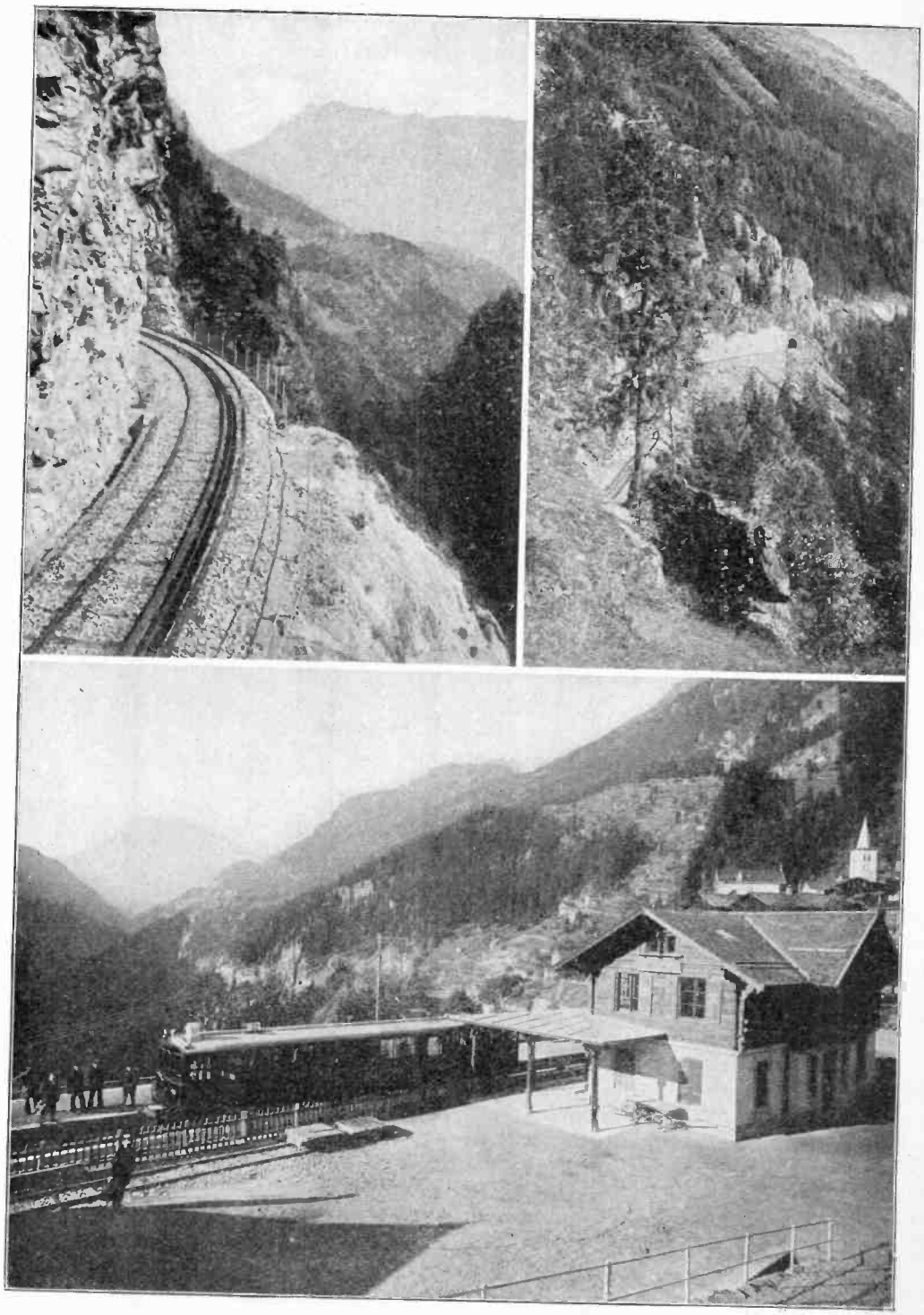
Let us take an example in order properly to illustrate how we can produce real artistic effects with very little effort. We have a dark window case, into which we place three objects: a cluster of blue flowers, a nice fern and a cluster of yellow flowers, say chrysanthemums. The fern we place in the center, the blue flowers to the left and the yellow ones to the right. Let us now arrange two lamps of two colors in such a way that the lamps are quite invisible to the eye. A blue lamp we place in front of the blue flowers; a yellow lamp we place before the yellow flowers. By observing these rules it will be found that the blue flowers appear strangely blue and the yellow flowers wonderfully luminous. The yellow and the blue together produce green rays which are thrown on the green fern, thus giving to it the most delicate hues of softest green. If we wish to expose a flower pot with purple flowers we need only place it next to the blue flowers, adding a small red lamp in front of the flowers, so that it is invisible to the eye of the observer. With some leaves or artistic cardboard we shut out the red rays which would spoil the soft green enveloping the fern. Thus, with the proper knowledge of color mixing, which, by the way, should be in possession of every window trimmer, it will be possible to arrive at the most wonderful showcase and window trimming. And this is the true art of creating a desire in the minds of the onlookers, by so arranging the articles that they appear as if they were seen in subdued sunlight.

Crowding should ever be omitted and a rich and pleasing effect will never be produced by exposing so many things in the same window that the eye gets tired to find them all.

The up-to-date business man needs to study the psychological make-up of the bystander who shall be his future customer. Beautiful music will arrest the attention of the musical people, while banal heart rending music will attract the vulgar. In order to get the customers one wishes to acquire it will suffice to present the things according to their various tastes.

But at all events it will be of the greatest importance to have the goods so exhibited that they produce the utmost results, which again may only be arrived at by means of artistic arrangement of the electric illumination.

The study of stage lighting as shown in the theatres can hardly be recommended too strongly, for there you will find the objects and subjects so illuminated that they produce the utmost effect. And never will you there see glaring lights in the scene, even if lamps are used on tables, etc. They are all supplied with shades so that the lamps themselves may not be seen directly.



SCALING MOUNTAINS BY TROLLEY

Scaling Mountains By Trolley

From Martigny to Chatelard, in France, an electric railway line has recently been built which is wonderfully interesting on account of the boldness of its track construction and the beauty and variety of the scenery which is to be enjoyed along its course. As far as Vernayaz it follows the side of the mountain, now bordering precipices, from the depths of which can be heard the noise of torrents, now winding amongst pastures or gliding beneath the shade of forests of larch.

There are on this mountain electric railway a number of summer resorts much frequented by tourists. They include Finhaut, the terminus of the line, located 4000 feet above the sea level, from which place one enjoys a magnificent and extensive view over the Glacier of Trient as well as Le Trientien which is suspended, as it were, from the steep slopes of the mountain; also Les Marecittes, a small village of picturesque chalets, a central attraction of the various excursions, and finally Salvan, the last station in the valley.

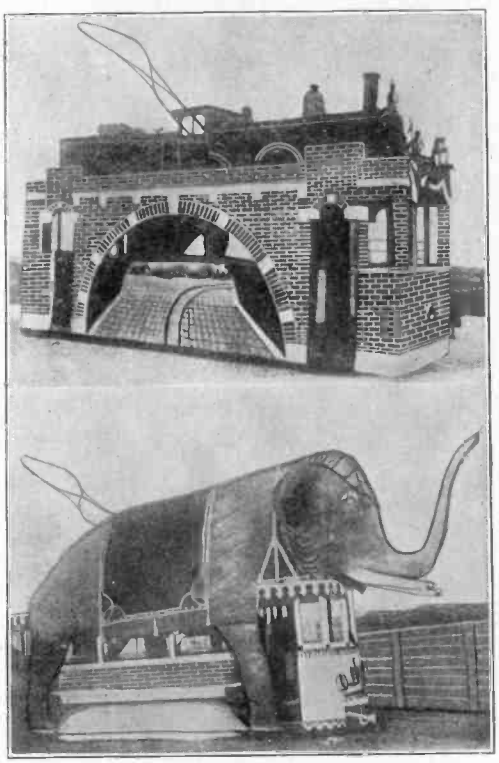
It is held that the most magnificent and boldest part of this mountain electric railway is found between Finhaut and Le Trientien. The line, which has been cut through a partition of very steep rocks, overlooks the deep gorges which have been hollowed out by the Trient. Shortly after leaving Salvan the slope of the railway line becomes accentuated, and reaches a maximum slope of 1 in 5, and the descent to the valley of the Rhone, which is overlooked by the line, is very impressive and thrilling.

After having traveled through a number of tunnels and over the Viaduct of Vernayaz, the embankment is passed, the train has descended from the mountain to the plain and at Martigny, the travelers from the Martigny-Chatelard railway alight on the platform of the Federal railway where they find direct connections in both directions to points in Switzerland—down the valley to Lausane and Lake Leman and up the valley towards Sion, Brigue and the Simplon Tunnel into Italy.

The line has a total length of about 13 miles, but in this comparatively short distance there are 33 viaducts and 13 bridges. For operating the trains power is supplied partly by overhead trolley wire and partly by third rail. Both the ordinary trolley car and the electric locomotive are used. The former are capable of carrying a load of 15 tons each and easily climb the 20 per cent grades at a rate of 10 miles an hour, being supplied with motors aggregating 240 horse power to each car.

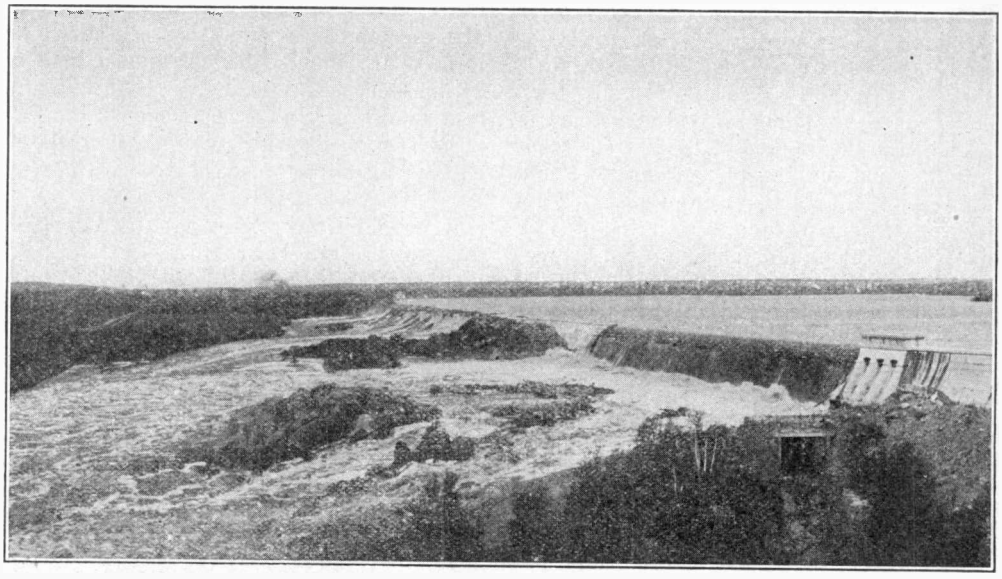
Street Car Novelties in The Hague Celebration

On the recent birthday of Queen Wilhelmina of Holland the electric railway company operating in the capital, The Hague, equipped some of its cars in novel and grotesque forms and got up a sort of



STREET CAR NOVELTIES

electric car parade. One of the cars was fitted up to represent a huge elephant. Another showed a locomotive crossing a bridge. In addition to the two shown there were a giant automobile, Chinese tea house and a Dutch bakery for wafers. These were all run as electric cars through the streets of The Hague and presented a very novel appearance.



Electric Power at the "Head of the Lakes"

At the head of Lake Superior lie two cities which are destined to grow into one of the chief centers of wealth and population in the great northwest if not in the whole country. They are Superior, Wis., and Duluth, Minn., with present populations of 45,000 and 85,000 respectively. While separated by the St. Louis river, and lying in different states, they are one in all essentials.

In going to them by railroad one passes through miles upon miles of a region profoundly desolate—the old pine barrens. Years ago every tree of the virgin forest was sacrificed to the lumber trade and their places are now occupied by a dense mass of second growth. Suddenly, and without warning of coming activity, the train leaves this labyrinth at the very door of these two great cities and we plunge into all the hurry and bustle characteristic of western metropolitan life. Here are the greatest coal and ore docks in all the world. Close by to the west and northwest, in Minnesota, lie three iron ranges with a hundred years' supply of the richest ore. Into Duluth harbor, one of the finest natural harbors in existence, come great steamers, surpassed in size by few ocean going ships, bringing coal from far down in the Pennsylvania regions, at ridiculously low rates as compared with railroad transportation. From here much of the Northwest secures its fuel supply. These same ships then go back down the lakes laden with ore for the smelters of the East.

These twin cities lie, therefore, at a focal point in the natural route of commerce between the East and the West and constitute a distributing point for the rapidly growing population of Minnesota, the Dakotas and states farther toward the coast, and their future greatness seems assured. As one of the leading citizens stated: "The only unknown factor of the future is not whether we will one day grow rich and populous, but when? Will it come as a heritage of those now living? We think it will."

Duluth lies just under the lip of a vast plateau, several hundred feet high. Miles back up in this elevated region is a water supply capable, with proper dams and canals, of furnishing electrical power second only in magnitude to that of Niagara. Years ago a plan of great scope was made to harness all of this power but it was found that the power so developed would be far greater than the requirements of the two cities then or for a long time to come. Some day when the methods of electrical smelting of ore have been perfected we may see this power all developed and iron and steel made electrically at the "Head of the Lakes" cities.

In the meantime the Great Northern Power Company has built on the St. Louis river a great dam and hydro-electric plant which is more than ample for the present needs of the two cities. A service reservoir with a capacity of 130,000,000 cubic feet has been built on the river 17 miles from Duluth. The river is by-passed from this reservoir to the power station 2.8 miles down stream in a direct line. This by-pass consists partly of an open canal and partly of pipe lines.

In the power house are 13,500 H. P. vertical, reaction turbines among the most powerful ever put in commission. Carried on the shafts of these turbines are 7500 kilowatt electrical generators delivering three phase current at 6600 volts which is carried to transformers which raise the voltage to 30,000 volts for the transmission lines.

Four-legged steel towers support the two transmission lines which end in a substation in Duluth. Here the current is stepped down in voltage for use in the two cities, all the electric light and power of both Duluth and Superior being taken from these lines.

Machinery is at present installed in the plant capable of developing 30,000 horsepower, 15,000 of which is now in use. With reasonable additional expense, the capacity of the plant may be increased to 60,000 horsepower.

Though it is not possible here to give a technical description of the plant, there are many features about it which are of interest to the layman. For instance, it develops the greatest amount of power per square foot of station area ever attempted in a water power plant.

One of the cables is laid across the harbor to Superior, in a trench dredged 30 feet below water line, or eight feet beneath the keel of the deepest laden ship that can pass the Sault River, either now or during the continuance of the present government plan for the improvement of the Lakes.

The electrical equipment is very complete. In the wiring scheme for the power stations, all connections between the busbars and the units are made through motor operated oil switches, all arranged for distant control from a benchboard placed on a gallery that gives the operator unobstructed view of the main units. All low tension wiring is insulated and carried in conduits laid in the floors, while all high tension wiring is bare and is hung on insulated supports in brick compartments. Throughout the scheme each set of unit wiring can be carried through any transformer and to any one of the transmission lines, and this plan will be continued as the number of units is increased to a maximum.

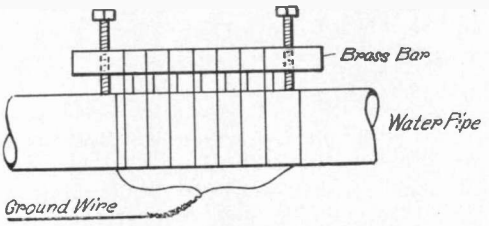
A telephone line from the substation to the power station is carried on the towers of the transmission line. The instruments on this telephone line are set in booths mounted on insulators, these booths also being entered from an insulated platform.

To excite the fields of the dynamos there are required two 250-kilowatt direct current dynamos—large enough to furnish all the current needed by a town of several thousand inhabitants.

This in a brief way describes one more of the thousands of water power electric plants that are producing current to aid in the building up of cities and industries. Every year the number increases, thanks to the perfection of high-tension transmission methods, fortifying us against the day when our natural legacy, the coal beds, will be no more.

Ground Clamp

A ground connection which does not require soldering is shown in the sketch. To make this clamp obtain a brass bar about one-fourth of an inch square by two inches long. One-fourth of an inch from each end drill and thread a hole to fit a bolt. Scrape the insulation off from your ground wire for



GROUND CLAMP

about 18 inches and wind it several times around the water pipe and the bar as shown. The bolts may now be lightened until the wire is taut and it will be found that this will give an excellent contact between the pipe and ground wire.

Electric Welding

By L. RAMAKERS

Electric welding was one of the first applications made of the voltaic arc, but it is only recently that it has assumed real practical importance, and now the use of it is increasing from day to day.

In 1881, Siemens, after having made several experiments with copper wire of from two to three millimeters in diameter, was struck by the degree of mechanical resistance of the welded points, which resistance very much exceeded that of other welds known at that time. Some years later, in 1887, the researches of Ries led to other new and interesting developments, and finally, in the same year, Joule established the rules of welding by electricity. It is from that time that are to be dated the really valuable experiments for the practical application of this process in the industries. The methods of use may be classed in two distinct categories: the first one being due to Elihu Thomson, consisting of a practical utilization of the Joule idea, while the second one, based on the judicious application of the high temperatures produced by the voltaic arc, is due to Bernardos and Slavianoff.

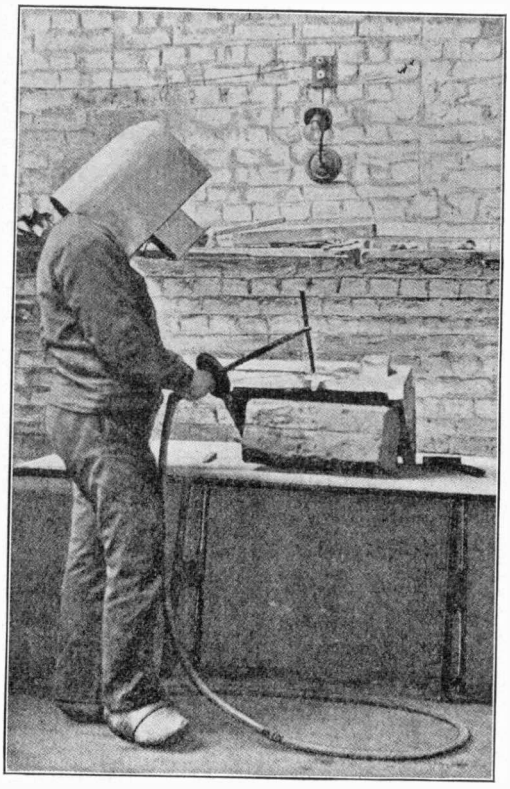


FIG. I. THE WORKMAN IS PROTECTED BY A MASK

The first method, known under the name of welding by incandescence, consists essentially in placing against each other the pieces or parts of pieces to be welded. The circuit is thus closed, and a current is made to pass through the pieces, of sufficient intensity to bring the metal to the temperature desired. The welding is then effected by pressure, by bringing close together the parts to be welded. As a matter of course, the intensity of current necessary for these operations varies with the volume and structural nature of the pieces to be welded; but it is always very strong. The advantages of this system are the regularity of the work and the total absence of danger to the operator. Finally, the metal is neither injured nor modified in its interior structure. But this method requires, for each kind of work, special arrangements or machines, all of which are more or less complicated.

The second method, which uses the heat of the voltaic arc, has the disadvantage of modifying a little the composition of the metal, by melting it. But this gives occasion to remark that this very fusion enables one to give to the metal any form desired at any given point whatever in the piece to be treated. On the other hand, the voltaic arc of high intensity produces physiological effects that cannot be passed by in silence. It can cause real attacks of insolation (or sun-stroke), while it has a very bad effect on the eyes. The painful effects resulting from this cause increase with the length and duration of the arc. These objections can, however, be avoided. It requires only to protect the workman by colored glass, and to save his face and hands by means of a mask and gloves of leather.

It is necessary, also, to avoid the danger of ophthalmia among the men engaged in the work of welding, by preventing the simultaneous presence of lights of different intensities in the workshops. Therefore, the metallurgical establishments in which there are several welding plants, install these plants in separate places, where pains is taken to diffuse the light in a regular manner. The welding rooms must also be well ventilated.

In the two general methods just described, use may be made either of a continuous current, or of an alternating current; the latter, of which the calorific power seems to be

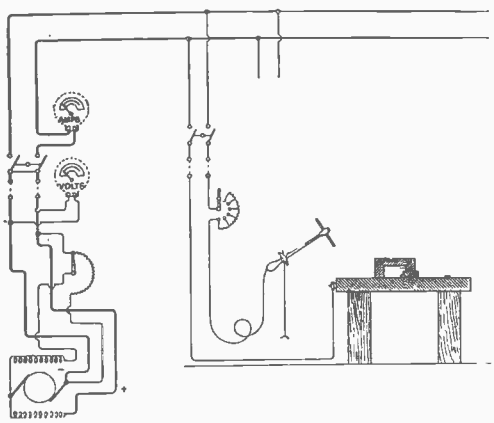


FIG. 2. ELECTRIC ARC WELDING EQUIPMENT

the higher, is usually preferred in the process of welding by incandescence.

PROCESS OF WELDING BY INCANDESCENCE

The number of applications of this method is quite considerable. Each one of them requires a special apparatus, but we will limit ourselves to describing the general principle of operation. It has been applied to the welding of railway rails, of projectiles, of boilers, to the fitting of carriage steps, to the welding of axles, the spokes of locomotive wheels, etc., etc. Its use is recommended generally, only when it is a question of welding pieces which cannot be allowed to suffer more than a slight deformation during the operation. All the metals, including bismuth, antimony, magnesium, brass and even aluminum have been welded by this process.

The surfaces to be welded must first be scoured off very carefully; then they are prepared by sprinkling over them borax or some other flux, so as to obtain a contact more or less perfect, which contact constitutes of itself the principal electric resistance of the circuit. The heat produced by the passage of the current through this resistance varies, therefore, according to the degree of resistance offered. It will vary according to the pressure exercised on the pieces to be welded, which pressure is obtained either by means of springs or by regulating the screw of a vise.

As we said above, the alternating current can be used as well as the continuous current. Facility in procuring either one or the other will then decide as to the choice to be made. At any rate, in case of the application of the alternating current, it will always be preferable to use one of low frequency so as to diminish as much as possible the effects of self-induction in the large conductors.

The process of welding is employed principally in England and in America, in wire-mills, where by this method several thousand weldings may be effected each day. Weldings are made there, for example, of iron bars 29 millimetres in diameter, in two minutes and 15 seconds, or about one-half the time it would take good blacksmiths to obtain the same result in the ordinary way. An idea may be had by this example, of the advantages of the application of this process in certain cases.

WELDING BY THE ELECTRIC ARC

The piece to be welded is itself used as an electrode, and the arc springs from a carbon stem, or from a stem of the same metal forming the end of the conductor, and which constitutes the second electrode. Ordinarily, for working with iron and steel,

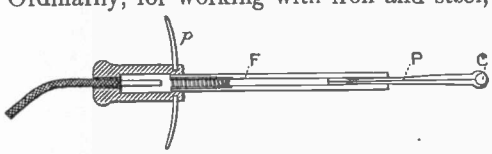


FIG. 3. WELDING TOOL

the carbon is attached to the negative pole, while for other metals, it is attached to the positive pole.

Let us take, for example, the case of a piece of casting in which there is a hole which has to be filled up. If use is made of carbon, there are first placed, at the spot where the welding is to be effected, a lot of little iron shavings, or chips, these being

covered with sand or some other soldering powder. The use of such a powder may frequently be dispensed with, as the vapors of the metal themselves form an atmosphere that answers the same purpose. The iron chips are melted by establishing between them and the carbon, an arc previously produced by direct contact. At the moment when the workman sees that the molten metal has become well attached to the surface of the piece, he cuts off the current and begins a rapid hammering. If the metal itself is used as a solder, the method of work is the same, but it is the electrode which melts and fills the cavity.

The electric connection consists simply of two cables of sufficient diameter, one of which ends directly at the welding table, and the other, passing by an ammeter and the regulating rheostat, conducts the current to the welding apparatus (Fig. 2). This latter consists of a block of carbon or of metal (C) held in the jaws of the pincer (P), this being conical and having contact with the interior of an iron tube (F) (Fig. 3). The tube has a threaded end furnished with an eyelet of a special form, upon which the conductor is soldered; a wooden handle furnished with a spark protector permits of the easy handling of this apparatus without danger. The carbon on the metal stem (C) constituted one of the poles of the circuit.

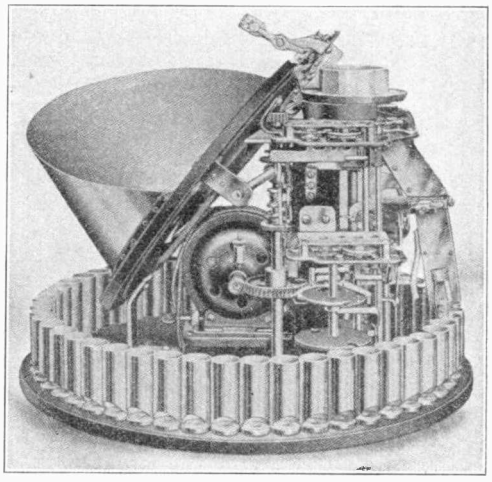
The table on which is placed the piece to be treated, consists of a block of iron or of casting, having sufficient surface for the purpose, at which block ends the second cable of the circuit, and of which it forms the second pole (Fig. 2). The outfit of the operator is completed by a leather helmet supplied with smoked or colored glass, to protect his face and his eyes, as seen in Fig. 1.

The workman charged with correcting a defect in the casting of a piece of steel, for instance, places the piece to be corrected upon the welding table. By means of the carbon soldering (or welding) iron, which he places in direct contact with the piece to be welded, he brings out the arc, which he causes to move all around the defective spot, so as to heat to the proper degree the surrounding metal. Then taking in his left hand a bar of iron or of soft steel, he thrusts it into the arc, thereby producing a fusion of the iron, which rapidly fills the spot to be concealed. Iron can thus be employed as a welding medium; it is from the iron, in this case, which divides the arc, the temperature of which causes the melting of the movable electrode, that the necessary metal is taken for the filling up of the fissure.

This operation, carried out with a movable electrode, either of iron or of carbon, requires no more than two minutes for the correction of defects of considerable importance.—Translation for Popular Electricity from La Nature, Paris.

Counting and Packing Coins Automatically

Connect the motor of this almost human machine to the nearest lamp socket, set the indicator to the count and package denomination required and pour the coins into the hopper. Then electricity does the rest and the coins are turned out, correctly counted



COUNTER AND PACKAGING MACHINE

and neatly wrapped in packages. The machine is small, being only 20 inches in diameter and 16 inches high.

There are two registers, one counting from zero up to 10,000, the other from 10,000 down to zero. These are patented counters, so constructed that any or all digits can be set at zero instantly. With these registers any method of checking accounts of collectors, conductors, depositors, cashiers, etc., can be easily devised, the machine acting in the double capacity of bookkeeper and money packager simultaneously. There is only one handling of the coin from time it is delivered until deposited, and all is absolutely accounted for with no chance of error.

Is Electricity the Energy of the Universe?

By J. J. SANDERS

That we shall some day understand a great deal more than we do now of the ultimate particle which goes to make up all matter, and of its relation to that mysterious form of energy which we call electricity, is presumable. And that when knowledge along this line has been sufficiently extended, our present day methods of applying energy to the accomplishment of work will seem ridiculously complicated, is also well within the bounds of possibility. Mr. Sanders is not alone in this belief, for many of the foremost scientists and thinkers of today are working at the problem. Although some may pick flaws in his theory, it is nevertheless interesting, and shows the trend of modern thought.—Editorial note.

The great congress of the British Association for the Advancement of Science held in Winnipeg, Manitoba, recently, has accepted as a fact the electron is the smallest particle of matter. Nearly all of the great scientists of Europe and America were there in attendance. The fact that the electron is the smallest particle of matter, the elementary corpuscle from which everything in the boundless universe is formed, was so stated by myself in an article in a local paper published in the month of May, 1907, about two and one-half years ago. I arrived at this conclusion by one line of experiments, the congress of scientists by another.

With the knowledge that the electron is the elementary corpuscle that enters into the formation of everything that we know in various combinations, there can be readily seen by anyone of average intelligence the possibility of man being able to manufacture all of his necessities out of the raw material, electricity.

You may ask, What is the electron? Our solar spectrum reveals several thousand separate and distinct lines representing every shade of color imaginable from the red to the violet. Each of these lines represents a line of elementary corpuscles of matter. Certain of these lines in innumerable combinations form everything in our solar system, including plant, insect, animal and human life. Our white solar light is a complete compound containing all of the elements.

Theodore Roosevelt during the term of his presidency called a conference of the governors of all of the states, including many representatives, senators, diplomats, statesmen and scientists, for the purpose of devising means of conserving the natural resources. Strange as it may seem, there was not a single man in that great gathering who expressed an opinion concerning the great natural resources of the universe.

The day is near at hand when the solar rays will be converted directly into electricity, furnishing power, heat, light and the raw material from which all human necessities will be manufactured. When man succeeds in converting our solar rays into electricity, the future of the fleets of the air will be assured; not only this, but with this knowledge he will learn to apply mechanically the natural laws of attraction and repulsion to his aerial craft, the laws that govern the movements of all spheres in space; then we will have Cooks innumerable exploring the distant worlds.

Everything radiates energy in a greater or lesser degree; this energy is carried through space, from sphere to sphere, by means of fine ethereal lines. The whole universe has a nervous system, the same as you and I, that carries the energy through all parts. Light is not hurled through blank space, as many think, but is carried on fine ethereal lines as electrical energy, and as it meets the resistance of the denser atmosphere it forms light the same as the electrical energy passing over metallic wires meeting the resistance of the carbon filament in the incandescent bulb forms light.

Our sun is not a blazing ball of fire as many astronomers think. All spheres are formed under the same unchangeable law, consequently the surface conditions on all must be the same, atmosphere, liquids and solids in this order of density until the center is reached. The interior of the earth is two and one-half times denser in its central makeup than any solid that we know of on the surface. If each planet and sun were a perfect ball, the surface conditions would be atmosphere and water, but owing to great

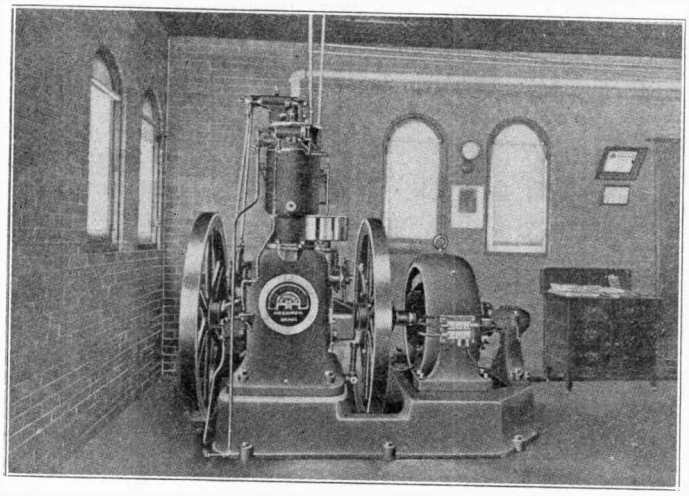
upheavals great bodies of solids rise above the water as continents and islands.

Each sphere radiates energy in proportion to its immensity. The greater the sphere, the greater it radiates energy. Many savants seem to think that man could not exist, that is man from the earth, on Jupiter or the larger spheres, because of the greater attraction of the law of gravity; and they also think from the lesser attraction, by this same law, that he would step around on the planet Mars like a hop toad. This idea is erroneous and will not bear investigation.

The law of gravity operates with equal force on the surface of all spheres of any magnitude. What is this law of gravity? It is the law of density; the law of attraction; the law of affinity. We are made up of surface matter, hence we have an affinity for the surface matter and the surface matter has the same affinity for us.

Electric Lights for the Country Home

Along with the farmer's telephone and his automoblie comes the desire to have electric lights and electric power on the farm. In summer resort hotels and summer country homes electric current is also practically a necessity. To fit such cases as this and for use anywhere that the regular central station current is not available small electric generating units are now made which are run by gas engines. It wasn't so very long ago that the gas engine was not suitable for driving a dynamo because of its poor speed regulation which caused the lights to flicker so as to be of little use. But now improvements have been made in the design of gas engines which permit of their use for this purpose, and as they are easily started and stopped and no boilers or bulky fuel are required they are nicely adapted to the country plant.



TYPICAL RURAL LIGHTING PLANT

Such generating units may now be obtained in almost any size desired from a few horsepower up to thirty-five or forty, which is larger than is required for the ordinary country place. An installation of this kind is shown in the cut and is used to light a country home in Westchester County, N. Y. In this particular outfit the engine is of the double cylinder type and the dynamo is driven direct from the engine shaft.

The Gyroscope Compass

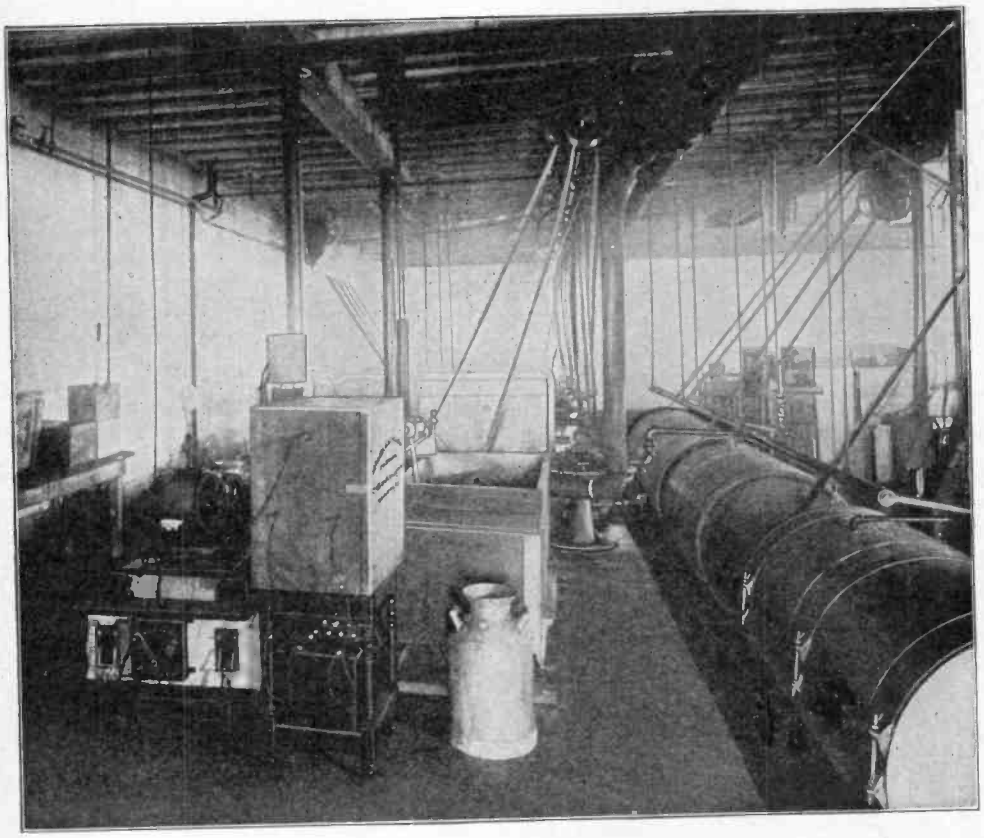
Announcement has been made that the German Admirality has decided to abolish all magnetic compasses on board German warships and replace them with the gyroscope compass.

The gyroscope compass is based upon the familiar principle that a rapidly rotating body tends to keep in the same plane, a principle which is already applied in the automatic steering apparatus of torpedoes. The compass consists of a wheel weighing about nine pounds, mounted with the usual compass card and working, in order to diminish friction, in a holder of quicksilver. A current of 150 watts is sufficient to give this wheel or top the speed of 21,000 turns a minute.

Two hours after being started the instrument is set in the direction of the mathematical meridian instead of toward the magnetic pole, and it keeps its position unchanged. It is not deflected as is the ordinary compass by neighboring iron and steel. It is unsusceptible to vibration and rolling and under all possible conditions of weather keeps obstinately true to the poles. The slight deviations resulting in different latitudes are all exactly calculable.

Ozone in Butter Making

Strange as it may seem now, the Pure Food Law passed by Congress a few years ago, did not include in the requirement of labeling all butter made from stale cream as "manufactured from stale cream." The loophole was left open and stale cream is made into butter every day all over the country, to find its way to the housewife both high and low.



OZONE PURIFIER INSTALLED IN A CREAMERY

Many creameries mix their stale cream with the fresh cream and all of it is finally made up into butter, some being good, bad and indifferent, but still all of it is consumed sooner or later.

The reason the creameries get stale cream is caused by the farmer, who now separates his milk and cream with his own separator and brings it to the railroad for shipment, or direct to the creamery, once or twice a week. Naturally cream separated say on Monday will not be fresh on Thursday when it reaches the creamery and so on through the week. Some years ago before the farmer became rich and independent, he was obliged to bring his milk each morning to the creamery at the railroad and have it separated and take back the skimmed milk. The cream in this way would reach the city creamery fresh every day and rarely ever was received in a stale condition. Now it is all different.

The creameries have tried many ways to deodorize and freshen up the stale cream which comes to them daily in this manner, so that it would make fresh, sweet butter. Several experimental stations have worked out different methods employing forced air, and after some years it was found the active

principle in the air to take up the rancidity, etc., in the cream and milk was the oxygen, and better still ozone which is condensed oxygen. This being proved without any question of a doubt, it remained for someone to take further along experiments in this line.

For some years past, since the application of ozone to dairy products was thought possible, this subject has claimed the attention of various agricultural colleges in various parts of the country. Some have advocated it while others have been noncommittal, and not until early in March, 1909, did the subject receive an impetus, sufficient to bring it to the immediate attention of several large creameries in Chicago. The stumbling block heretofore has been the generating of ozone in sufficient commercial quantities, and above all the purity of the gas to be used. Added to these conditions the application of the gas itself to raw milk, cream, etc., had been little experimented with owing to the scarcity of pure ozone gas.

A manufacturer of ozone generators of large size set about to find a solution of the problem and finally produced an electrical ozone generator adapted for the complete deodorizing and purifying of stale cream. Not satisfied with their own tests, however, they placed a trial installation in a large creamery in Chicago where a prolonged test could be made under practical working conditions, a view of the apparatus being here shown.

In sampling the raw cream in cans, where one would be encountered as being quite stale and foul smelling, it would be set aside and so on until about 80 gallons were obtained which ordinarily would be condemned as unfit for use. This was first put through the pasteurizer at a temperature of 130° F.; from there it was promptly run into the agitator and treated with ozone for 40 minutes. At the end of this period the cream was bleached and completely deodorized, the acidity being reduced from .7 to .36. After being cooled it was churned into butter grading up to No. 1. On subsequent runs the results were duplicated with the exception that in one case, through carelessness of the operator, too much ozone was taken up by the cream and the butter tasted strongly of "mountain air."

The cream subjected to the above tests varied in age from two to five days and the rancidity was pronounced. The treatment of unskimmed milk showed a large reduction in the acidity and, further, a freshened condition afterward, leaving unchanged the butter fats, etc.

In describing briefly the National ozone generator used in these tests it is as follows: An electric air pump is employed to force dry filtered air through the ozone generator. Ozone is produced in the generator by high potential discharges between specially formed electrodes. The ozone is forced through at a volume rate of four cubic feet per minute, this in turn is discharged in the bottom of the agitator varying in duration of time from four minutes to 40 minutes.

In creameries which have an output of 50,000 pounds of butter per day, the ozone generator is installed so as to discharge directly into the pasteurizer, thereby saving one operation and time consumed.

The Prodding Voice of Experience

If Professor Morse, through some miracuous means, should be permitted to again visit this world and personally inspect the paraphernalia of a modern telegraph office today, it is almost absolutely certain that he would not only pronounce the plant perfect, but probably believe that improvements were utterly impossible; yet we who have listened to the voice of long experience and thereby gained wisdom know that not a day passes during which this ever-present monitor is not heard not only depreciating, but actually finding fault with our very latest and proudest achievements. Were it not for this prodding voice the world's progress would cease.

When that historical first message, "What hath God wrought," was transmitted over the circuit between Washington and Baltimore in 1844, the fulfilment of Morse's greatest expectations was accomplished. He had established a practical means of instantaneous communication between widely separated localities on the surface of this globe. What more could be expected or even desired?

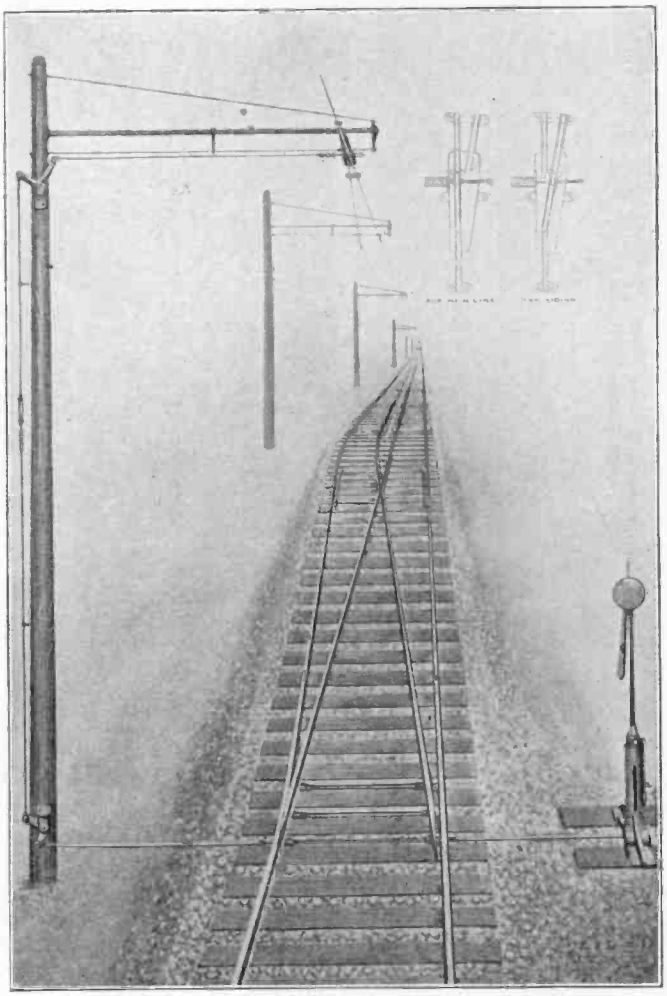
Had the little voice remained silent during the resulting popular enthusiasm and period of supreme contentment with the achievement which followed for a while, we would still be receiving messages on a running tape by means of the old register, and would also require a metallic circuit, or two wires, instead of one.

Fortunately, for posterity, one day one of the wires broke and the two ends fell to the ground, where they luckily found good "earth" connection, or as we say today, both ends "grounded." This fact was not discovered for several days, but when the situation was finally disclosed and the officials learned that they had been working the circuit right along although one side of the loop was out of commission, they heard the faint voice of a newly born experience protesting that two wires were used when the earth itself would perform the same service as a return wire. That one little "kick" alone doubled the mileage of the telegraph plant without incurring the expenditure of an additional dollar.—*Telegraph Age.*

Automatic Trolley Switch

On high speed interurban electric lines the general tendency is more and more toward improved equipment which shall bring the operation of trains upon such roads, as far as speed and the maintenance of schedules is concerned, on a par with the best steam road practice. As a consequence there are new devices and methods being constantly applied to save a minute here and there in the running time and to obviate, as far as possible, the little annoying delays which once were frequent.

For instance, in entering or leaving a siding, at meeting points on the line, it is not only necessary that the track switch be thrown, but also there must be a similar device at the branching point of the two trolley wires in order that the trolley wheel may always follow the right wire. Such a system is shown in the picture. At the branching point of the trolley wire is placed a little switch or frog similar in operation to the track rail switch; that is, there is a movable tongue which works horizontally and causes the trolley wheel to follow either the main line or the siding wire. This movable tongue is operated by the same mechanism that throws the track switch, through the agency of the rods as shown going up the side of the pole.



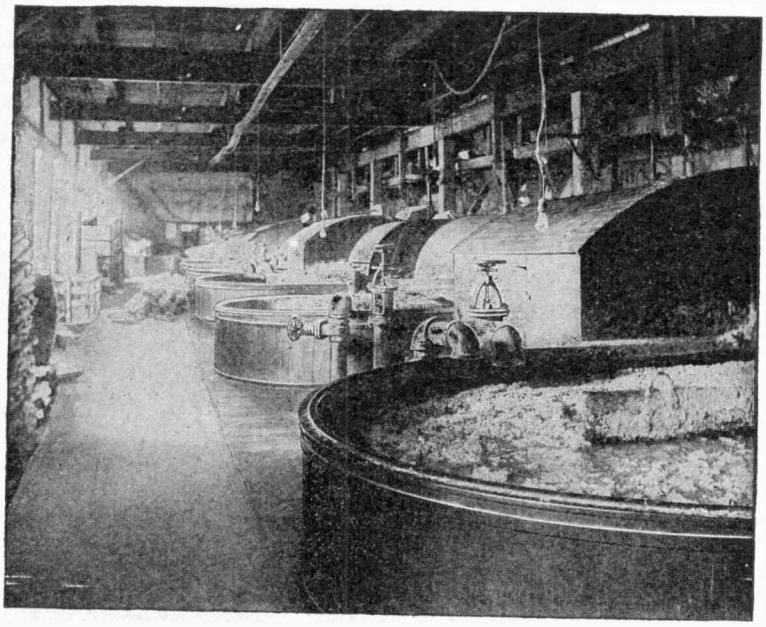
AUTOMATIC TROLLEY SWITCH

This is all done to save a moment's delay which would be occasioned if the conductor were required to yank a trolley pole over into place.

Electricity in Pulp and Paper Making

Most paper pulp mills are located upon a water power site for the reason that not only is power required, but also a large quantity of water for the pulp making process. But the fact that wood pulp may be made up in large quantities and stored for future use brings up the question as to whether or not electric motors may not be profitably used as auxiliary power, in spite of the fact that water power is already available on the mill site. That electricity may be used with economy has been demonstrated in a great many instances. The reason lies in the fact that the electric central stations near the paper and pulp mills are generally also operated by water power. At times of plentiful water supply, which are the times when the pulp mills "make hay", the central station can make current at its greatest capacity and as a consequence can grant current at very low rate during flood seasons. The pulp mill takes advantage of this low rate current to drive its auxiliary machinery and utilizes its own water supply for the making of large quantities of pulp to tide over the season of low water.

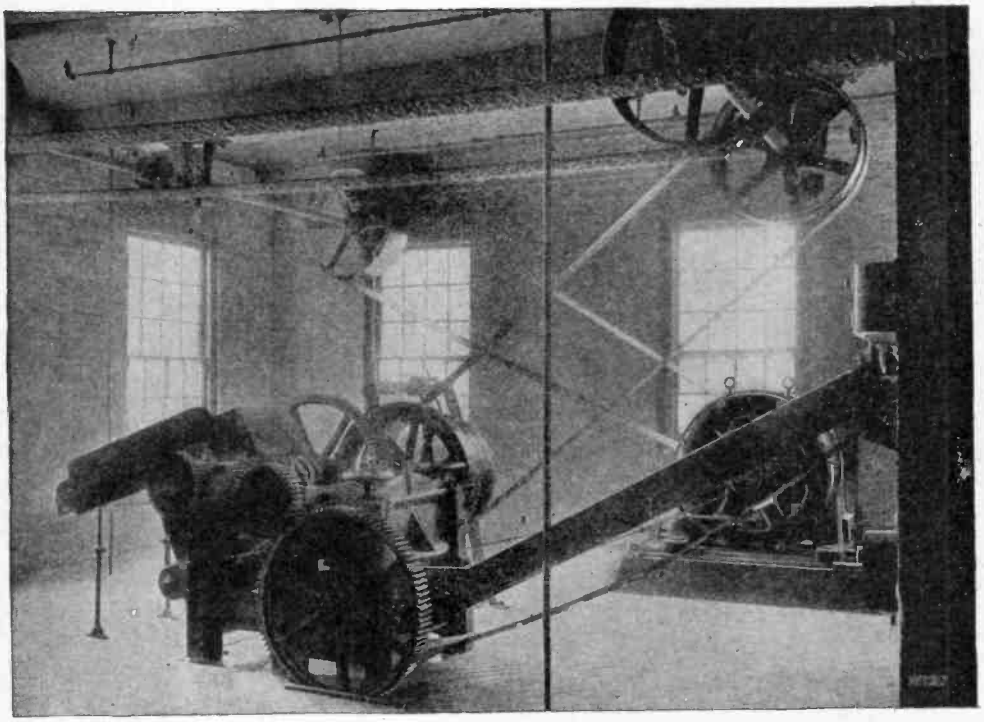
During these low water seasons the mill is also able to utilize the electric current with economy by running at night and taking advantage of the low night rates for current which most central stations allow, thereby husbanding its own water for the pulp making process.



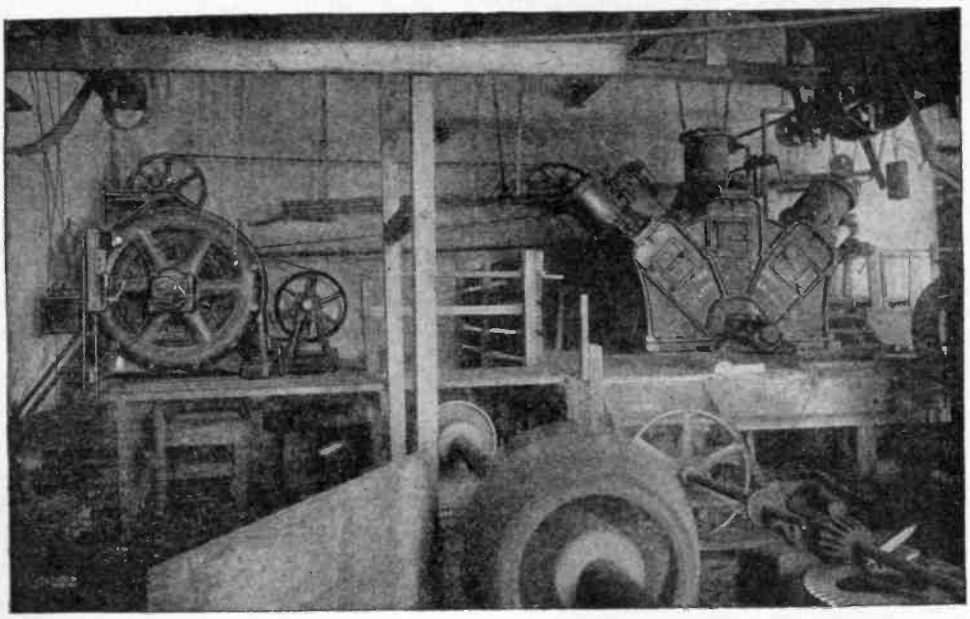
MOTOR DRIVEN BEATERS OF 1,100 POUNDS CAPACITY EACH

In cases where it is not possible for the pulp mills to obtain electric central station power and where water wheels have been used to drive the machinery, it has been found that to take these waterwheels and make them drive electric generators supplyiny current for motor drive, insures the direct application of a far greater percentage of the power than is possible where mechanical drive with its heavy friction losses is used.

Thus electricity has come to be a large factor in the pulp and paper making industry, and as the majority of the readers of this article have never had the opportunity of visiting such mills the accompanying pictures will be instructive and interesting, as showing the uses of current in an industry which is today among the greatest.

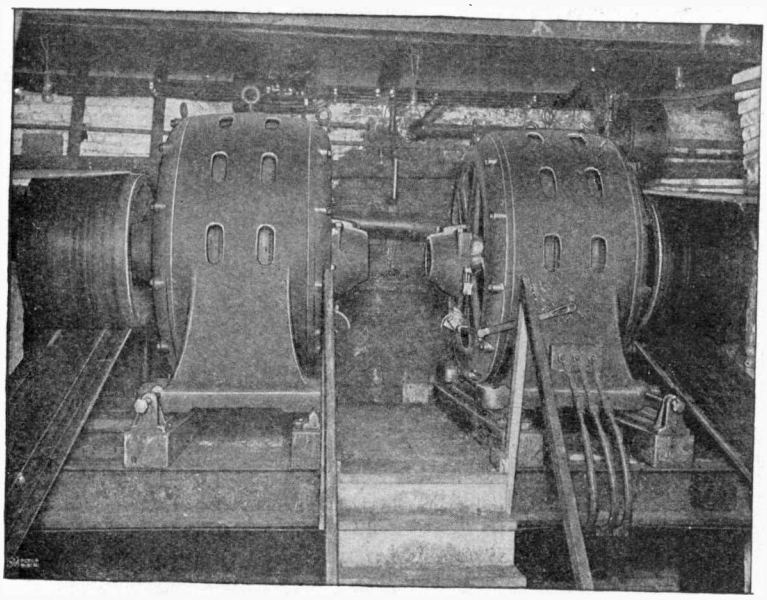


THIRTY HORSE POWER MOTOR DRIVING RAG CUTTER, THRASHER AND DUSTER



THREE HUNDRED HORSE POWER MOTOR DRIVING A PULP GRINDER

The upper illustration shows a room in a paper mill where rags are cut, thrashed and dusted by the machine which you see in the foreground, and which requires for its operation a motor of 30 horse power. The power consumed by this individual motor



TWO MOTORS OF 200 HORSE POWER EACH DRIVING SIX BEATERS

In this plant the change from mechanical to electrical drive was made about a year ago. Prior to that steam engines had been used to drive the machinery by shafts and belts. This required a capacity of 2250 H. P. of which 528 H. P. was consumed in friction losses on shafting. At present the capacity of the plant is greater with only 1700 H. P. in motors connected.

In the last illustration are shown two 200 horsepower motors driving six beaters and six washers in a Massachusetts plant. The notable feature of this installation is that the motors are installed on a mezzanine floor beneath the beater room, and therefore occupy space which could not be used otherwise.

may be readily measured by suitable instruments, showing whether or not the power consumed by the rag cutter is normal. In this way any defect in the machine, entailing an unusual consumption of power may be detected at once and remedied.

In the second illustration on the preceding page is shown a pulp grinder in a large mill in Wisconsin. It takes a large amount of power and the motor at the left is of 300 horse power capacity. Rope drive instead of a belt is here used. This is an instance showing how electric power may be subdivided, by the use of individual motors, so that isolated machines may be started and stopped without interfering with the work of other sections. This is a great economy over the use of heavy line shafts which must be run all the time for the operation of even one machine.

Pulp beaters are also used in the mills—great circular tanks in which the semi-fluid pulp is beaten and swirled about. The first cut shows a long line of these beaters having a capacity of 1100 pounds each. They are located in a paper mill in New York state and the installation exemplifies the reliability of motors under severe service conditions, as they operate 24 hours a day, six days in the week and during the year they have been installed they have been subjected to this practically continuous operation without a single breakdown.

The Principle of High Tension Transmission

Many persons undoubtedly do not know, or do not stop to think, why people are killed by contact with some "live" wires, and are not harmed by others. Many know that the electric light circuit in the house is practically harmless except in rare cases, or except for a painful shock, while trolley wires will almost kill a man, and long-distance transmission wires are deadly. There is a reason for this as there is for everything else. The death-dealing power of electricity lies in the amount of current forced through the body, but this in turn depends on the voltage, electrical pressure, potential or whatever you may call it, which is necessary to force current through the high resistance of the bodily tissues. Therefore the greater the voltage the more danger to life.

Now to explain the reason for this difference in voltage of various wires: Every electrical circuit carries amperes and volts, amperes standing for the quantity of elec-

tricity in the wire, and volts for the pressure that forces it through the circuit, as noted above. The product of these is watts which represent energy. Accordingly, a wire carrying 10 amperes at 110 volts is carrying energy equal to 1100 watts, but if it carried 10 amperes at 6,000 volts the energy would be 60,000 watts, or a little over 80 horsepower, as one horsepower equals 746 watts.

We have noticed that trolley wires are more dangerous than house lighting wires, and that long distance transmission wires are more dangerous than trolley wires. Therefore, trolley wires must carry more voltage than house wires, and long distance transmission wires more voltage than trolley wires. Such is exactly the case. The voltage commonly used in houses for lighting is 110, that used to run trolley cars about 550, while transmission wires carry all the way from 2200 to 125,000 volts.

The reason why transmission wires carry such high voltages can be easily explained. The more amperes a wire carries, the larger the wire must be, but a wire that may have one volt impressed upon it may have one million just as well. That is, the size of the wire must be regulated, not by the number of volts it carries, but by the number of amperes.

Now suppose it were required to send electrically 84 horse-power over a distance of 20 miles to light the houses in a town. The voltage in the houses must not exceed 110, because otherwise it would be dangerous. But 84 horse power is (84x746) about 62,664 watts. Dividing this by 110 we get nearly 570 amperes. To carry this quantity of electricity would cost $3,736 per mile for wire, or $73,000 for twenty miles, But if the electricity were generated at 5500 volts instead of 110, the amperes would be equal to 62,664÷5500, not quite 12, which could be carried by No. 15 wire at a cost of only $650. By comparing this with the cost of the larger wire, the reason is plain why the higher voltage and smaller wire are used.

When the current arrives at the town it is transformed down in a substation, either to 110 volts, to be used directly in the houses, or to 2200 volts, and carried to distributing points, and again transformed down, this time finally to 110 volts at each house. In large cities the latter system is used exclusively. The mains in the streets carry the current, generally at 2200 volts pressure, from the power-house to the transformers where it is transformed to 110 volts as required by the lamps.

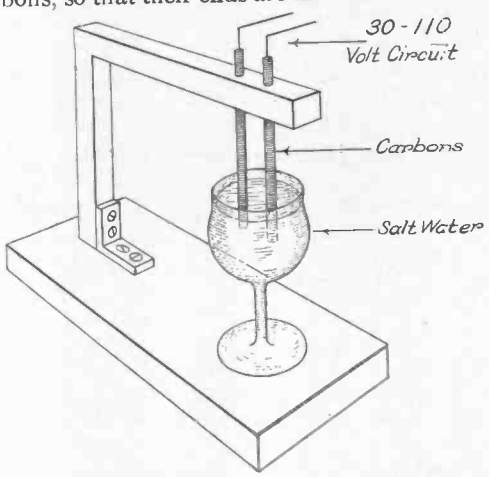
The trolley system is an example of high tension transmission, although it is not generally so considered. The trolley wire carries a varying amount of amperes at 550 volts. If the voltage were 110, trolley wire five times as large as it now is would have to be used at a proportionately greater cost in order to carry the required amperes.

High tension transmission, which means transmission of power at high voltage, or tension, has solved many problems of power transmission, for without it, the vast sources of energy such as the water falls of thousands of horse power in the mountains far distant from any city would remain unharnessed, and the one million horsepower of Niagara which is now being utilized for power many miles away over circuits carrying 60,000 volts still would be serving mankind only as beautiful scenery. HAROLD H. CUTTER

Electrical Experiment

To boil a glass of water in less than 15 seconds, at a cost of almost nothing, try the following experiment:

Take two plain arc lamp carbons about three inches long and mount them in a stand as shown in the diagram. Place a glass of slightly salt water under the carbons, so that their ends are immersed. Con-



nect the carbons through a switch to the two sides of a 110-volt circuit and turn on the current. The more salt there is in the water the quicker it will boil. Be careful that the two carbons do not touch.

—Lindsay McMillan.

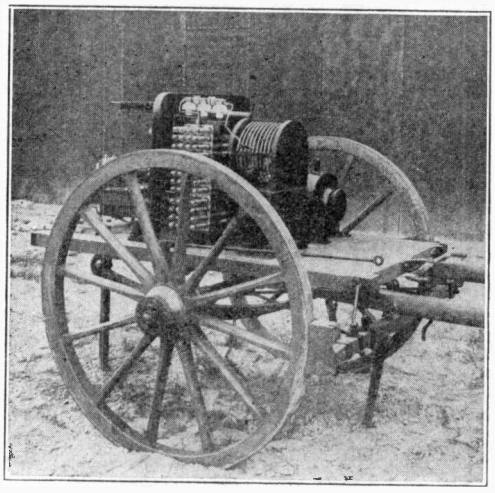
POPULAR ELECTRICITY WIRELESS CLUB

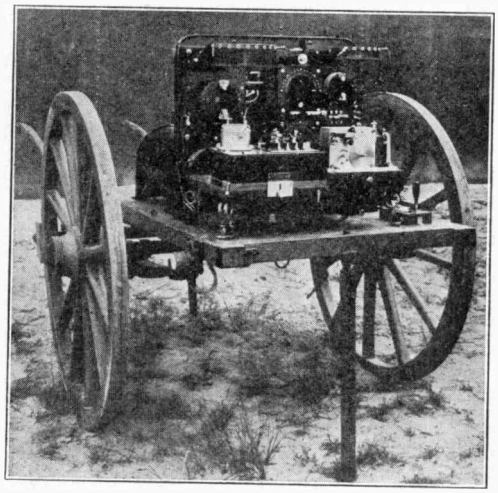
Membership in Popular Electricity Wireless Club is made up of readers of this magazine who have constructed or are operating wireless apparatus or systems. Membership blanks will be sent upon request This department of the magazine is devoted to the interest of the Club, and members are invited to assist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

Armies and Navies Directed by High Power Wireless

By FRANK C. PERKINS

On account of the development of the high power wireless telegraph stations it is now possible to direct the movements of a great army and navy simultaneously from a centrally located point. The accompanying illustrations Figs. 1 and 2 show two views of the German portable equipment for wireless telegraphic communication including apparatus for sending and receiving messages by a commander to and from the various army posts at distances of many miles. It is possible with the receiving





FIGS. 1 AND 2. GERMAN PORTABLE WIRELESS EQUIPMENT

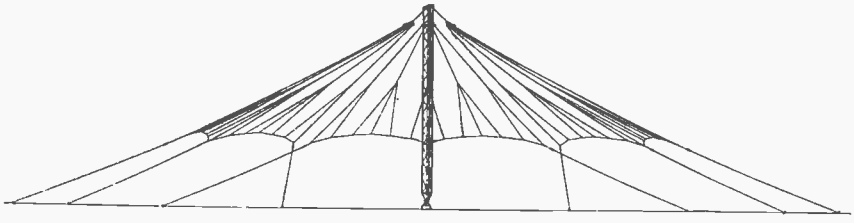


FIG. 3. ARRANGEMENT OF THE SIX FOLD UMBRELLA ANTENNA

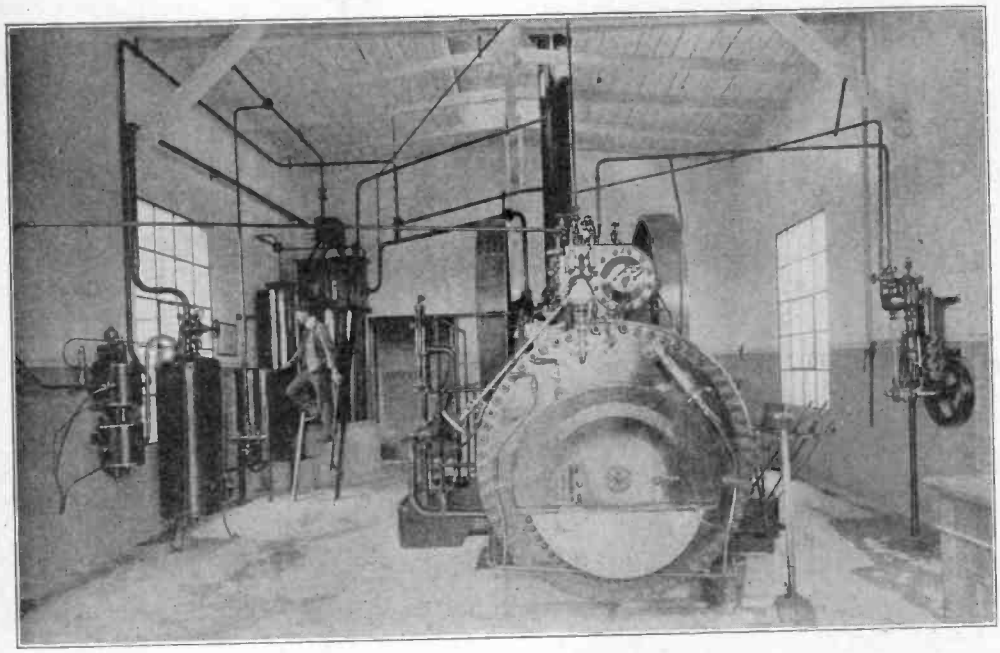


FIG. 4. THE POWER EQUIPMENT.

apparatus to take directions from a commander or superior officer located hundreds of miles away at a high power transmitting station, the same commander being able to direct the movements of the various battleships, cruisers and torpedo boats of the navy from the same fort or other high power stations.

It may be of interest to note the details of construction and the electrical equipment of one of the first high power wireless stations in Germany, illustrating the methods employed and unique apparatus utilized.

The Nauen high power station is located northwest of Berlin at a distance of about 25 miles. A steel tower was erected for supporting the antenna as seen in the frontispiece of this issue. This lattice work steel tower is 328 feet high and supports a large number of wires forming a six fold umbrella antenna above the wireless station as indicated in Fig. 3. The location of the station and tower is in a large field with favorable conditions of soil, ground water being struck at a depth of 6½ feet, thus providing an excellent earth connection. Conditions, however, were unfavorable for the construction of the tower, making it difficult to provide a secure foundation for the heavy tower of triangular form measuring 13 feet on each side. But by the liberal use of concrete a good foundation was finally provided. The tower is kept vertical by the use of guys running to a point 246 feet above the earth. These guys are insulated from the tower and anchoring, on account of the high tension used, the spark sometimes reaching a length of 40 inches. The total surface covered by the umbrella antenna is 642,000 square feet. The leads to the station house consist of 154 cables

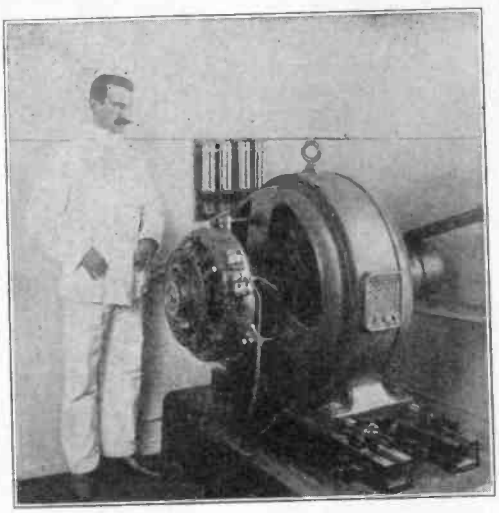


FIG. 5. SINGLE PHASE ALTERNATOR

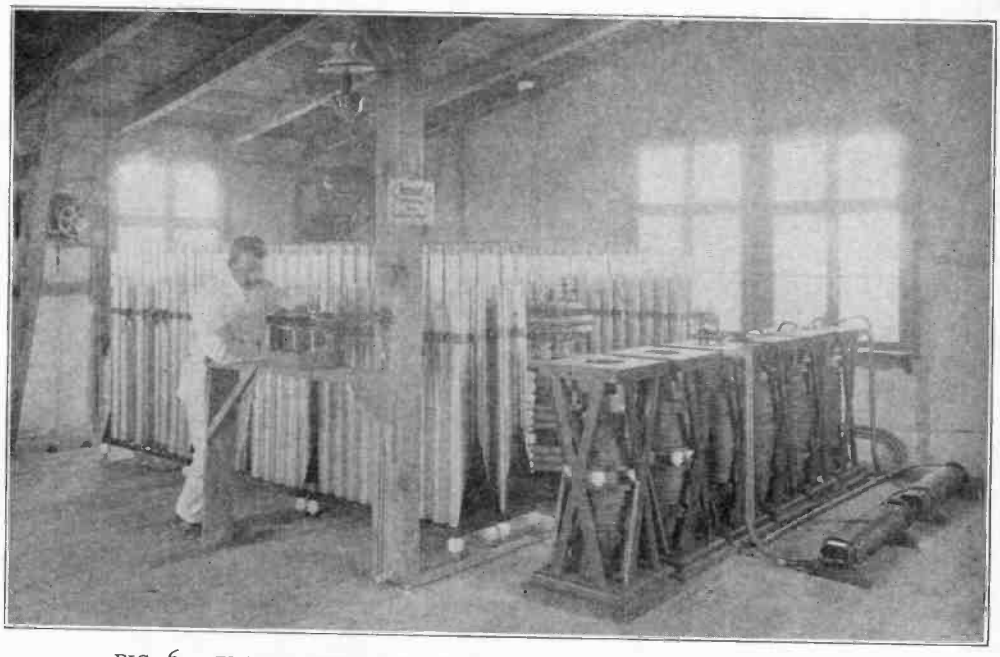


FIG. 6. TRANSMITTING EQUIPMENT CONTAINS 360 LEYDEN JARS

in the form of six grids carried from the top of the tower to a bus bar and then into the station.

In the station the high tension room is located on the upper floor and the machine room and receiving room on the ground floor. The power equipment is noted in Figs. 4 and 5, the former showing a portable boiler and engine of 36 horsepower capacity, working at a steam pressure of seven atmospheres, the speed of the engine being 120 revolutions per minute. The latter view shows the single phase alternator employed which is driven by belt transmission from the engine fly-wheel. This single phase alternator has a capacity of 25 kilowatts and supplies a current of a frequency of 50 cycles per second.

On the first floor are located four choking coils and four induction coils through which the alternating current is fed. The transmitting equipment is shown in Fig. 6, with its Leyden jar battery. There are 360 large jars connected in three-fold series. The jars are charged from the secondary winding of the induction coils which are connected to four high tension choking coils.

It may be stated that this high power station equipment and its operation differs from that in small stations, in that the cutting off of the induction coils from the Leyden jar battery is not done by interrupting the primary circuit but by short circuiting the primary winding of the induction coil and simultaneously the winding of the

FIG. 7. THE KEY IS SEEN AT THE RIGHT

generator through the choking coils. By breaking this short circuit the Leyden jar battery is charged. On account of the very heavy current utilized a special switch is provided in the transmitting relay which is said to be very reliable and effective.

For transmitting, an ordinary Morse key is employed on the receiving table in the telegraphing room as noted at the right in Fig. 7, this key operating a transmitting relay.

By operating a single switch only one movement is required to change over from transmitting to receiving. This operation switches the air wire and earth from the transmitting circuit to the receiving circuit, the receiving apparatus being noted in Fig. 7. The same operation above referred to disconnects the alternating current circuit by means of a cut-out, this being absolutely necessary in order to protect the sensitive cells and detectors from the influence of the exciting circuit. It is possible with the equipment shown in Fig. 7 to receive with both writing and hearing receiver simultaneously or independently as desired.

From this station messages have been received with hearing and writing receiver over land a distance of 500 miles, chiefly over mountains in Switzerland. Messages have been sent from this station a distance of nearly 850 miles over land.

Messages have also been transmitted to the steamship Bremen on a voyage to New York at a distance of 940 miles largely over land, the telegrams being received very distinctly by the hearing receiver on board this ocean liner.

By means of the latest improvements in wireless transmitting and receiving apparatus it is now possible to transmit messages from this station far greater distances than when the station was first equipped, communication being possible with warships thousands of miles away and with armies in the field with as great facility and even to better advantage than by the land telegraph line on account of the portability of the wireless field equipment.

A Hot Wire Ammeter

By A. B. COLE

In wireless stations where tuned systems are used, some device is required to show when the aerial is radiating a maximum amount of energy. Since the energy supplied to the aerial is alternating in character and of high frequency, a meter depending on magnetic forces would be difficult and costly to construct. The most satisfactory meter in use for this purpose operates upon the principle that current passing through a wire heats the wire and causes it to expand, and the amount of expansion is dependent on the quantity of current passing.

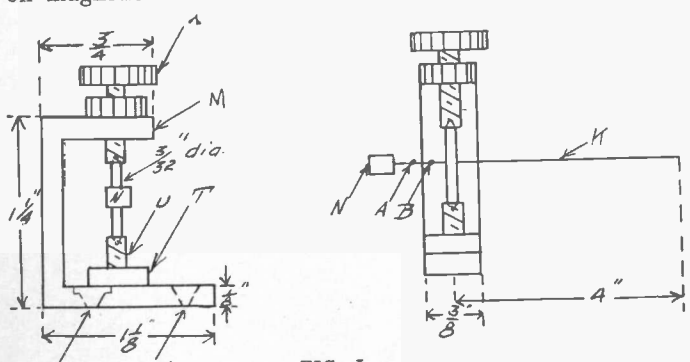


FIG. I

The purpose of this article is to show how a simple hot wire ammeter for tuning purposes may easily be constructed. The most difficult part of the construction is that of the pointer and its supports. These must be accurately made if the meter is to be reliable. The detailed construction of these parts may best be seen from Fig. 1. Here, (M) is a brass support bent in the shape shown. Two holes, (V) and (W), are drilled for screws to hold (M) inside the case; (V) is countersunk to allow the screw head to be flush with the surface. (T) is a brass nut soldered to (M), into which is screwed and soldered a short piece of $\frac{1}{8}$ brass rod (U) which is then drilled at its upper end with a 3-32 drill to a depth of about $\frac{1}{8}$ inch. (X) is an 8-40 thumb-screw

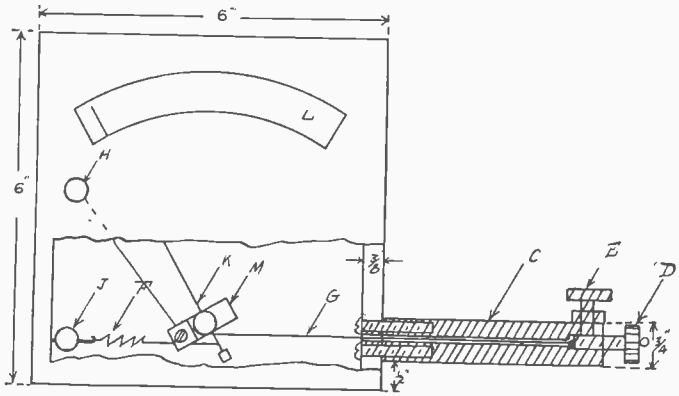


FIG. 2

with lock nut, and is drilled at the lower end with a 3-32 drill to a depth of about ⅛ inch. The aluminum pointer (K) is made of a piece of No. 14 aluminum wire, and fits tightly a hole in the brass spindle, sharpened at both ends, which turns freely in the holes drilled in (U) and (X). It is important that (U) and (X) be adjusted so that (K) swings with practically no friction. To this end a small lead weight (N) should be made just heavy enough to balance (K).

At (A), ¼ inch from the center of the spindle, is fastened a silk thread whose other end is tied to a light phosphor bronze spring (F), Fig. 2. The spring may be of the type used on "pony" telegraph relays. The other end of (F) is held by a short piece of 1-16 inch brass rod bent at one end in the form of a hook, and passing through a binding post (J). By moving the rod with respect to (J) the tension on (F) can be varied.

At (B), ⅛ inch from the center of the spindle, (Fig. 1), is fastened a wire (G), Fig. 2. For stations from ¼ to ½ K. W. capacity this wire may be a No. 40 copper; from ½ K. W. to two K. W. (G) should be of No. 36 copper wire. (G) passes through a ⅛-inch hole in the instrument case and through the center of a round fibre rod (C), and terminates in a wire hook whose shank passes through an 8-40 thumbscrew (D), and is bent into a circle beyond the head of (D). As (D) is turned the wire hook should not revolve with respect to (D) so that (G) is not twisted. An 8-40 thumbscrew (E), provided with a lock nut, passes through (C), so that it may be screwed down on (D), making electrical connection with it, and serving to prevent its turning when once adjusted. Since (D) seldom needs adjustment, the wear on the threads of (E) is small. (C) is held to the case by two 8-32 machine screws, as shown in Fig. 2. Frame (M) is connected by means of a No. 18 wire to a binding post (H) on the outside of the instrument case. A cardboard scale (L) is shown in Figs. 1 and 2. The spring (F) and binding post (J) have been omitted from the latter figure to enable the construction and location of the moving parts to be more readily understood. (G) should be tightened by nut (D) and spring (F) should exert enough tension on (K) to pull (K) around the scale when (G) expands.

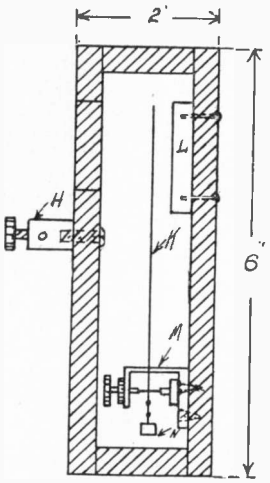


FIG. 3

The scale (L) may be divided into any convenient number of parts, and easily calibrated. However, in small stations it is only necessary that the meter give a comparative reading.

To use the meter, connect post (H) to the aerial, and post (E) to the transmitting instruments. When the transmitting key is depressed, the current flowing into the aerial must pass through wire (G) thereby heating this wire and causing it to expand. The expansion allows the spring (F) to draw (K) around the scale a distance proportionate to the quantity of current flowing. The meter, which is recommended for stations from ¼ K. W. to two K. W. capacity, works in both horizontal and vertical positions, and will be found to give great satisfaction.

Dr. Cook Experiments with the Wireless Telephone

Wireless telephones, as most of the readers of this department know, have been now perfected so as to admit conversations being held, as distinctly as with the wire instruments, over a distance of 250 miles. Wireless telephones are in use along the Pacific coast and between the islands of Casco Bay, Maine, and it is claimed that wireless telephony will soon become as useful as wireless telegraphy.

While in Cincinnati recently, Dr. Frederick Cook, discoverer of the North Pole, and his friend, Dr. Axel L. Kopp, Danish electrical engineer, made experiments with the wireless telephone for business purposes. The accompanying pictures show Dr. Cook conversing over a wireless telephone located in a Cincinnati hotel and Dr. Kopp using an instrument located temporarily in one of Cincinnati's public parks.

DR. COOK AT THE WIRELESS TELEPHONE

The experiments made by these two noted men were with a new wireless telephone system with which great results are expected to be obtained. It is outwardly of much the same appearance as the ordinary telephone with an additional attach-

DR. AXEL L. KOPP EXPERIMENTING WITH THE WIRELESS TELEPHONE

ment similar to the automatic type. It is, on general principle, like the wireless telegraph, in that it transmits messages through ethereal waves.

There will be no wireless telephone exchanges, since each telephone is an exchange in itself. It is said that a device has been perfected in this system whereby a wireless telephone user can call up any number in a city of 100,000 telephones. Each telephone will be equipped with this device which consists outwardly of a dial and numbers ranging from one to ten as in the automatic wire telephone. A telephone user wishing to call up telephone No. 47 only has to move the hand on the dial to number 4 and then switch it over to number 7 and instantly telephone number 47 will begin ringing, if it is in working order and within the etherial wave limit, be the instrument stationary or being transported. Conversations have been held, so it is stated, from trains and automobiles.

Attachment for Morse Key

When an ordinary Morse key is used to break the primary current to a wireless transformer it is found to be very unsuitable, owing to the small contact points adhering, on account of the heavy current they are called upon to carry. When large contacts are used this difficulty is eliminated. An attachment which can be cheaply constructed to be used in connection with an ordinary Morse key and which will add a "professional air" to the wireless set is described below, and the appearance will deviate from the simple telegraph key.

The following materials are required for the construction of this attachment. Five inches of ¼-inch square brass rod, six inches of 5-32-inch round brass rod, one inch of ⅜-inch round zinc rod.

If a leg key is to be used, the leg with the contact point should be removed and the other sawed off. The square brass rod is now bent and holes drilled with 11-64-inch drill as shown in Fig. 1. Two pieces of the zinc rod ⅜ inch long are now cut and one end on each piece bored and threaded with an 8-32-inch tap. One length of the round brass rod 2 11-16 inches long and one

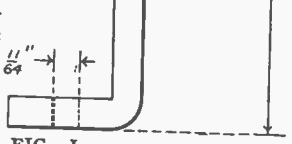


FIG. 1

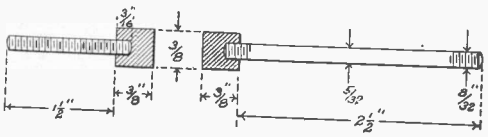


FIG. 2

1 11-16 inches long are now cut. The longer one is threaded ¼ inch on each end and the other is threaded the whole length. The zinc pieces are now screwed on tight, one on each rod, as shown in Fig. 2. If the amateur is fortunate enough to procure platinum, platinoid, or iridium of fairly good diameter, same can be used instead of the zincs for contacts, but zinc has been found to answer admirably for breaking current of 110 volts and 2½ to four amperes, which is about the quantity taken by ¼ to ½ K. W. transformers.

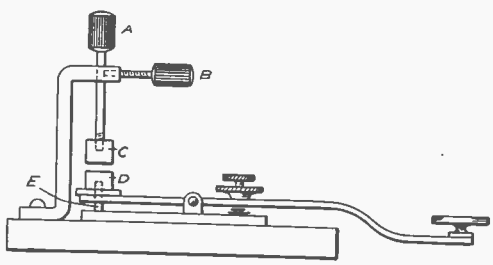


FIG. 3

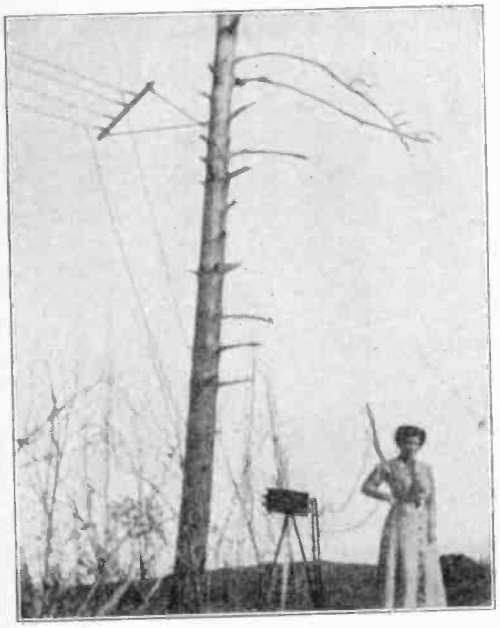
The thumb screw with lock nut at the end of the key lever is now removed and the lock nut screwed on the shortest length of rod to which the zinc piece is attached, which in turn is screwed on at the end of the key lever.

A base of any insulating material four by six inches is made, on which the key and attachment are mounted. Fig. 3 shows the key with attachment mounted.

From Fig. 3 it will be seen that when the rod (A) is in position, it is locked by the screw (B). The space between the contact pieces (C) and (D) should be about 1-32 inch. The screw (E) should slant slightly to the left so that the contact pieces will strike each other evenly.

Experimental Station on Middle Island

Away up on Middle Island in Lake Superior, near Marquette, Mich., an experimental wireless telegraph station was in use this Fall, for receiving only. It was installed by W. J. Chilton for the purpose of trying out some new ideas in the line of receiving apparatus, which he hopes will prove of value to the art. One of the pictures shows the inventor and his portable apparatus. The other shows a friend of



WAITING FOR THE FIRST MESSAGE

the inventor, also a wireless enthusiast.

The antenna for this station, which consisted of four No. 14 copper wires 150 feet long, was erected on the summit of the island, 200 feet above the surface of the water. The ground was made by sinking a mass of metals into the lake.

The receiving set was condensed into a portable case and carried to and from the island in a boat. It consisted of a double tuning coil, two 1000-ohm receivers, a detector, embodying a large number of different minerals, and some other experimental devices embodying the new ideas.

This receiving set, used in the commanding position on the summit of the island, was within easy range of passing boats, Duluth, Minn., and Calumet, Mich., and even Cleveland, Ohio, was heard at one time.

Wireless Etiquette

Rumors insistently crop out of contemplated legislation to abolish the amateur wireless station. No definite steps have thus far been taken and it is to be hoped that none will be taken. In an art so young as that of wireless telegraphy and telephony the sustained interest of thousands of amateur workers all over the country cannot but result in good to the cause. Many of the important achievements in this field have been stumbled upon, so to speak, even by the most noted of the inventors and it is sure to happen that from the amateur en-

W. J. CHILTON WITH HIS PORTABLE RECEIVING SET

thusiasts things new and useful to the art will be forthcoming.

In addition, there are now numerous thriving manufacturing concerns which are building up an extensive business in amateur wireless equipment to which a falling off in this class of trade would mean serious loss if not failure.

Most amateurs are working with small coils and limited equipment. That they may in some instances conflict with the large stations is true, but a large proportion of the adverse criticism is without foundation. The distance over which they operate is nine times out of ten comparatively insignificant. They are more apt by far to conflict with each other than with the big stations.

But the surest way to avoid criticism is to remove the cause, and those few amateurs who are located close to the big government or commercial stations should remember that it is "up to them" to put an end to this talk, both for their own sakes and for that of their amateur friends who, though they are so far from a large station that they could not make it in two "yumps," as the Norwegian said, would have to share alike with the offenders in case of prohibitory legislation. Remember, if you are close to a commercial or government station, if you find they are operating, "get off the line." Don't try to talk to them in any case. They have their own business to take care of. The ether is free to all but there is a wireless etiquette to be observed, and let us observe it.

Things for the Amateur to Remember

All wireless operators in the amateur class should realize the great importance there is in trying to do away with the talk of licensing all wireless stations. Now we can help to stop this by observing a few set rules and abiding by them.

First: Learn to receive, so as to understand when a commercial or government operator sends out the interruption signals.

Second: To refrain from using the distress signals C. Q. D. or S. O. S. (which cause needless worry and expense).

Third: Try and find out what time of the day the commercial and government stations are busiest, and try and keep out of the atmosphere during those hours.

Fourth: When we find a commercial or government station sending or receiving don't "butt in" with a lot of unreceivable signals and interrupt them.

Fifth: Don't call commercial or government stations, unless you are allowed to do so by special permission which has been given you.

Now there are a great many other rules which could be laid down for the average young experimenter to follow, but I believe these are the most important.

A good way for the young operators to learn to receive is to take a small buzzer, a battery and key, and connect them up with a receiver. They can learn the codes by this means and when they are familiar with the different letters they can soon find out what is being said by the larger stations. Of course it will take time before they will be able to catch all that is sent out. But when they are proficient enough to take the signals as they come then it is time for them to start in to send, keeping out of the way of the larger stations. This only applies, of course, where there is a commercial or government station within sending distance of their apparatus.

A. G. HUMPHREY.

WIRELESS QUERIES

Answered by Valentine B. Seitz

Telephone Poles; 100-Watt Transformer

Questions.—(A) Where can I buy a 100-foot pole for an aerial? (B) How many amperes does a 100-watt transformer take on ten volts?—G. T. S., New York, N. Y.

Answers.—(A) The telephone company usually maintains a pole yard where poles for use in case of emergency are kept, and local lighting companies having overhead mains also keep on hand a supply. If you cannot get what you want there look in a telephone journal for the address of advertisers who deal in poles.

(B) A transformer is rated according to the power it can deliver steadily to a non-inductive load without running too warm. If your primary is ten volts, and the transformer is rated at 100 watts, a current of ten amperes on the primary should not unduly heat it. The secondary voltage will depend on the ratio of the secondary turns to the primary turns, and if run only up to its rating, the secondary current will equal 100 watts divided by the secondary voltage.

Tuning Coil and Sending Helix

Questions.—(A) What will be the wave length of a tuning coil one inch in diameter and wound with 262 turns of No. 20 C. C. wire? (B) What would be the wave length of a sending helix five inches in diameter wound with 15 turns of No. 18 bare copper wire?—C. A. F., Alamogordo, Mich.

Answers.—(A) The tuning coil described, when used with a medium sized aerial, will respond to about a 650 meter wave.

(B) The sending helix can be used for a wave up to 450 meters with the same aerial. As No. 18 wire is rather small for a sending coil would advise rewinding with copper ribbon or stranded wire of a larger size to get a larger conducting surface.

An Eight Inch Coil Outfit

Questions.—(A) How many miles will an 8-inch coil transmit? (B) How many dry batteries are required? Can I use storage batteries? (C) Could a Telim auto-coherer be used with the outfit? (D) How high would the aerial be? (E) How could I protect the station against lightning —M. E., Jr., Reserve, La.

Answers.—(A) You will probably be able to cover about 15 to 20 miles with an 8-inch coil under ordinary conditions.

(B) Storage batteries will give much better results than the dry cells. If the storage batteries are used, would advise getting a 12-volt, 60 ampere hour set. If dry cells are to be used, two sets should be connected in multiple, each set consisting of seven cells in series.

(C) The Telim auto-coherer can be used for short distance work, but if you wish to do good work would advise using a thermo-electric detector such as the ferron, silicon or pericon.

(D) With an aerial 150 feet long and 50 feet high, you should be able to get good results.

(E) Ground your aerial when not in use.

Operation of Electrolytic Interrupter

Questions.—(A) I am using a home made electrolytic interrupter to operate a small spark coil on 110 volts A. C., but it causes the lights in the house to burn dim. I have tried an eight candle power lamp resistance, but the coil will not work. How can I remedy this trouble? (B) What is the highest power wireless station near Toledo?—R. W. H., Toledo, Ohio.

Answers.—(A) You will probably find that you have too much of the point in your interrupter exposed. If this is the case you are using too much current. To overcome this trouble see that the opening through which the point projects, is not too large, also shorten the point a little. To get the best results a rectifier should be used in connection with an electrolytic interrupter on alternating current.

(B) 10 K. W. at Cleveland, 10 K. W. at Marquette, Mich., 2 K. W. at Toledo.

Resistance Coil for Potentiometer

Question.—How can I use a resistance coil wound to 7½ ohms on the potentiometer described in the July, 1909, issue in place of the choking coils?—W. E. B., Picton, Ont.

Answer.—The resistance will serve the purpose of the choke coil if it is wound in the form of a spiral. It is unnecessary to have a choke coil, in this case, as the telephone receivers have a high inductance.

Connections for Tuned Receiving Set

Question.—How should a double slide tuner, carborundum detector, fixed condenser and 2,000 ohm head receiver be connected and how far would same receive with two wire aerial thirty feet high? —W. A. S., Petaluma, Cal.

Answer.—See diagram, page 458, November, 1909, issue. You do not give the length of your aerial. If about 150 feet long, you should be able to receive from 150 to 200 miles.

Aerial Construction; Telim Auto-Coherer

Questions.—(A) How shall I string my aerial wires? They have two poles 50 feet high and 35 feet apart. (B) What size coil will I need to transmit from here to New Orleans, 28 miles? (C) Give diag am showing how the Telim-auto-coherer is made.—M. E., Jr., Reserve, La.

Answers.—(A) Use a "T" aerial composed of four horizontal No. 14 hard drawn copper wires spaced 10 inches apart. Tap your horizontal by connecting four vertical wires in the centre of the 35-foot stretch. These four wires are connected together at the base and brought in to the instruments.

(B) Would advise using at least ½ K. W. transformer to be on the safe side. With a good aerial and good working conditions you would probably be able to cover the distance with a ¼ K. W. transformer.

(C) The Telim auto-coherer is nothing but a small glass tube having two iron electrodes inserted and spaced by about one-sixteenth inch, the space between the ends being filled with carbon granules.

Auto-Coherer; Call Bell; Telegraph Key; Telegraph Receiver

Questions.—(A) What are catch wires and why are they used on an auto-coherer? (B) Can a call bell be arranged to work with the telegraph over a distance of one mile? The sending apparatus at the other end has a one-inch spark, both aerials 35 feet high. (C) Will an ordinary telegraph key work with a one-inch spark coil? (D) Will a telegraph receiver work up to one mile (receiving) with an auto-coherer?—F. J. M. Lynbrook, L. I

Answers.—(A) The catch wires on the auto-coherer are used in place of an aerial and ground, when working short distances, as from one room to another.

(B) A call bell can be used, if a sensitive coherer and relay are used at receiving end.

(C) Yes.

(D) No. Would advise using receiving apparatus consisting of a thermo-electric detector, tuning coil and a pair of telephone receivers, as this makes a more reliable and efficient set.

ELECTRICITY IN THE HOUSEHOLD

The Luminous Electric Open Fire Place

In the countless generations which have passed since man first made fire there has been inborn in people the love of meditation at night by its cheerful rays. This natural love of the open fire is so strong that only necessities of modern ways of living could drive it from the home. But now we must have polished floors and costly rugs, which would be ruined by snapping coals, and we have come to know that an open blaze eats up the oxygen of the comparatively tight modern house altogether too fast—so exit the fireplace.

Along comes electricity, however, to give us back the old-time pleasure, and now by the simple turning of a switch we are able to obtain all the benefits of the open fire, with none of its drawbacks—this by the use of the luminous electric open fireplace.

THERE IS AN INBORN LOVE OF MEDITATION BY THE FIRELIGHT

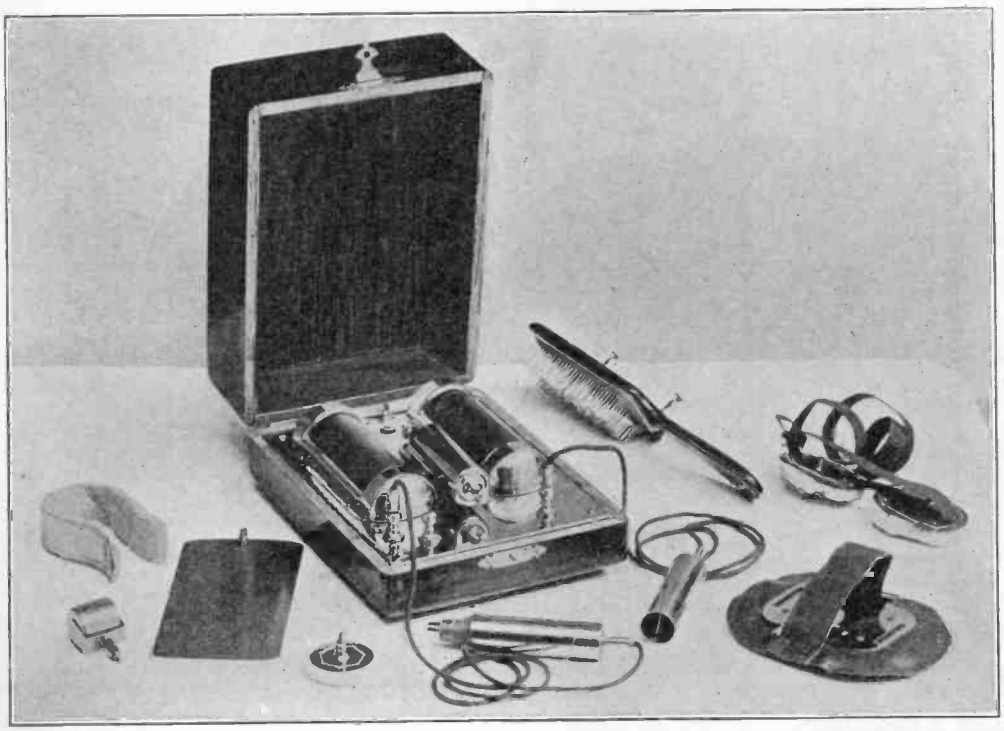
This modern development of electric heating is brought about by the use of a modified form of the electric incandescent

lamps. These lamps are made with long tubular bulbs which stand in a vertical position in front of specially constructed bright copper reflectors set in a frame of stove-plate cast iron—the best heat radiating substance known. The lamps are made with special filaments and give out a great deal more heat than the ordinary bulb. This heat goes all over the room by both radiation and reflection, and the lamps at the same time give out soft and pleasing light.

In the fall and early winter one of these luminous radiators is all that is necessary in a room. If any of the members of the family are "caught in the rain" it serves to dry damp shoes or skirts. In the bedroom on chilly mornings it furnishes warmth comfortable to dress by, and may be placed in any part of the room.

A Home Medical Battery Outfit

With a home medical battery outfit such as the one shown in the illustration it is possible to obtain the pleasant and stimulating effects of both galvanic and faradic currents applied in many different ways. The induction coils and batteries are contained in a neat case, and the picture also shows the various kinds of electrodes which are used to apply the current to the various parts of the body.



A HOME MEDICAL BATTERY OUTFIT

Connected to the instrument are seen the two metal handles which you grasp to obtain current through the arms and body as in the ordinary medical coil. These are easily removable and any of the other types of electrodes connected. At the left you will see a U-shaped pad. This may be connected in place of one of the hand electrodes and applied to the wrist, the other electrode being grasped in the other hand. Beneath the pad is a little roller which may be connected and used for electrical massage.

The metal plate is to rest the feet upon while a sponge electrode is applied to different parts of the body in the treatment of rheumatism. An electrical bath may also be taken by having one electrode in the water and the other connected to a special sponge.

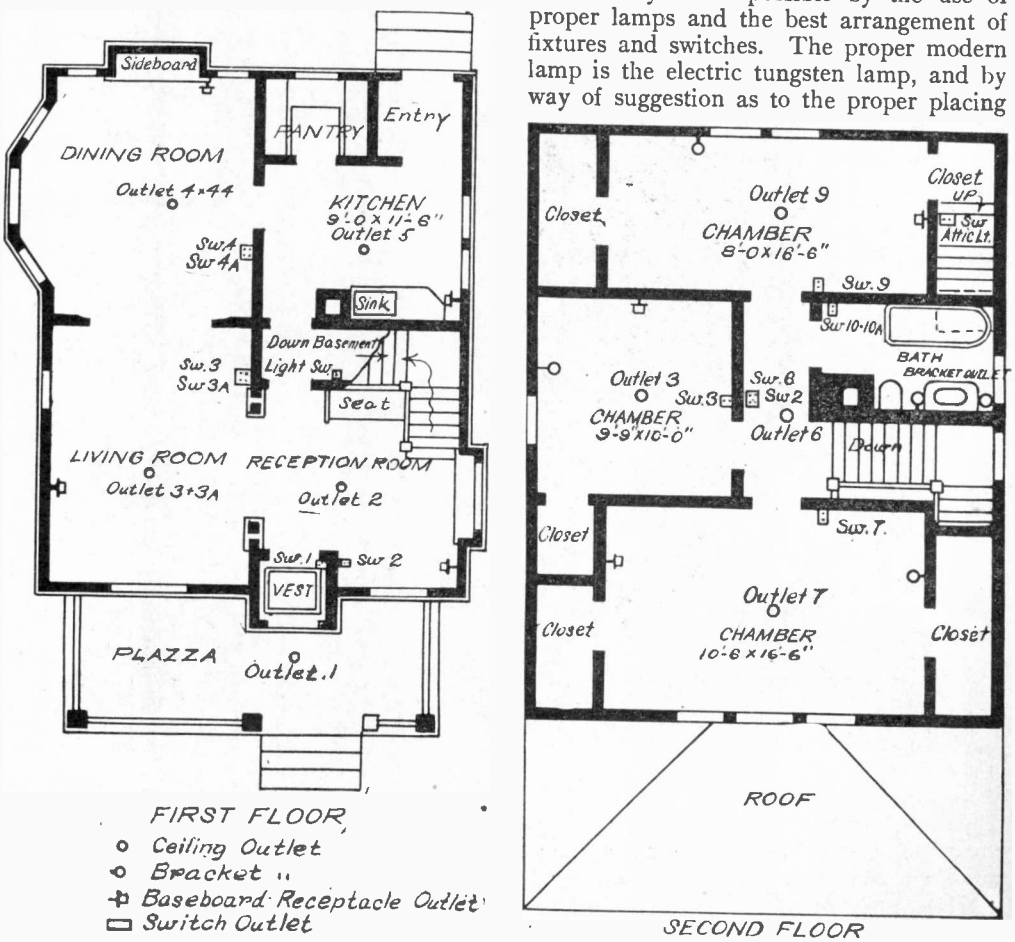
The hair brush is another attachment to which the electrodes are connected and which sends a stimulating current through the scalp.

In the upper right hand corner is a head band electrode, This is used in cases of nervous headaches. As physicians will tell you, the headache which we feel is not "brain ache," and does not come from the parts within the skull cavity. It really originates in the skin of the forehead and scalp and therefore it is natural to suppose that the stimulating influence of the current applied to these parts, which brings about better circulation, will have a beneficial effect.

Standard dry batteries are used with these sets which may be readily replaced when run down, although one pair will last for a long time.

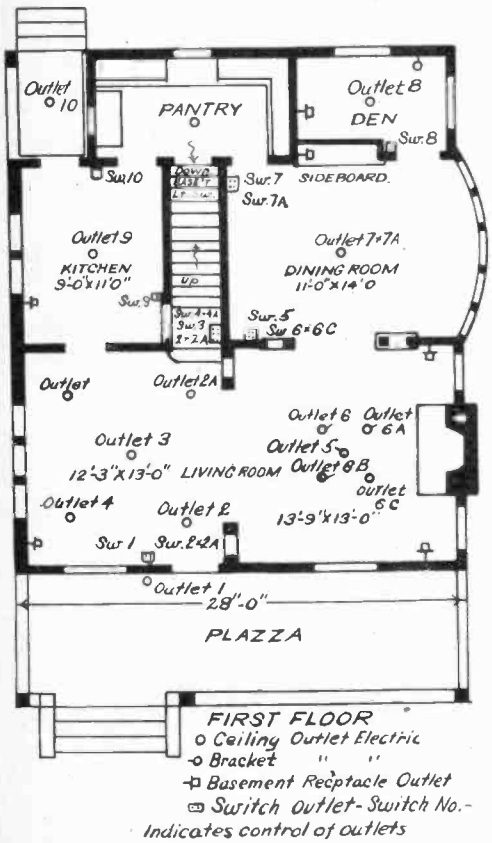
Home Lighting Suggestions

The superiority of electricity being a fact now well established, it is not necessary to dwell upon this subject, but that which should be emphasized in the interest of users and prospective users of current, is the practice of economy made possible by the use of proper lamps and the best arrangement of fixtures and switches. The proper modern lamp is the electric tungsten lamp, and by way of suggestion as to the proper placing



PLANS FOR A SIX ROOM HOUSE

of outlets and switches the accompanying plans of a six room and a seven room house are reproduced. These plans were obtained through the courtesy of the Minneapolis General Electric Company, which assists its patrons to a better understanding of the subject by printing for them a neat little book of plans for various sized houses, together with valuable suggestions.

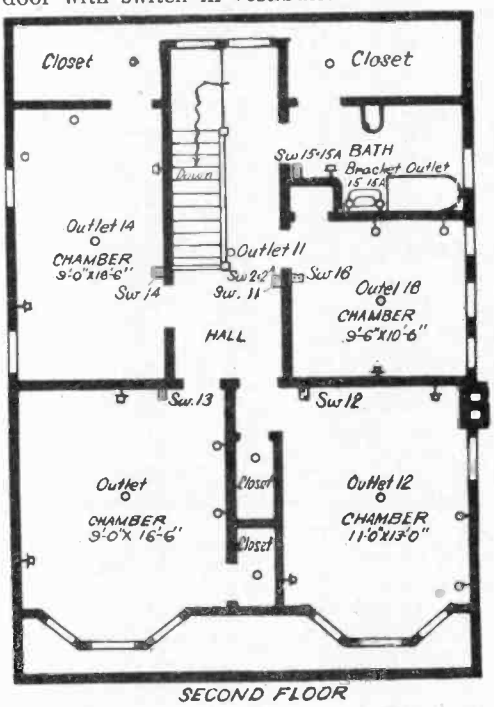


Electric lighting is no longer expensive. On the contrary, it is necessary to the economic management of the home. It now costs no more than inferior lighting, and its cheerfulness, cleanliness and convenience cost nothing.

The subject of proper planning of home lighting deserves the attention of every architect, contractor and particularly every home builder. The general suggestions offered, through the medium of graphic illustrations will be of special interest to home builders.

SIX-ROOM HOUSE—FIRST FLOOR PLAN

Porch Light is located directly above front door with switch in vestibule.



PLANS FOR A SEVEN ROOM HOUSE

The proper planning of a well lighted home rests in the true conception of what modern science calls "efficient illumination", and a clear understanding of the essential factors necessary to produce "artistic effects," having constantly in mind that important item, "economy," for economy can best be obtained by a little careful consideration as to location of fixture and switch outlets at the time of installing wires than at any other time.

You are familiar with the advantages of electric light, but do you realize how recent improvements have greatly reduced its cost?

Reception Room Lighting is controlled by switch on the reception room side of vestibule wall, and also from the head of stairs. This arrangement is most convenient.

Living Room Lighting has been so planned that two lighting effects are made possible, thus giving to special occasions additional brilliancy. Switches are placed at point of vantage when entering from dining room after dinner or from the reception room.

Dining Room Lighting is also arranged so as to produce a double lighting effect. Switches are located near swinging door connecting the room with the kitchen.

Kitchen Lighting is obtained from a single lamp in the center of the room, switched on from wall near dining room entrance.

Basement Lighting is controlled from head of stairs, which enables servants or members of the family to have lights burning upon entering and turn them off after leaving basement.

Electrical Appliances having now become so popular, it was deemed advisable to provide suitable receptacles in the walls of each down stairs room to accommodate the fan motor, portable lamp, flat iron, chafing dish, cooker, etc.

SIX-ROOM HOUSE—SECOND FLOOR PLAN

Upstairs Hall Lighting is switched from the head of the stairs.

Chamber Lighting is controlled at the entrance to each room and arrangements made for lights near dressers. Wall brackets are not shown in any of the plans because their positions must necessarily vary with the location and style of furniture used.

Bathroom Lighting consists of one light on each side of mirror, a most convenient arrangement when shaving. Chambers and bathroom are provided with baseboard receptacles so as to attach plug for electric fan, heating pad, curling iron, etc.

SEVEN ROOM HOUSE—FIRST FLOOR PLAN

Porch Light is of the bracket type and is switched from the living room.

Living Room Lighting is so designed that either portion of the room may be lighted as desired, and either a group of four, five or but one lamp in each portion burned at one time.

Dining Room Lighting has coupled into one fixture two separate light schemes, controlled by a pair of switches located near door leading into butler's pantry.

Den Lighting consists of one ceiling light controlled near doorway.

Pantry Lighting is of ceiling type turned on or off by means of pull chain extending down to within easy reach.

Basement Lighting is switched on from top of cellar stair near pantry.

Back Porch Lighting is controlled by switch just inside of kitchen.

Kitchen Lighting provides for a ceiling type fixture and the switch is located at a convenient place near entrance to stairs leading to second floor. Wall receptacles are provided in each down stairs room.

SEVEN ROOM HOUSE—SECOND FLOOR PLAN

Upstairs Hall Lighting, together with a portion of living room lighting, which aids in illuminating stairway, is switched from upper hallway as well as at foot of stairs.

Chamber Lighting is from the center of the room and is switched at the entrance to each room.

Bathroom Lighting is as in Plan No. 1, namely, one light on either side of mirror.

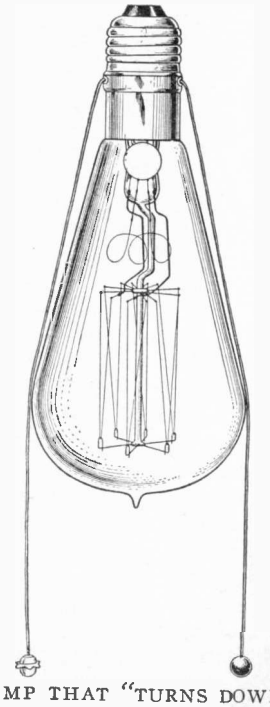
Attic Lighting is switched from foot of stairs leading to same.

In living room and dining room we suggest the use of frosted lamps for at least a portion of fixtures, thus giving a subdued light when the occasion requires, it not being advisable to have the direct rays of unprotected lamps.

If tungsten lamps are used in the lighting of this home you will not only have the best illumination known to modern civilization, but also a lighting system which costs no more than the many inferior illuminants.

The Lamp That "Turns Down"

I wish I had an electric incandescent lamp that would turn down so that I could leave



LAMP THAT "TURNS DOWN"

it burning dim all night, in the sleeping room or bath room, and still not have to worry

about next month's light bill. Those who have made a remark similar to this will be interested in the new turn-down tungsten lamp which gives the desired result.

This lamp contains two filamets. One of these, the lower and larger one, is of tungsten, the highest efficiency filament known. It gives 27 candle power on about two-thirds the number of watts of electric energy that is required for the ordinary 16 candle power carbon filament lamp. The other filament is a small one of carbon which gives one candle power on an expenditure of about one-fifth the current required for an ordinary 16 candle power lamp. Pulling one of the strings turns on the small filament and pulling the other causes the tungsten filament to glow. So you can have which ever light you desire.

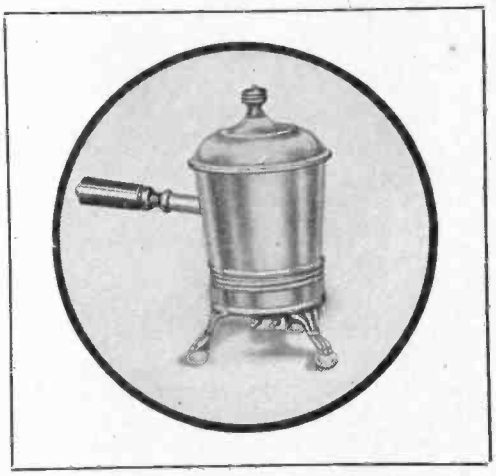
At ordinary rates for current the small filament may be burned all night for less than one cent. It lights the room enough to see one's way about and in the bedroom the light is not strong enough to prevent sleeping. At a moment's notice the large filament may be turned on with its full 27 candle power.

Appropriate Holiday Gifts

An impetus has been given the use of the popular electric household devices such as percolators, chafing dishes, tea kettles, etc., owing to the fact that a large choice of designs is now available. Hitherto manufacturers have taken only a few styles of heating devices and equipped them electrically. Manufacturers of non-electric cooking utensils have come to realize, however, that electricity is the coming heating agent in the home and that the housewife who is to employ electricity must have a "full line" of utensils if she is to use current to the best advantage. As a consequence the variety has been greatly increased and one manufacturer offers a choice of 30 designs for the Holiday trade.

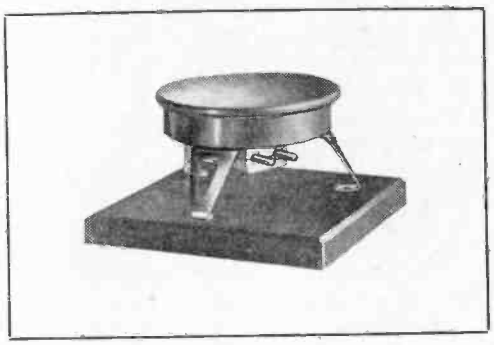
Two of these latest types are illustrated. One is a new electric water heater which can be used in a hundred different ways, particularly as a milk warmer, egg boiler or for heating liquids generally. It is made of copper, heavily riveted, and is available in pint and quart sizes. A larger size of heater for two, four or six quarts is suitable for preparing an entire dinner. A range of three heats allows a satisfactory regulation of the thermal effect.

Disk stoves are rapidly being adopted for small households. These stoves are remarkably quick and efficient, being of the



ELECTRIC WATER HEATER

encased disk unit type. These new stoves are able to operate at a much greater activity (watts per square inch) for a given size than electric stoves have formerly been. This is due not only to radical improvements in

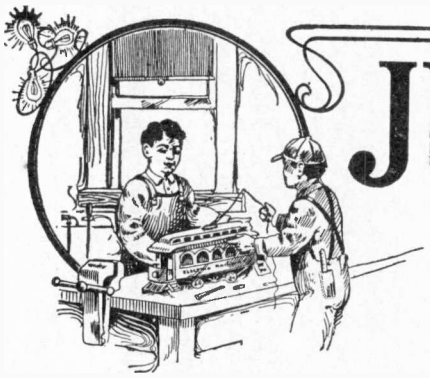


DISK STOVE

the design or application of the heating elements, but also to the material and construction of the heating element itself.

Either one of these utensils makes a very appropriate Holiday gift.

In Kerns, Switzerland, is an electric bakery oven eight feet long by four feet wide which will bake 100 pounds of bread at once. Modern methods on a large scale have made bread making in the home almost a lost art.



JUNIOR SECTION

Construction of An Electrical Influence Machine

By PAUL S. WINTER

Several years ago, I decided that an electrical influence machine or static machine, as it is often called, was necessary for a line of experimental work which I wanted to pursue. It did not take me long to discover that my pocketbook would not allow the purchase of a first-class machine. I therefore decided to build one for myself, and had no trouble in finding descriptions for the construction of small two-plate machines which make very nice toys, but are utterly worthless for practical X-ray work. The following description is of a large machine which proved the most satisfactory of the several which I have built. This machine has been in use for several months in X-ray work with good success, producing the high tension current which is so essential for the operation of high-vacuum tubes.

The case is made of poplar, the four corner pieces, marked (1), Fig. 1, being cut from 2¼ inch square stock, five feet long. Three cross-pieces, marked (2), (4) and (5), Fig. 1, are cut four feet eight inches long from ¾ by 3 inch stock for the front and three more of the same for the back. These are braced both front and back through the center by pieces of the same stock cut four feet nine inches long. At the ends are three pieces of the same stock 20 inches long, one placed at the top, one in a position corresponding to the cross-piece marked (4), and the third corresponding to the cross-piece marked (5). The corner posts are cut out to receive these cross-pieces in the manner shown in Fig. 3, the cuts being ¾ by 3 by ½ inches deep and are readily made with chisel and mallet, three screws being used to hold each in place. The vertical pieces (6), Fig. 1 (front and back), are joined to the cross-pieces in the manner shown in Fig. 4, four ¼-inch bolts being used to hold them in place.

Next cut two pieces of the same stock 26 inches long, (3), Fig. 1. These should be centrally located. Four pieces six inches long should be cut and fastened in the corner posts as shown at (7) and (8), Fig. 1. Before putting (7), (8) and (3) in place, the ends marked (9) should have three ⅝-inch holes drilled into them ½ inch deep.

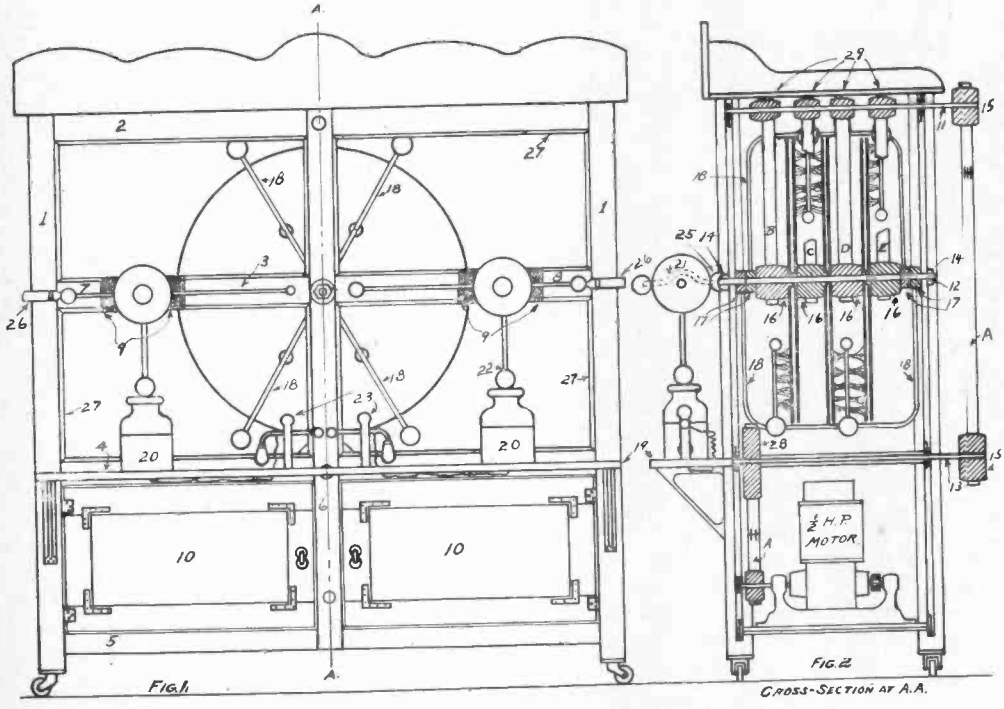
The flooring, sides, and back of the cupboard, cut from ⅜ by 8 inch stock, can now be put in place; also the top made from the same material, the builder following his own ideas as to the shape of the edging around the top. Two doors, marked (10), Fig. 1, were placed in the front of the cupboard. I made a frame of ¾ by 3 inches, the whole held together by corner irons. Hinges, locks and handles may be bought at any hardware store to suit the builder's fancy. Four suitable casters were fastened to the corner posts. Three pieces of cold rolled steel ⅝ inch in diameter were used for shafts marked (11), (12) and (13) Fig. 2. The center shaft (12) should be just long enough to allow a nut on each end outside the case

as shown at (14), Fig. 2. The top and bottom shafts should be long enough to extend through the case and take a six-inch pulley, as shown at (15), The bearings for these shafts were made by boring a 1½-inch hole through the uprights (6). The shaft should then be placed in a central position with washers of heavy cardboard fastened on each side of the cross-pieces and Babbitt metal poured into the holes. When cool, the cardboards should be removed and 3-16-inch oil holes drilled.

The pulleys (16), Fig. 2, which support the glass plates can be turned from good, well seasoned hardwood. They should have an inch hole drilled exactly through the center and be fitted with a brass bushing which should fit the shaft very closely. The two center pulleys should be faced on each end, leaving a boss 1½ inch in diameter projecting 3-16 inch. The end pulleys have a similar boss on one end only. Great care must be taken to have the face true with the bore; otherwise the plates will not run true.

Six glass plates are now needed 32 inches in diameter with a 1¼ inch hole exactly in the center. These should be of double-strength glass, as clear and flat as possible. I would advise the builder to have these cut to order as it is a very difficult job to do and would prove more expensive in the end to try to make them himself. These plates should be cemented to the pulley with a flannel washer between the pulley and the plate, great care being taken to have the plate square with the pulley. Use Le Page's glue and allow to stand for 36 hours.

Four brass collars should now be made as shown by Fig. 6, and at (17) in Fig. 2. Procure some ¼-inch iron rod and cut long enough to make four U-shaped pieces shown at (18). These should be long enough to reach the holes in the collars and clear the plates by at least two inches. They are called the neutralizing rods.



Next have cast at the nearest foundry, of good quality gray iron, twenty-five balls one inch in diameter, and twenty-five, two inches in diameter. Eight of the large balls should have a 5-16 inch hole drilled clear through them and another, 3-16 inch, drilled at right angles to the first and to the center of the ball, the latter being tapped ¼ inch. Cut eight pieces of ¼-inch rod 10 inches long and thread on both ends. These are to be fitted with brushes as shown at Fig. 2, which is accomplished by drilling five holes, ⅛-inch diameter, equally spaced.

The rods may then be screwed into the large balls on the neutralizers far enough to nip the neutralizing rods, which will hold them in position. The brushes are made of gilt braid which should be cut just long enough to sweep the plates, unraveled and drawn through the five holes with a small wedge of wood driven in to hold them securely. One of the small balls should now be screwed on the other end of the rod.

The approximate position of the neutralizers is shown in Figs. 1 and 2. As no two machines act exactly the same, it is best to

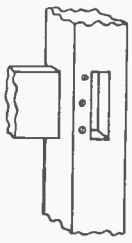


FIG. 3.

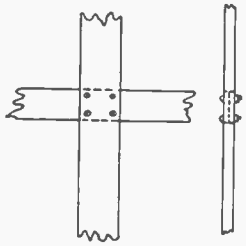
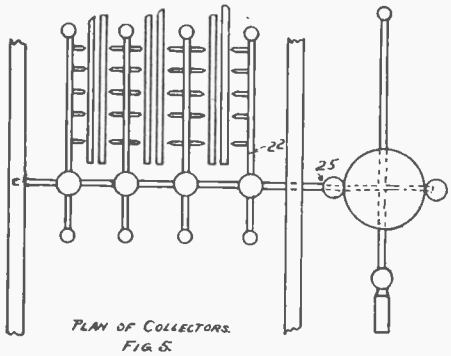


FIG. 4.



PLAN OF COLLECTORS.
FIG. 5.

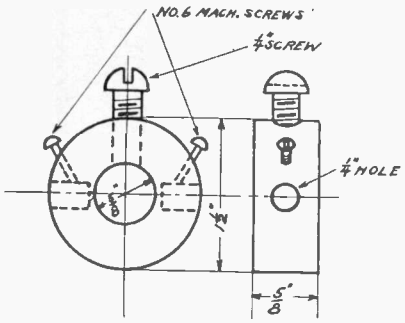


FIG. 6.

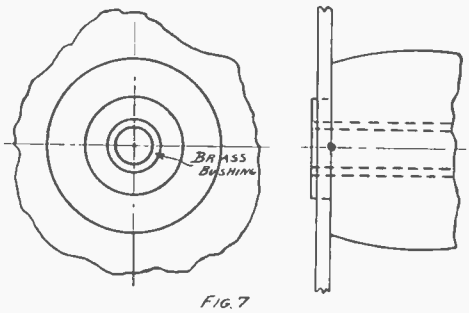


FIG. 7.

experiment with them after the machine is running, to determine their proper position.

A shelf should now be cut from 1 by 12 inch wood and placed on the front of the machine supported by brackets as shown at (19). It will improve its appearance as well as its practicability to round off the corners of the shelf. Upon this shelf are placed two quart-size Leyden jars, as shown at (20). I would advise the purchase of these jars as it does not pay to try to make them.

We now come to the most difficult part of the work, which is the placing of the collector rods and spark gap. First procure two five-inch steam-trap floats. They may be bought at any plumbing supply house, and are generally found to have a ¼-inch tapped hole. At four points of the circumference, 90 degrees from this hole and from each other, drill ⅜-inch holes. Now cut two pieces of ⅜-inch iron rod, 25½ inches long and thread one end; cut two pieces of the same size rod, six inches long and thread both ends. These latter should be slightly bent in the center as shown at (21), Fig. 2. They should then be slipped through the floats and a large ball screwed on each end tight against the float.

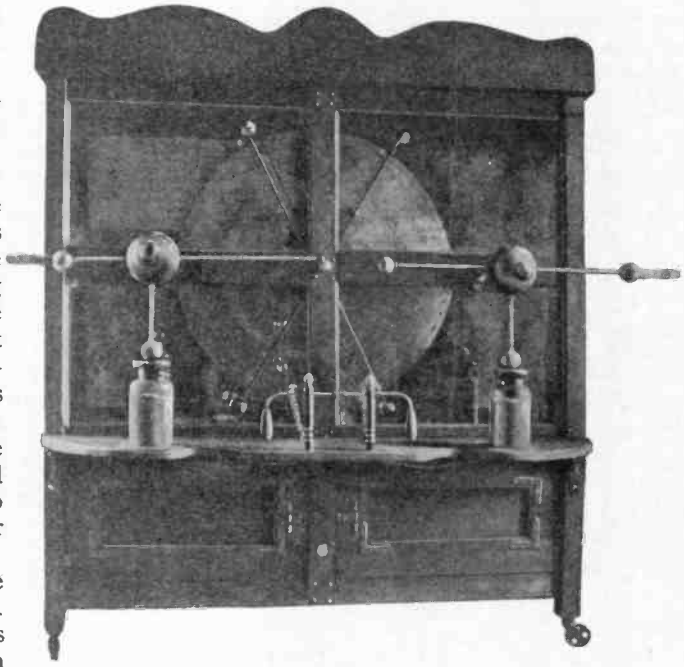
The longer rod should be screwed into one of the cast iron balls as shown in Figs. 2 and 5 at (25). Through eight of the large balls drill a 13-32-inch hole. A 3-16-inch hole should now be drilled at right angles to the first and tapped ¼ inch. Four of these balls should be placed on each of the collector rods and 10-inch lengths of ¼-inch rod screwed into each ball as shown at (22), Fig. 5. These rods should have five points of ⅛-inch steel wire driven into them and one of the small balls screwed on the end. On the opposite side of each large ball should be screwed a two-inch length of ¼-inch rod with a small ball screwed on its other end. These latter act as set-screws

and clamp the collectors in position. Fig. 5 shows a plan of the collectors, both sides being the same. The collectors should then be temporarily fastened in the center of the opening between the cross-pieces (3) and (7) and (3) and (8).

A piece of ¼-inch iron rod should now be cut long enough to reach from each float to the Leyden jars, the balls on the top of the jars being tapped out to receive the rod as shown at (22), Fig. 1. Pieces of stout cardboard should be bent to cover the sides and bottom of the opening between the pieces (7) and (8), and (3). Next procure some good quality sealing-wax which should be melted and poured into the moulds, thus formed. This acts as an insulator for the collectors, the wax running into the ⅝-inch holes in the ends of the cross-pieces at (9) as before described holding the wax in place. It is well to first reinforce with stout twine. When cool, the cardboard should be removed and the collectors shifted to a position on the collector rods as shown in Fig. 5.

The spark gap rods are made from ⅜-inch iron rod. They pass through the floats and are fitted with a ball on each end, a large size chisel handle being fitted to the outer ball as shown at (26). A secondary spark gap should now be made by fastening two hardwood standards as shown at (23), Fig. 1, with ¼-inch rods passing through them, a ¾-inch ball on one end of each and a small handle on the other. These rods should be connected to the outer coatings of the Leyden jars as shown. Glass doors may now be fitted in the ends, a frame-work being made of ¾ by 3 inch stock and fitted with hinges and locks. Also four plates of glass can be fitted in the front, and four in the back, and held in place by quarter-round nailed on each side of the glass as shown at (27). The best way to drive this machine is by an electric motor, one rated at ½ horsepower being required. The position of the motor in the case is shown at Fig. 2, also the manner of belting it up to the plates. The size of the pulleys 28 and 29 will depend entirely upon the speed at which the motor runs. They should be figured large enough to give the plates a speed of 200 to 250 revolutions per minute when working at full load.

Belt marked (A), Fig. 2, should be 1¼ inch wide, (B), (C), (D) and (E) are one-inch belts, alternately open and crossed, causing the plates of each pair to run in opposite directions.



THE COMPLETED STATIC MACHINE

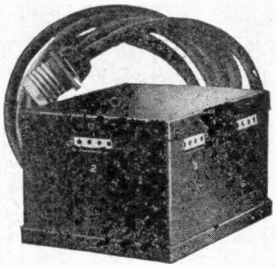
The case may now be given any desired stain or finish, the iron rods painted black and the balls gilded, thus giving the machine a very fine appearance. The machine may now be started up. As a rule, it will not generate at once, but may be started by applying friction. The best method of doing this is by holding against one plate, while the machine is running, a stick of wood covered with leather coated with amalgam of tin, mercury and zinc. After the machine is started, if the room be darkened, the points of the collectors on one side of the machine will be seen to glow like stars, while those on the other side will appear as brushes. The side showing the stars is the positive side, the one showing brushes being negative. If the spark gap be pulled out now for eight or ten inches, the

builder will feel well repaid for the time and money expended. I have found that if the ball on the positive side of the spark gap be one-third the size of the one on the negative side, much better results will be obtained. This machine, when thoroughly dried out, should give an 18-inch spark when the plates are running at a speed of 250 revolutions per minute.

In closing, I would warn the builder to be very careful in handling this machine as a very dangerous and even fatal shock may be obtained from it. The current obtained is small, but the voltage is very high.

Toy Transformer

The old system of using storage or dry batteries for operating toys and miniature lights was very troublesome. Dry batteries are very easily short circuited and thereby put out of commission at once, and the majority of storage cells contain acids and other compounds which are liable to spill and ruin clothes, carpets and rugs. No such troubles are experienced with the small transformer shown. It is designed to be

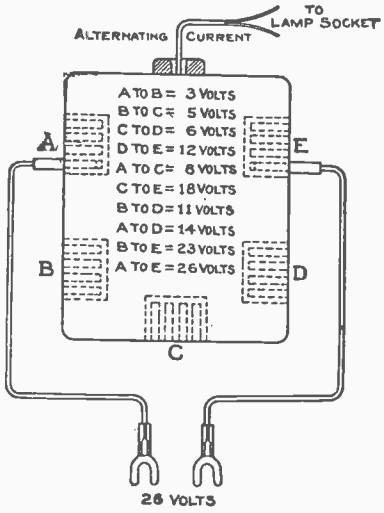


TOY TRANSFORMER

connected direct to any alternating current lamp socket and does the work more satisfactorily than batteries.

The Thordarson transformer shown in the cut generates ten different secondary potentials, stepping down the 110 volts to ten different voltages. These voltages may be used singly or all at one time, or two or more voltages may be used at the same time. There is no danger owing to the fact that the secondary windings are entirely separate from the primary and are thoroughly insulated. Any inexperienced boy may readily use the transformer by following the instructions, becoming familiar with the different circuits in a few moments.

The transformer will operate all classes of electrical toys, such as small motors, electrical trains, bells, buzzers, electric engines, miniature lamps, etc. Another feature of this field and one that is not generally known is that all small direct current battery



TEN DIFFERENT VOLTAGES CAN BE OBTAINED

apparatus that does not require more than 50 watts may be operated with a toy transformer on an alternating current without any change in the windings or connections.

QUESTIONS AND ANSWERS

Readers of Popular Electricity are invited to make use of this department. State your questions as clearly and concisely as possible. No consideration will be given to communications which do not contain the full name and address of the writer

Enclosed and Open Arcs

Question.—I have had trouble with my outside arcs. There are four of them all feeding from the same circuit. Three of them had the inside globes broken and would eat up the carbons in two hours of burning. The one having an enclosing globe burned normally. What action has air on the carbons to make them burn so fast?—J. C. G., Minneapolis, Minn.

Answer.—Experiment proves that the arc of a lamp enclosed in a small globe which practically excludes the air, burns the carbon up, leaves no dust, and also burns the carbon at a slow rate. The voltage of the enclosed arc should be 70 to 75 volts on A. C. lamps and 75 to 85 volts on D. C. arcs. Least current three amperes; maximum, 7½ amperes. When the arc begins to burn, the enclosing globe of course contains air. The oxygen in this is soon combined with carbon and in five minutes or less the bulb is filled with hot carbon monoxide (CO) carbon dioxide (CO_2) and nitrogen. The globe of an arc lamp is not air-tight, consequently a little oxygen is always inside, just enough to burn the carbon that would otherwise deposit on the glass. In the open arc lamp where the oxygen can freely reach the carbon, the latter is consumed at the rate of 1½ inches per hour as against .05 to .08 inch per hour in an enclosed lamp.

Winding a 110 volt Shunt Motor

Question.—Will you please tell me what size and kind of wire to use on the armature and field of a 110 volt shunt-wound dynamo?—E. R. P., Chicago, Ill.

Answer—In winding such a motor double cotton covered wire is the best to use. Allow 1200 circular mils cross-section in the wire for each ampere. This rule is a standard one in dynamo construction. Other information than these generalities we cannot give you as you give us almost no data to work on. To give full directions for winding a dynamo, specific data must be given as to dimensions of machine, voltage and amperage, etc.

Earth Magnetism; Magneto; Condenser

Questions.—(A) What is the value for this place (Lat. 30°, Long. 95½°) of the horizontal component of the earth's magnetism? (B) What is the voltage and amperage of a common five-bar telephone generator? (C) In calculating voltage and amperage of a slot armature does the same rule as for drum armatures apply? (D) How should I construct a ½ micro-farad condenser?—J. E. W., Brashear, Tex.

Answers.—(A) As given by the United States Coast and Geodetic Survey the value of the earth's horizontal component, H, for El Paso, Texas, is .277.

(B) The voltage of any magneto generator depends upon the strength of the magnetic field, the number of turns of wire on the armature, the speed, and the relation between the face of the armature and the pole pieces. Sixty to 80 volts is the usual E. M. F. The current is smal..

(C) Yes. See answer to C. F. S., in the November, 1909, issue.

(D) The capacity of a condenser depends upon the nearness of the conductors to each other and upon the area of same. A condenser of one micro-farad contains about 3,600 square inches of tin foil. With this information see page 34 of the May, 1909, issue for construction of "The Condenser."

Rail Expansion

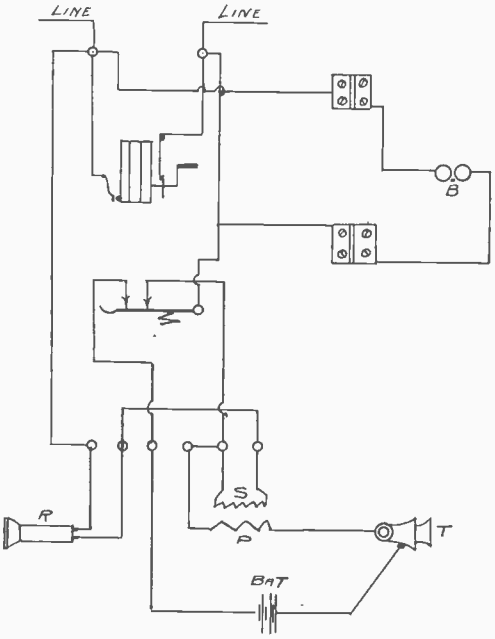
Question.—Will you explain how street railways allow for expansion and contraction in their rails where they use the modern method of welding the rails together.—J. G. P., Morris, Ill.

Answer.—As street railway rails are now laid, only the upper flange of the rail is exposed to the sun's rays and air currents, the lower part of the rail being covered by concrete, brick, and gravel. "For this reason," a railway engineer states, "the extremes of temperature to which the rails are subjected are not nearly so great as in railroad work. In addition to this the concrete and earth surrounding the rail diminish expansion and experience shows that welded rails are a success."

Bell and Telephone Wiring

Questions.—(A) Kindly tell me how I can arrange several bells on two wires so I can ring any one bell without the others ringing. (B) Of what use is an induction coil in a telephone? (C) Please explain the Bell system of operating a four-party line. (D) How is the inside of a telephone wired? —R. A. Z., Cleveland, Ohio.

Answers.—(A) See "More Doorbell Engineering," in the October, 1909, issue. Omit the fifth push button and middle wire with back contacts to bells.



HOW THE INSIDE OF A TELEPHONE IS WIRED

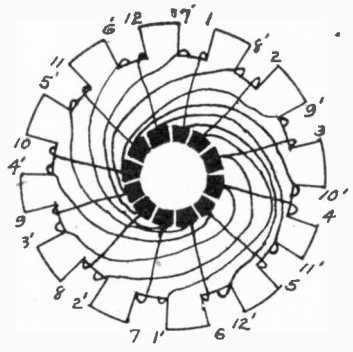
(B) The resistance of the line-wires of a telephone circuit is high compared to the resistance change that a transmitter in this circuit may produce. But, suppose the line wires be connected to the secondary of a coil, while the primary wires be placed in series with a local battery and a transmitter. The result will be that a variation say of one ohm in the transmitter resistance, will in this local circuit be in a far greater ratio to its total resistance than this variation would be to the resistance of the long line wires. Hence current fluctuations will be larger by using the induction coil.

(C) The telephones are bridged across a two wire metallic circuit, while the bell when the hook is down is connected between one side of the line and the ground. Central grounds when ringing a subscriber.

(D) See diagram.

Winding a 12-slot Armature

Question.—Will you please show diagram for winding a 12-slot armature?—G. E. H., St. Louis, Mo.



WINDINGS OF A TWELVE SLOT DRUM

Answer—See diagram with coils numbered 1-1′, 2-2′ and so on.

Single Phase Induction Motor

Questions.—(A) Why is the field of an induction motor always laminated? (B) How are the latest types of single phase induction motors wound to give strong starting torque? (C) Are the starting coils wound in every slot of the field? (D) Why are the poles of these motors twisted of line with the shaft?—A. L. C., Albany, N. Y.

Answers.—(A) To prevent eddy currents in the core and consequent loss.

(B) The Wagner single phase induction motor starts up as a repulsion motor, but after it has attained speed it operates as a regular single-phase motor with short-circuited armature. The armature is provided with a regular direct-current winding placed in slots and connected to a commutator.

(C) Special slots are provided in the core for the starting winding.

(D) Your question is not clear.

Two and One Wire Telephone Circuits; Aerial Wire

Questions.—(A) Please show me a telephone circuit with only a transmitter, receiver with a hook, a push button and two line wires. (B) Show the same using one line wire and a ground. (C) What is the best wire for aerials?—W. S. H., Bath, Me.

Answers.—(A) See answer to W. C. V. in the February, 1909, issue.

(B) See answer to K. Y. in the March, 1909, issue.

(C) Stranded phosphor bronze wire is best, but copper wire no smaller than No. 16 B. and S. gauge is next to be preferred.

20-Watt Dynamo; Battery Operation; Pony Telephone Receiver

Questions.—(A) With what size wire should the field of a 20-watt dynamo be wound to give ten volts and two amperes. (B) Please show how to connect batteries in series multiple. (C) Explain how to make a voltmeter and ammeter. (D) Please give solution for a gravity cell. (E) Why are the tungsten lamps so saving? (F) Show how to make a pony telephone receiver.—G. D. P., Ridgeway, Pa.

Answers.—(A) No. 22 B. and S. gauge.

(B) See diagram page 164, July, 1909, issue.

(C) Refer to page 797, April, 1909, issue.

(D) See Prof. Houston's "Elementary Electricity" in the October, 1909, issue.

(E) Tungsten filaments may be brought to a much higher temperature within the globe than carbon filaments, as the latter vaporize slowly at a temperature far below their fusing point and tend to blacken the interior of the globe. Though tungsten melts at a point lower than carbon it can be operated at a temperature quite up to this melting point without vaporizing, consequently tungsten filaments, in a lamp, are "run hotter" than carbon filaments, and the higher the temperature the more intense the light. Tungsten filaments are also much better conductors than carbon, so to have, say, the same resistance as a carbon filament they may be made thinner and about three times as long, giving more light per watt consumed. A tungsten lamp takes only about 1¼ watts per candle power.

(F) See article on "How the Telephone Operates" in the July, 1909, issue.

Varying Speed of Shunt Motor; Running Shunt Motor as a Generator

Questions.—(A) How may the speed of a shunt motor be reduced? (B) How may a shunt motor be set up as a generator?—E. T. N., Portland, Me.

Answers.—(A) In a direct current motor

$$S = \frac{m \times 10^8 \times 60 \times E}{P\ H\ Z}$$ where

S = speed of armature,
m = number of paths through each winding,
P = number of poles,
H = total number of lines of force leaving or entering each pole piece,
Z = number of face conductors on the armature,

From this equation it is evident that S may be reduced by reducing E at the brushes. This may be done by placing an adjustable resistance in series with the armature. The speed may also be reduced by increasing H. This may be accomplished by cutting out resistance in the field rheostat.

(B) Connect the positive lead as a generator to the positive feed wire, and the negative lead as a generator to the negative side of the line, providing a starting-box of proper capacity in series with the armature. Also provide a service switch, and protect each lead by a fuse. The machine will now run as a motor in the same direction that it did as a dynamo.

Winding Eight-Slot Drum Armature

Question.—I have a drum type armature 3¼ inches long, 3 inches in diameter, 8 slots 9-16 inch wide by 5-16 inch deep. How shall I wind it? Commutator has 8 segments, field is bi-polar shunt wound.—H. A. G., St. Paul, Minn.

Answer.—See answer to T. F., April, 1909, issue for information as to how to wind an eight-slot armature. Use 2½ ounces of No. 22 wire on the armature, and 10 ounces of No. 24 wire on the field cores.

Rectifier; Motor Operation

Questions.—(A) How can I make a small liquid rectifier to change 10 volts a. c. to d. c.? I am using a transformer to step down from 110 volts to 10 volts, and wish to get 10 volts d. c. (B) Why will not my ⅛ horsepower d. c. motor run on a. c.? The motor is shunt wound. (C) Why does a 12-inch fan dim the lights in the house when starting up? They remain that way until the motor is switched off. I can find no grounds and six ampere fuses protect the circuit. The transformer is in front of the house so there ought not to be any voltage drop.—J. H. S., Wilkesbarre, Pa.

Answers.—(A) See article on "Changing Alternating Current to Direct" in August, 1909, issue. In this case use the rectifier on the 110-volt circuit. It will give you 80 to 90 volts d. c. Then reduce to 10 volts by resistance.

(B) Reduce the number of turns in each field coil and place the fields in series with the armature.

(C) See "Talks With the Judge," November, 1909, issue. Are your feeders from the transformer to the house service switch large enough? Look for a loose connection or nearly broken wire.

Transformer Winding

Question.—Please give the proper winding for the right angle core illustrated in the September, 1909, issue, so that with 475 volts on the primary, 110 volts may be obtained on the secondary.—J. E. McC., McCormick, Wash.

Answer.—Leaving the secondary winding as suggested, provide 2,370 turns of No. 23 double cotton-covered wire on the primary. Protect the primaries by a one ampere fuse.

Notes on Patent Infringement

By OBED C. BILLMAN, LL. B., M. L. P.

Use of equivalents—Definitions; Additions to and Improvements upon Patented Invention; Comparative Superiority or Inferiority of Infringing Device.

Definitions.—The term "equivalent" as used in the law of patents has two meanings, one relating to results produced by inventions and alleged infringements, and the other to the devices, elements, or ingredients by which those results are produced. Wherever used in this article pertaining to infringement, it invariably has the latter meaning. For the purpose of determining the question of infringement, the substantial equivalent of a thing is regarded as the same as the thing itself.—Union Paper Bag Mach. Co. vs. Murphy, 97 U. S. 120.

Mechanical Equivalent.—When in mechanics one device does a particular thing or accomplishes a particular result, every other device known and used in mechanics which experienced and skillful workmen know (without the exercise of the inventive faculty) will produce the same result or do the same particular thing, is a known mechanical equivalent for the first device, although the first may never have been detached from its work and the second put in its place.—May vs. Fond du Lac County, 27 Fed. Rep. 691.

Chemical Equivalent.—A chemical equivalent of a substance is another substance having similar properties and producing substantially the same effect.

As Affected by Nature of Invention.—Patentees of combinations are undoubtedly as much entitled to the benefit of equivalents as are the patentees of all other classes of inventions.—Boston, etc. St. R. Co. v. Bemis Car-Box Co., (C. C. A.) 80 Fed. Rep. 287; Bundy Mfg. Co. v. Detroit Times Register Co. (C. C. A.) 94 Fed. Rep. 524. It is believed, however, that in reality no case has gone further than to lay down the correct proposition that a mere improver of a known machine cannot invoke the doctrine of equivalents for the purpose of suppressing subsequent improvements which are not mere colorable evasions of his own. The true rule is that the range of equivalent depends upon the nature, merit and extent of the invention; Miller v. Eagle Mfg. Co., 151 U. S. 186; a pioneer inventor being entitled to a broad and liberal range. Morley Sewing Machine Co. v. Lancaster, 129 U. S. 263; and an improver to a more or less restricted range, proportioned according to the prior state of the art and the advance which he has made therein, Erie Rubber Co. v. American Dunlop Tire Co. (C. C. A.), 70 Fed. Rep. 58; Thus, a device is the equivalent of a device in a pioneer invention or simple machine when it performs the same function without varying the principle of the invention; but in order to be the equivalent of an element of a combination, it must not only perform the same function, but must perform it in substantially the same way, or as the doctrine is stated in a number of cases, it must perform the same function, and have been well known at the date of the patent as a proper substitute for the omitted element.—Jensen Can Filling Mach. Co. v. Norton, (C. C. A.) 67 Fed. Rep. 236.

Superior Device as Equivalent.—A device may be an equivalent even though it performs more functions than the thing for which it is substituted, or performs them better.—Consolidated Fastener Co. vs. Hays, (C. C. A.) 100 Fed. Rep. 984.

Substitute not Known as Equivalent.—The use of a substitute is not an infringement unless it was known to ordinarily skillful mechanics or chemists at the date of the patent as an equivalent for the thing for which it is substituted; but if it was known to others, it need not have been known to the patentee. —Detwiler vs. Bosler, 55 Fed. Rep. 660

Additions to and Improvements upon Patented Invention.—*Use of Patented Article by Improver.*—A person does not acquire the right to appropriate a patented invention or the substance thereof without the consent of the patentee by merely adding to or improving upon it, even though his addition or improvement is of itself patentable, or has, in fact, been patented.—Kinsinger-Ison Co. vs. Bradford Belting Co., (C. C. A.) 97 Fed. Rep. 502; National Cash Register Co. vs. American Cash Register Co. 47 Fed. Rep. 212; Goshen Sweeper Co. vs. Bissell Carpet Sweeper Co., (C. C. A.) 72 Fed. Rep. 67. This rule, however, does

not permit an improver of a known machine to hold as an infringer the inventor of a substantially different improvement.

Use of Patented Improvement by Original Patentee.—A prior patentee is not entitled to use a patented improvement of his invention without the consent of the patentee thereof.—Bowers vs. Pacific Coast Dredging, etc., Co. 99 Fed. Rep. 745.

Comparative Superiority or Inferiority of Infringing Device.—*In General*—The comparative utility of two machines or processes is not an absolute test of infringement; nor does comparative superiority or inferiority necessarily import non-infringement.—Crown Cork, etc., Co. vs. Aluminum Stopper Co., (C. C. A.) 108 Fed. Rep. 845. Hence a device may be an infringement of a patented invention, even though on the one hand it is better, simpler.—National Typographic Co. vs. New York Typograph Co. 46 Fed. Rep. 114; cheaper, —Odiorne v. Denney, 3 B. & A. Pat. Cas. 287, 18 Fed. Rep.; No. 10,431; or productive of better results;—Crown Cork, etc. Co. vs. Aluminum Stopper Co., (C. C. A.) 108 Fed. Rep. 845, or on the other hand is inferior in its structure, usefulness, operation or results.

A COURSE IN PRACTICAL ELECTRICITY, in Twelve Lessons for Home Study. By Joseph G. Branch, B. S., M. E. Chicago: The Branch Publishing Company. 1909. Price $10.00 in monthly installments.

The author of this series of books, composing a most practical course in electricity, is a well known engineer and electrician, he having been for years chief engineer for the city of St. Louis, member of the Examining Board of Engineers for that city, and has also held other responsible positions. In addition to much practical work, he has also written a number of practical books for engineers and electricians. In presenting this Course of Home Study in Electricity, he is to be congratulated on the delightful way in which he has treated the subject, every lesson leading up to the next in regular order through a system of questions and answers, which are valuable by reason of their very suggestiveness.

The complete course of instruction comprises twelve lessons which are bound up in six books, being two lessons to each book. A membership certificate, entitling the member to ask any questions pertaining to his lessons for a period of one year from receipt of his first lesson, forms a part of the course.

The entire course is written in the form of questions and answers. Practical experiments are given throughout the course, and full directions also given to the student so that he can make almost all the apparatus described, thereby enabling him to perform the experiments for himself.

There is but little mathematics in the entire course. The lessons are written in the simple and clear language which characterizes all of Mr. Branch's writings, there being little or no superfluous matter, but every word is made to count. As the course is intended chiefly as a practical course of instruction for those who wish to learn electricity as a trade or profession at the least expense and in the shortest possible time, there is but little theory throughout the course.

The lessons are just long enough to occupy the short time in the evenings that a tired workman, or boy, can afford to give to study. The lessons are so arranged that portions of each lesson may be mastered in an evening. They may be picked up at any leisure moment, in the engine room, in the office or shop, or at any time one has a few moments to spare.

With this object in view, he has divided the study of electricity into lessons so arranged as to cover the entire field of practical work. In Lessons 1 and 2 he treats on static and dynamic electricity; in Lessons 3 and 4 energy, work and power, together with types of cells and the electric circuit; in Lessons 5 and 6 is given the different forms of magnetism, electrical measurements and the electrical researches of Faraday; in Lessons 7 and 8 the dynamo, together with the mechanical generation of currents; in Lessons 9 and 10 properties of alternating currents, and in Lessons 11 and 12 electric lighting, electric railways, power stations, central station work, electric wiring, and wiring tables are fully explained.

The chief value of this course of study lies in the practical way the subject is treated, and the clear and simple language used by the author.

EDITORIAL ANNOUNCEMENTS

It is perhaps a little early to make New Years promises, but there are some things in store for the January issue about which we are sure our readers will be interested in knowing beforehand.

The New Year seems to be the generally accepted time to "start something," and there are several good things which we are saving up for the occasion.

Plans are under way to give in succeeding issues more, if possible, of the "human interest" side of electrical development, which of course adds interest to any theme. But it isn't the easiest matter in the world to strike the proper balance between the proportion of the reading pages which should be devoted to articles of this character and the proportion which should be devoted to the more scientific and practical phases of the subject. There is the casual newsstand buyer who may not care to "do things" with electricity but who is interested in it as a wonderful and mysterious force. To him the articles along general lines, intermingled with people and events will appeal. Again, there is a large class of readers who would like to see every number of this magazine crammed with diagrams showing them how they could apply electricity to this and that operation —these are the students and practical workers. Still another class looks to the magazine for descriptions of the newest electrical devices turned out by the manufacturer, that they may apply them in their business operations or in their homes. All these must be made satisfied as great a portion of the time as possible.

As intimated above, however, it has seemed to us that perhaps the "human interest" reader hasn't had quite his share, and we are going to take care of him.

But this isn't telling of those things which are to come in January.

"In the Beginning"

In the year 1850 the firm, Hinds, Ketcham & Company, which has been out of existence these many years, did a color printing business in the very heart of New York City. In the fall of that year they were visited by a man who said he represented Thomas A. Edison and who desired statistics concerning the number of gas lights they used and the cost of operating the same. The "Wizard of Menlo Park" was even then no stranger to the public, and people had heard of his experiments in the making of light by electric current. Quick to grasp the significance of these facts and the advertising possibilities which they presented Joseph E. Hinds went to see Mr. Edison and finally persuaded him to install in their printing establishment a dynamo-electric machine, which was done before the close of the year. Then, one night in December, electric current was for the first time made to light a building—an event which marked an epoch in the world's history.

Of this historic plant, sadly enough nothing now remains in its original place. Parts of the equipment only are in existence which were saved from the scrap heap. But, fortunately, Mr. Hinds has realized the importance of keeping alive the facts concerning this remarkable plant and the incidents connected with its construction and early operation. These facts he will present to us under the title "In The Beginning" which will appear complete in the January issue of Popular Electricity, together with reproductions from photographs of the original apparatus just as it appeared in the plant. The author says: "Without pretending to possess any technical or practical knowledge on the subject, my purpose is to relate in as few and simple words as possible the story of the establishment of the very first plant in the world whereby a building was illuminated for practical purposes by incandescent electric lamps." That his narrative is intensely interesting you will see.

Where Electricity Stands in the Practice of Medicine

We are all interested in those things which have to do with our health. Of late years electricity has been an efficient assistant to the physician and surgeon and as such it commands the attention not only of those following the profession, but of the layman as well. It is not a cure-all though, unfortunately, there have been and are unscrupulous practitioners who, for personal gain, attempt to create this belief in the public mind. On the other hand the manifold ways in which electrotherapy may be employed, as an adjunct to the customary treatment of disease and a diagnostic aid, and the numerous instances in which it is a specific treatment have given it a recognized standing in the practice of medicine.

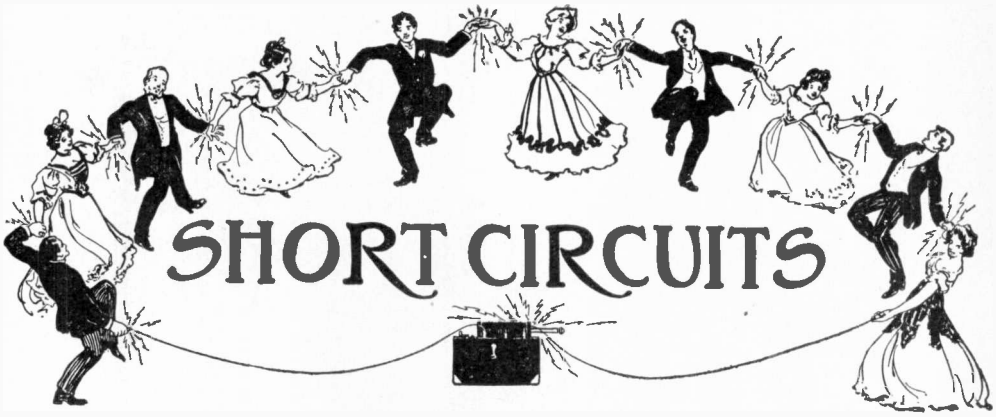
Dr. Noble M. Eberhart is going to tell us in a forthcoming series of articles, the first of which is to appear in January, just where electricity stands in the practice of medicine, and he is going to tell it in a way which will be interesting not only to his brothers in the profession but to every reader of Popular Electricity. Everything will be in "plain English" with numerous original illustrations. He is well qualified to write upon the subject, being Professor of Electrotherapy in the Chicago College of Medicine and Surgery and a specialist in this line of work, and from him we may expect a fair and unbiased treatment of the subject. The series will embody several chapters taking up all the ways in which electricity is used by the doctor.

An Electrical Laboratory for Twenty-Five Dollars

Any boy with a capital of twenty-five dollars (this does not necessarily need to be all "paid in" at once) may possess an electrical laboratory—a place where he may use "current" to his heart's content, mystify his parents, entertain his companions and gain for himself hours of pleasure and real profit. How this may be done will be told in a series of articles in the "Junior Section," beginning in the January issue.

"An Electrical Laboratory for Twenty-five Dollars" will be the title of the series, and it will be prepared by a man whose occupation is teaching boys electricity and who knows what boys want. He will tell the junior readers how to go to work with tools and make a large part of their equipment, many of the devices at a cost of only a few cents; he will tell how to perform a great many electrical experiments with these devices—some of them highly spectacular; he will explain the whys and the wherefores of the experiments and make clear the principles of electricity which they illustrate.

It is not presumed that the series will be a complete course in electrical experimental work, but it will serve to start the young worker along the right lines and create a desire for a still broader knowledge of the subject. To finally become the possessor of a real electrical laboratory obtained largely through the results of one's own efforts, will appeal to any live American boy, and here, boys, is the chance to do thi very thing.



A minister in a small town thus addressed his congregation: "You don't love me because you don't pay my salary; you don't love one another because there are no weddings, and God doesn't want you because nobody dies. Now, brothers, as I have been appointed chaplain of the Penitentiary, this will be my last Sunday among you and I shall preach from the text, 'I go to prepare a place for you,' after which the choir will please sing, 'Meet me there.'"

* * *

A wise old owl lived in an oak;
The more he heard the less he spoke;
The less he spoke the more he heard;
Why aren't we all more like that bird?

* * *

"It is easy enough to be pleasant
When life goes on like a song,
But the man worth while is the man who can smile
When the telephone rings and he answers it and says, 'Hello!' and the operator says, 'What number?' and he says, 'The bell rang,' and she says, 'No it didn't.'"

* * *

At the lunch stand: Freshman—A dog, please.
Lunch Man—All gone; will have some in a minute.
Freshman (returns after a minute's wait)—A dog, please.
Lunch Man—The wurst is yet to come.

* * *

"Why did Bink's widow feel so indignant at his funeral?"

"The members of his volunteer hose company sent him a floral fire extinguisher.

* * *

Little Eleanor's mother was an American, while her father was a German. One day, after Eleanor had been subjected to rather severe disciplinary measures at the hands of her father, she called her mother into another room, closed the door significantly, and said: "Mother, I don't want to meddle in your business, but I wish you'd send that husband of yours back to Germany."

* * *

Dr. Osler's jest still recoils upon him. At Oxford on occasion of his sixty-first birthday, an undergraduate poem ran:

Brothers, I am sixty-one,
And my work on earth is done;
Peace should follow after storm,
Reach me down the chloroform.

* * *

A Western newspaper man visited Washington recently and told the following story on former Representative Amos J. Cummings, of New York, who was once city editor of the Sun. One Saturday night it was announced that all the saloons were to be closed next day.

Cummings called his star reporter, Murray.

"Tom," he said, "go out tomorrow and find out if the saloons are selling liquor."

It was Thursday when Tom again appeared at the city desk.

"They were," he reported.

A Western business man walking down Broadway encountered a friend of former days. It was evident that times had dealt harshly with him. His clothes were frazzled and he bore every visible sign of failure and dejection. It was evident from his watery eyes and red nose that liquor had played no little part in his undoing. The business man, however, wanted to be cordial and asked him to have a drink. When the other gladly agreed the two stepped into a cafe, and the business man said to the bartender:

"Two highballs, please."

The derelict edged to the bar quickly and in a tremulous but eager voice, said:

"Give me the same."

* * *

A hen having performed her oviparous duty left the nest cackling. Having thus informed the world of her achievement she returned to the nest a little later to feast her eyes upon the treasure. Alas, the egg had disappeared and she was heard to remark: It's funny I never can find things where I lay them.

* * *

Long George—Here, boy, your dog has bitten me on the ankle.

Dog Owner—Well, that's as high as he could reach. You wouldn't expect a little pup like him to bite your neck, would yer?

* * *

"Some adjectives," said the teacher, "are made from nouns, such as dangerous, meaning full of danger; and hazardous, full of hazard. Can any boy give me another example?"

"Yes, sir," replied the fat boy at the end of the form, "pious, full of pie."

* * *

The editor was dying, says an exchange, but when the doctor bent over, placed his ear on his breast and said: "Poor man! circulation almost gone!" the dying editor sat up and shouted: "You're a liar; we have the largest circulation in the country."

* * *

A little boy bustled into a grocery-store one day with a memorandum in his hand.

"Hello, Mr. Smith," he said. "I want thirteen pounds of coffee at thirty-two cents."

"Very good," said the grocer, and he noted down the sale, and put his clerk to packing the coffee. "Anything else, Charlie?"

"Yes. Twenty-seven pounds of sugar at nine cents."

"The loaf, eh? And what else?"

"Seven and a half pounds of bacon at twenty cents."

"That's the Arrow brand. Go on."

"Five pounds of tea at ninety cents; eleven and a half quarts of molasses at eight cents a pint; two eight pound hams at twenty-one and a quarter cents, and five dozen jars of pickled walnuts at twenty-four cents a jar."

The clerk bustled about, and the grocer made out the bill.

"It's a big order," he said. "Did your mother tell you to pay for it, or is it to be charged?"

"My mother," said the boy, as he pocketed the neat accurate bill, "has nothing to do with this business. It is my arithmetic lesson, and I had to get it done somehow."


ASSHUR-BANI-PAL, THE SARDANAPALUS OF THE GREEKS, WAS DISTINGUISHED FOR HIS MAGNIFICENT PATRONAGE OF ART AND LITERATURE. DURING HIS REIGN ASSYRIA ENJOYED HER GOLDEN AGE—
UNCLE TELMORE, WHO WAS AWARDED GRAND PRIX AT PARIS FOR BEING A BORE
1
ASSHUR-BANI-PAL CAUSED A GREAT LIBRARY TO BE COLLECTED AT NINEVEH, IN WHICH WAS GATHERED WHATEVER WAS OF GREATEST VALUE IN THE LITERATURE OF THE LAND.
2
BUT ASSHUR-BANI-PAL WAS ALSO POSSESSED OF A WARLIKE SPIRIT. HE BROKE TO PIECES WITH TERRIBLE ENERGY, IN SWIFT CAMPAIGNS, THE ENEMIES OF HIS EMPIRE. ELAM WAS MADE AN AWFUL EXAMPLE OF HIS VENGEANCE—LETS SEE NOW, WAS IT ELAM OR KHORSABAD?
SWITCH... BASEMENT ..... 1 MINUTE ..... 25 CENTS
SURE
3
STRANGE! WHY SHOUD THE LIGHTS BE EXTINGUISHED?
4
NOW I WONDER WHAT CAN BE THE MATTER
PECULIAR, -- THE LIGHTS GOING OUT LIKE THAT
REMARKABLE!
5
ASSHUR-BANI-PAL WAS ONE OF THE PILGRIM FATHERS, WASN'T HE, UNCLE?
I'VE ALWAYS BEEN INTERESTED IN THOSE OLD SCOTCH GLADIATORS
GIMME THE TWO BITS
—C. DEBALL
6

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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INTERRUPTERS—DOUBLE THE CAPACITY of your coils with our Electrolytic Interrupter. Large Iridium Platinum Electrode which does not eat away. Solution does not rise in tube, nothing to wear out, always ready, very rapid, continuous interruptions, can be used on any sized coil without resistance. Price complete with formula for solution and instructions for using, $4.00. O. S. Dawson, 156 Wabash Ave., Chicago, Ill.

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BOYS—BOYS—THIS IS FOR YOU, AND those who like boys. "The Boy Electrician," by Prof. Edwin James Houston. A book every boy will enjoy and learn something from. 326 pages—10 full page illustrations. Price $1.50—or free for only three paid yearly subscribers to Popular Electricity. Popular Electricity Pub. Co., Book Dept., Monadnock Block, Chicago, Ill.

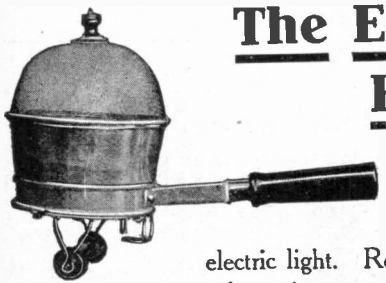
The Electric Traveling Utility Outfit

NEVER was a more handy and convenient electrical device made for traveling. Consists of small flat iron with attachment for heating curling irons; a dish holding about 1½ pint of water, with detachable handle and tight fitting lid which can be heated on the inverted flat iron. All contained in a dainty ooze leather bag—the whole outfit weighing only 3¼ pounds. Attaches to any light socket instantly—irons everything except heaviest pieces—heats curling irons with same current—provides 1½ pint dish. The inverted iron becomes a stove for heating its contents. Price, express paid, **$6.50.**

Electric Cigar Lighter

CURRENT heats the center of disc to a white heat, furnishing continuously the means of lighting cigars and cigarettes, at a cost for current of about 3 cents per day. Very handsome in design and finished in oxidized copper. Much safer and, everything considered, more economical than other types of cigar lighters. Price, **$7.00.** Express prepaid.

The Electric Corn Popper



A DELIGHTFUL and novel utensil for popping corn in any room wired for electric light. Requires no flame. Simply put in the corn—turn the switch and electric current heats it to popping. Small rubber-tired wheels enable one to push it back and forth, even on a polished table, without danger of marring. Price, **$4.80.** Express prepaid.

Other Electrical Suggestions

Traveling Iron	$3.90	Luminous Radiator	$16.00
Shaving Mirror	4.25	Water Heater	5.00
Hot Water Cup	4.25	Heating Pad	5.00
Curling Iron Heater	3.20	Coffee Percolator	10.50 up
Curling Iron	3.85	Chafing Dish	10.50 up
Bread Toaster	3.85	Massage Vibrator	26.00
Christmas Tree Outfits { 16 lights	8.50	Foot Warmer	5.00
Christmas Tree Outfits { 24 "	12.50		

The above sent express prepaid at prices given.

ELECTRIC SHOP

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FREE—Sample of Johnson's Under-Lac and Color Book

WE WANT you to test Johnson's Under-Lac at our expense, so you may know that it is better than varnish or shellac, and we also want to send you a copy of our illustrated booklet, "The Proper Treatment of Floors, Woodwork and Furniture." Send us your name and address on coupon below.

Use Under-Lac for any purpose that you would ordinarily use varnish or shellac, and you will find that it produces a far more satisfactory and permanent finish. You will find, too, that it is the easiest finish to apply.

Johnson's Under-Lac

Better Than Varnish or Shellac

Imparts a beautiful, brilliant and durable finish to floors, woodwork, and furniture, over surfaces being dressed for the first time; over dye, stains, filler or the bare wood; over an old finish of any kind.

Under-Lac is not sticky, thick or slow to dry like varnish. Neither does it dry too quickly like shellac, which laps and crawls and dries while being applied.

Under-Lac is thin and elastic and dries hard in half an hour. When used on floors, rooms may be put in order again within an hour.

Unlike varnish or shellac, it produces a finish that will not show heel-prints or scratches or turn white and slippery under water.

For Linoleum and Oil Cloth

Under-Lac is the most satisfactory coating prepared. It brings out the pattern to best advantage, giving a finish as glossy as new; protects from wear and makes cleaning easy.

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Write today for the samples and our book of Home-Beautifying Suggestions, Edition P. E. 12. Clip coupon or take down address now.

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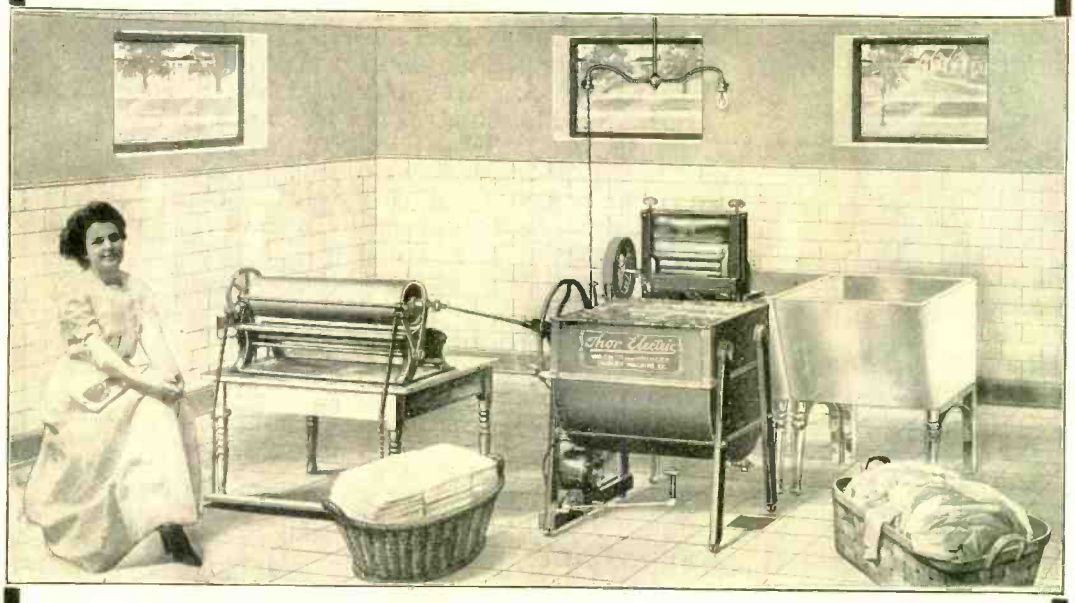
Thor-Electric
Laundry for the Home

Operated from any Electric Lamp Fixture



Above is shown the Thor-Electric Ironing machine—Thor-Electric Washer and Thor-Electric Wringer—the most complete and satisfactory outfit of its kind for the Home.

Both the ironing machine and the wringer are simply but ingeniously operated by the same power as the Thor-Washer, from any electric lamp fixture.

With this laundry outfit the ***hardest*** work of the home is made the ***easiest***—and for ***one-third*** your present wash-day ***cost.***

Thousands of women in every state in the Union who are using Thor-Electrics, simply place their soiled clothes in the smooth, wooden cylinder, turn on the electric light and in ten to fifteen minutes the most dainty garments and heaviest blankets are washed beautifully white and clean, without a particle of wear or rub on the clothes and without any effort on your part.

You ought to know more about this wonderful Laundry outfit—and the labor and expense it will save you.

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