Largest Circulation of Any Electrical Publication in the World.

POPULAR ELECTRICITY

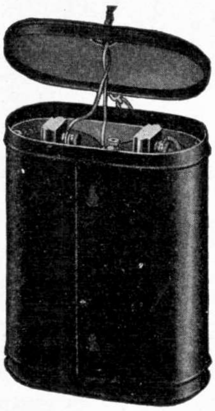
Trade Mark

IN PLAIN ENGLISH

Vol. I. NOVEMBER 1908 No. 7

PRICE 10 CENTS.

The Paragon Battery Box



For Electric Bell and Telephone Work

The Paragon Battery Box used in electric bell installations, or with desk or hotel types of local battery telephones, provides a neat receptacle for the batteries, which are generally left exposed and unprotected.

It prevents broken connections and protects the carbons, which frequently are broken when batteries are knocked over. It also keeps the batteries free from dust and dirt.

It can be fastened in any convenient place and may be attached to wall, post, desk or any desired surface. Can be removed to renew batteries, without taking out screws.

It holds two standard size (No. 6) dry cells. The box is made of sheet steel, finished in black Japan, and is lined throughout with heavy insulating fibre which protects the sides of the box and the edges of the holes. Has holes at top and bottom for leading in wires. The cover is attached to the box by a nickel plated chain.

F. W. PARDEE, Mfr., Cambridge Bldg., Chicago

Know All Men:

By PERSONAL INVESTIGATION

OF the remarkable time and labor saving quality of the modern improved **STAR EXPANSION BOLTS & ANCHORS.**

THESE are used to vast advantage wherever there be occasion to make a fastening of any sort to brick, stone, marble, tile, concrete or masonry. Made in **One Hundred Different Styles and Sizes**, of either malleable iron, brass or soft lead metals, to meet every possible requirement.

HERE follows cut showing the famous **Star Screw Anchor**, which is made in one piece of soft lead composition metal to fit any ordinary wood or machine screw. Nos. 5—18 inclusive.

HOW much time and trouble have YOU often wasted in a vain endeavor to make satisfactory fastenings to masonry with wood plugs or that tedious messy old "leading in" process? **WASTE NO MORE!**

WRITE today for our new descriptive catalog and a set of samples, and meet modern requirements with modern methods!

DON'T hesitate to ask any questions you want to. We have a man here who likes to answer questions. He is a practical man. Chances are he can give you some valuable suggestions. Consultation free. Try him.

There's a dealer in your section carrying Star Expansion Bolts. Tell us your section—we'll tell you your dealer.

STAR EXPANSION BOLT COMPANY
Trask Avenue
BAYONNE, NEW JERSEY. U. S. A.

DO YOU HEAR WELL?

The Stolz Electrophone—A New, Electrical, Scientific and Practical Invention for those who are Deaf or Partially Deaf—
MAY NOW BE TESTED IN YOUR OWN HOME.

Deaf or partially deaf people may now make a month's trial of the Stolz Electrophone at home. This personal practical test serves to prove that the device satisfies, *with ease*, every requirement of a perfect hearing device. Write for particulars at once, before the offer is withdrawn, for by this *personal test* plan the *final* selection of the *one completely satisfactory hearing aid* is made easy and inexpensive for every one.

Mrs. C. Lidecka, 238 12th Ave., Maywood, Ill., wears an Electrophone. Less conspicuous than eyeglasses

This new invention, the Stolz Electrophone (U. S. Pat. No. 763,575) renders unnecessary such clumsy, unsightly and frequently harmful devices as trumpets, horns, tubes, ear drums, fans, etc. It is a tiny electric telephone that fits on the ear and which, the instant it is applied, *magnifies* the sound waves in such manner as to cause an *astonishing increase* in the *clearness* of *all sounds*. It overcomes the buzzing and roaring ear noises and, also, so constantly and electrically exercises the vital parts of the ear that, usually, the natural unaided hearing itself is gradually restored.

What Three Business Men Say.

The Electrophone is very satisfactory. Being small in size and great in hearing qualities makes it preferable to any I have tried and I believe I have tried all of them. M. W. HOYT, Wholesale Grocer, Michigan Av. and River St., Chicago.

I got so deaf I could not hear with my speaking tube and was advised to try the Electrophone. After 15 years of deafness, discomfort and worry, I now hear perfectly at church and at concerts. W. R. UTLEY, Sales Mgr., S. A. Maxwell & Co., Chicago.

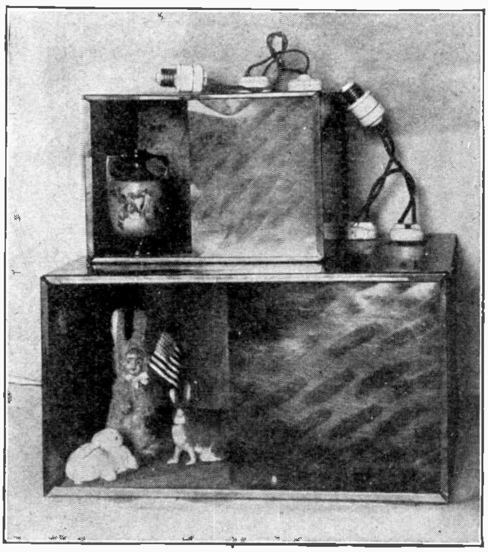
I have now used your Electrophone over a year and know that it is a first-class, scientific hearing device. Without it people have to shout directly in my ear to make me hear. With it, I can hear distinctly when spoken to in an ordinary tone. Best of all, *it has stopped my head noises*, which was a terrible aggravation. LEWIS W. MAY, Cashier, 100 Washington St., Chicago

Write to, or call (call if you can) at our Chicago offices for particulars of our personal test offer and list of other prominent endorsers who will answer inquiries. Physicians cordially invited to investigate aurists' opinions.

STOLZ ELECTROPHONE CO., 1292 Stewart Bldg., CHICAGO
Branch Offices: Philadelphia, Cincinnati, Seattle, Indianapolis, Des Moines, Toronto. Foreign Office, 82-85 Fleet St., London, Eng.

AN ELECTRIC MAGIC BOX

A mysterious Electric Toy, Fascinating Window Display and Parlor Magic Optical Illusion. $2.00 to $10.00.



Buffalo Mechanical and Electrical Laboratory
Erie County Bank, Buffalo, New York

POPULAR ELECTRICITY

IN PLAIN ENGLISH

H. W. YOUNG, Editor.

Vol., 1. NOVEMBER 1908. No. 7,

CONTENTS

ISSUED MONTHLY BY POPULAR ELECTRICITY PUBLISHING COMPANY

MONADNOCK BLOCK, CHICAGO, ILL.

YEARLY SUBSCRIPTION, $1.00 CANADIAN AND FOREIGN, $1.50 SINGLE COPY, 10 CENTS

ENTERED AS SECOND CLASS MATTER APRIL 14, 1908, AT THE POST OFFICE AT CHICAGO, UNDER THE ACT OF MARCH 3, 1879.

HOTEL TOURAINE

BUFFALO, N. Y.

Delaware Avenue at Chippewa Street

ABSOLUTELY FIREPROOF

250 Rooms with Bath and Long Distance Telephone.

EUROPEAN PLAN—$1.50 Per Day Up
With Bath Connection

Excellent Music and Grill Room

Send for Booklet. **C. N. OWEN, Prop.**

HOTEL RICHMOND

17th and H Streets, WASHINGTON, D. C.

OPEN ALL THE YEAR

100 Rooms, 50 Private Baths, American Plan. $3.00 Per Day Upwards; with Bath, $1.00 Additional. European Plan, $1.50 Per Day, Upwards: with Bath, $1.00 Additional.

A High-class Hotel, conducted for your comfort. Directly on car line. Union Station, 15 minutes. Capitol, 15 minutes. Shops and Theatres, 5 minutes. Two blocks to White House and Executive Buildings. Opposite Metropolitan Club.

Summer Season, July to October

Wayside Inn and Cottages. Lake Luzerne, N. Y. in the Adirondacks. Switzerland of America, 45 minutes from Saratoga *Send for Booklet.*

CLIFFORD M. LEWIS, Proprietor

OAKS HOTEL CO.

THE KENMORE

ALBANY, N. Y.

ONE OF THE BEST HOTELS IN THE CITY

European Plan. **$1.50 and Upwards.**

Within five minutes walk of Capitol Building, and one block from Union Depot.

LAFAYETTE HOTEL
Buffalo, N. Y.

NEW ROCHESTER
Rochester, N. Y.

00 Rooms and Bath; 175 Rooms with Hot and Cold Running Water,

Busses meet ALL TRAINS and BOATS

J. A. OAKS, Proprietor

ALSO THE LAKESIDE HOTEL, newly built in 1907., Thompson' Lake, N. Y., in the Heiderberg Mountains, 17 miles from Albany. Altitude 1650 feet. Hot and cold running water, tub and shower baths. Service unexcelled. Rates moderate. Boating, fishing, hunting, golf, tennis, etc. Good livery. Send for booklet.

J. M. OAKS, Manager

Meet me at the College Inn, under the Albany, New York's Leading Rathskeller, a place to eat, drink and be merry . . . Music.

ROBERT P. MURPHY, Proprietor

HOTEL ALBANY

41st Street and Broadway, NEW YORK

Remodeled, Handsomely Furnished New Throughout

ABSOLUTELY FIREPROOF

In the heart of the City

500 Rooms **300 Bath Rooms**

European Plan Cuisine Unexcelled

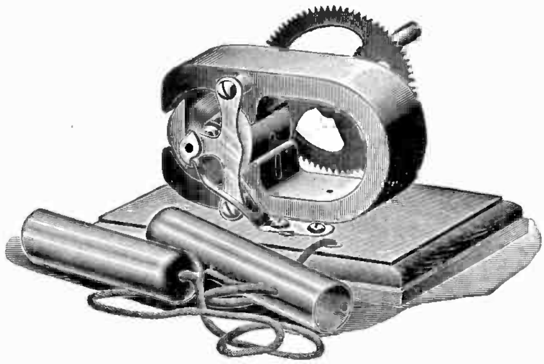
Gentlemen's Cafe, Ladies' Restaurant, and Moorish Rooms. Popular Prices. Plenty of life—but Home-like.

$1.00 per Day and Up.

SEND FOR BOOKLET.

Special Subscription Premium Offer

Boys, Get Busy!



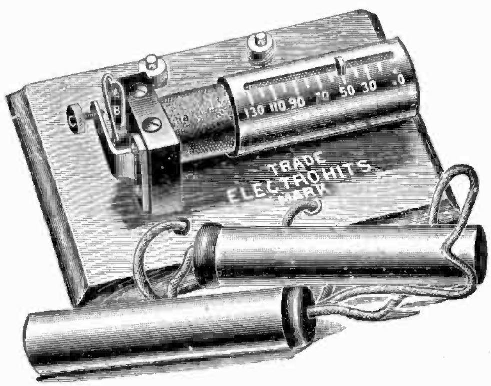
No. 4 Premium

2 Subscriptions paid secures this Magneto Set. This little shocking machine is a surprise in mechanical perfection, finish and cheapness, and free from danger.

By turning the crank slow or fast the current can be regulated so that a slight or severe shock can be produced.

Every boy wants one for instruction and experiment. It is a veritable fun factory and in a group side-splitting laughter is created by the many amusements and tricks the machine is capable of producing.

Furnished complete with hand electrodes, crank, multiplying gear, etc., etc.

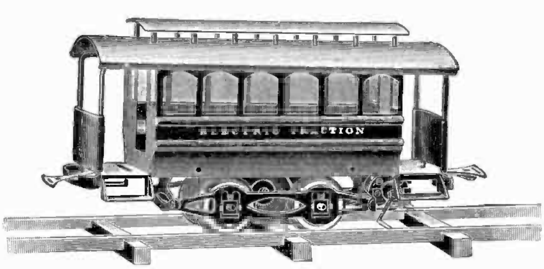


No. 5 Premium

3 Subscriptions paid secures this Electrohits. Electrohits is a complete medical coil with the features of a more expensive machine, and is mounted on a polished base 4⅜x3⅜″, metal parts nickeled, current regulating tube with graduated scale, fastened to coil.

The full current will make a strong man dance or can be regulated at will so as a child can hardly feel it.

Boys Delight! in its scientific, instructive and experimental demonstrations. It is entertaining and many tricks with it can be sprung on a group that will create roars of laughter.

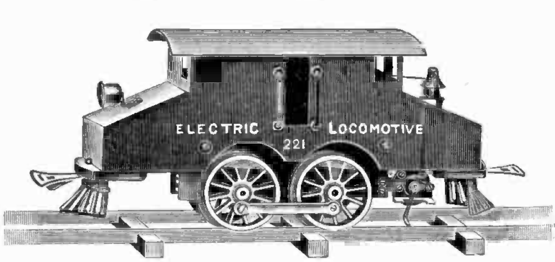


No. 6 Premium

10 Subscriptions paid secures this Trolley Car Outfit. Our miniature trolley car, 11 inches long, 5 inches high, is equipped with our improved motor (described on page 14) and in consequence is able to draw trail cars. Modeled after the improved lines of the modern trolley—it may be sent on suburban trips into the next room where our automatic reverse will compel it to return without further attention.

The car may be run by dry cells (4 to 6 cells being required) or by the house current, direct or alternating.

Packed with 8 sections, making 9 feet of circular track.



No. 7 Premium

10 Subscriptions paid secures this Electric Locomotive. The electric locomotive is a comparatively recent development in electric traction. For those who would be strictly up-to-date our miniature reversible engine possesses superior advantages.

The design of the body is a miniatured duplicate of the double-ended engine in frequent use. Our improved motor, described on page 14, furnishes the motive power. The gauge is the standard 2 inch, the engine is low, has splendid traction, being more powerful than any of its size on the market, and in combination with the flat or coal cars, will form a train superior to any elsewhere obtainabe.

Popular Electricity Publishing Company

1252 Monadnock Block **Chicago, Ill.**

PUBLISHER'S PAGE

OUR READERS' OPINIONS

"I consider your new magazine the most interesting and instructive electrical publication now before the public. Electricity now enters into our every day life so intimately that a knowledge of the general facts and principles of the science is necessary to every one. Popular Electricity will fill a long felt want, for it is the first magazine to talk about electricity 'in plain English'. It will interest every member of the family and if you keep up the good work started, success is assured."

That's from a well known electrical engineer.

A prominent physician, connected with a medical journal says: "Your magazine will fill a long felt want in its field."

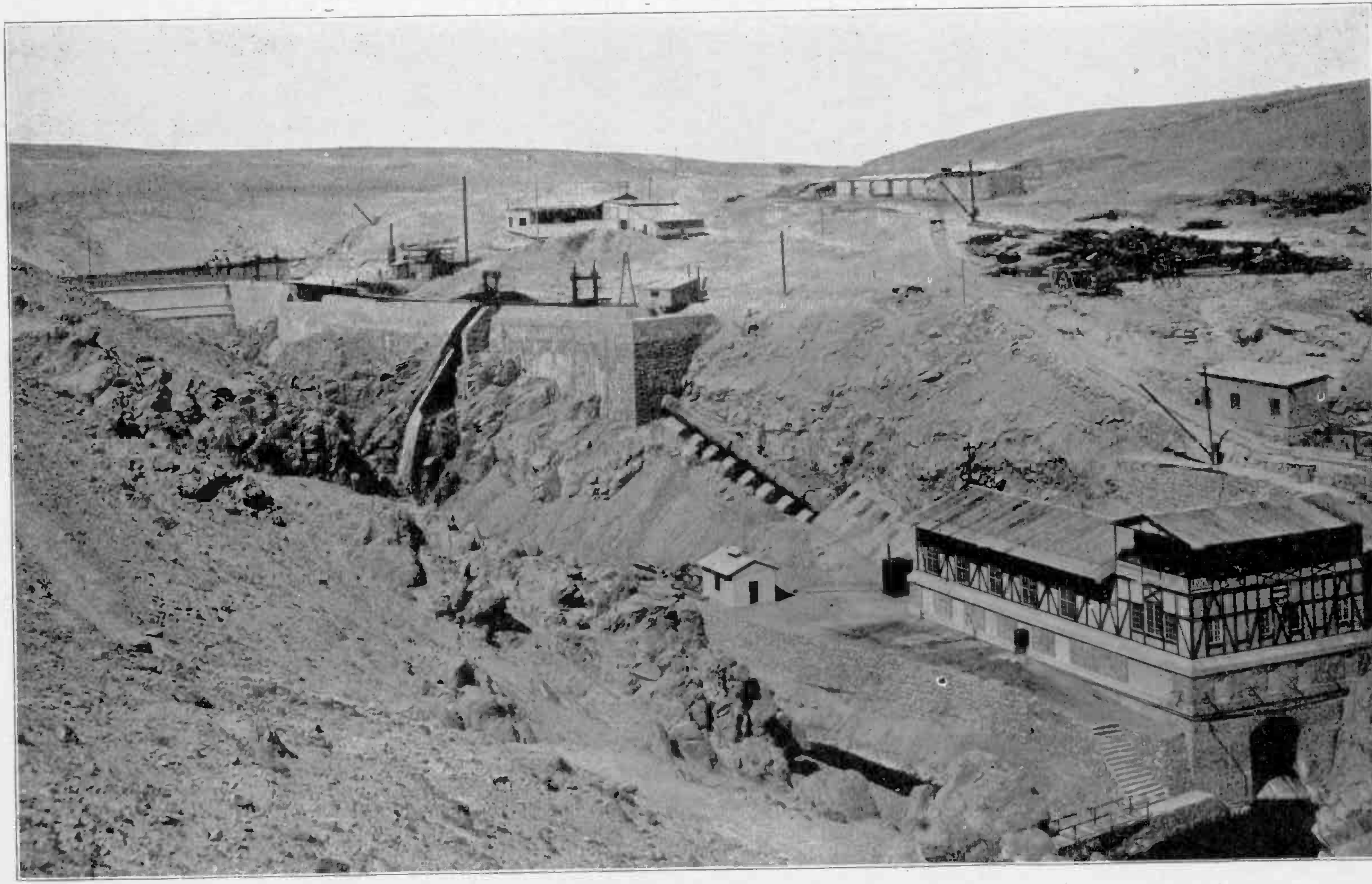
Other readers tell us: "You certainly are putting out a rattling good magazine which ought to prove a grand success, for it deserves it."—"I am very much interested in your magazine. Your section for boys is very good for it brings into their laboratories new and interesting experiments each month."—"Your paper looks good to me and would feel justified in recommending it to my men."—"I purchased a copy of Popular Electricity for October and it 'beats them all hollow.'"—"I am more than pleased with the magazine."—"I am of the opinion that the work has great merit and will enjoy a large circulation."—"I happened upon your publication by mere chance and find it a little the best yet."—"I received your magazine. It is a dandy."—"I consider Popular Electricity a very interesting magazine and easily understood by all. Shall look for next issues with pleasure."—"I find your magazine of great value, not only to amateurs but to advanced electricians."—"Your magazine is just the thing for one who wants to get acquainted with the laws of electricity."—"Your magazine is the best thing of its kind I have ever seen."—"From the viewpoint of instruction and information your publication is worth many times the price."—"I can honestly say your magazine is 'there with the goods.' It is just what everybody has been looking for."—"In my opinion, Popular Electricity fills a long felt want and fills it well."—"My son has enjoyed your first number very much. I want him to have the benefit, also pleasure of so nice a publication."—"I am an earnest reader of your magazine which is the finest published."—"Your new publication is a fine piece of work. What has been needed for several years. I admire it and shall be a permanent reader."—"I find your magazine to be just as advertised. It is one of the best papers on electricity I have ever read. I have got Mr. ——— to send for your paper."—"I am very well satisfied with your magazine in every respect."

Those are just a few. Every mail brings commendatory letters from our readers all over the world, proving that we're giving people in every walk of life—men and women, boys and girls—the magazine they have been looking for.

We take pardonable pride in the present issue. Particularly the article on an electric power plant for the farm, showing how one farmer harnessed a stream to generate electricity for furnishing heat and light and to perform most of the labor about the place, even to beating eggs and playing the mandolin. The article on the manufacture of incandescent lamps entertainingly explains the intricacies of an interesting process, that has been more or less of a mystery to the average reader. The description of the largest motor operated single leaf bascule bridge in the world gives an idea of the extent to which electricity is replacing other forms of energy.

We want the co-operation of our readers in making Popular Electricity both interesting and instructive, and to that end will appreciate suggestions and criticisms as well as compliments.

POPULAR ELECTRICITY PUBLISHING CO.
MONADNOCK BLOCK, CHICAGO, ILL.
W. A. WADSWORTH, Advertising Manager H. W. YOUNG, Editor J. A. HARNEY, Circulation Manager



A DESERT POWER PLANT.

See Page 416

POPULAR ELECTRICITY
IN PLAIN ENGLISH

VOL. I NOVEMBER 1908 No. 7

ELEMENTARY ELECTRICITY.

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

CHAPTER VII—LUMINOUS EFFECTS OF ELECTRIC DISCHARGES.

As we have already seen, light differs from heat only in that the to-and-fro motions of the molecules of a heated luminous body are far more rapid than those of a non-luminous heated body. The passage of electric discharges through circuits must therefore produce light, as soon as the temperature reaches a certain value.

Generally speaking, an electric discharge can be caused to produce luminous effects in the following ways:

(1) By the passage of the discharge through air or other gases. In both the lightning discharge and the electric spark, the light is due to the incandescence of the molecules of the air or gas through which the discharge passes.

(2) By the passage of the discharge through carbon vapor, or through the vapor of a metal that has been produced by deflagration, or vaporization by heat.

When a sufficiently powerful discharge is passed between two rods of carbon that are placed in contact with each other, and then gradually drawn apart, a brilliant arc or bow of light appears between them. This is known as the carbon, or voltaic arc, and is partly due to the incandescence or glowing of the carbon vapor. As we shall afterwards show, the greater proportion of the light is due to the incandescence of the ends of the carbon rods

(3) By the passage of an electric discharge through the fragments of metal or metallic salts that are mechanically torn off the electrodes. As the discharge passes these fragments are deflagrated or volatilized, and their molecules heated to incandescence. The color of the light so produced varies with the character of the metal or metallic salts. When taken between rods of copper, such a discharge has a green color. Between rods of zinc it assumes a bluish white. When the electrodes are saturated with a salt of soda, such as common table salt, it assumes a yellow color; between salts of lime, a violet red; between salts of sodium, a violet color; between salts of strontium, a crimson or deep red color.

(4) By the passage of a discharge through solid conductors, such as filaments of carbon or thin metallic wires. Here, the amount of heat is liberated in so small a space that the conductor glows by incandescence.

It will be observed that in all these cases the light is due to incandescence. The discharge heats portions of the circuit to such an extent that the to-and-fro motions of the molecules become sufficiently rapid to produce light waves in the ether. The portion of the circuit affected may consist of molecules of the air through which the discharge passes; it may consist of molecules of the vapor of carbon; of the vapors of the metals or the metallic salts torn off from the electrodes, or of the molecules of the solid terminals of the conductors.

Besides these four ways of producing light by electric discharges, there is another differing from any of them; i. e.:

(5) By fluorescence or phosphor-

escence. The passage of an electric discharge through any vacuous space may result in the production of light that completely fills the space. This light is due to the incandescence of the molecules of air or other gas that have not been removed during exhaustion. On the passage of the discharge, the molecules colliding with one another are raised to incandescence. The passage of the discharge, however, may not render the space very luminous. This is especially so if the vacuum is so high, and the molecules of the remaining gas are so few, as to prevent their colliding with one another. In such cases, the molecules moving across the entire space within the vessel without colliding produce little or no light. They do, however, produce light when they strike against the walls of the vessel. They especially produce light if they are permitted to bombard or be projected against a variety of substances possessing the power of fluorescence or phorsphorescence. Under these circumstances the fluorescent or phosphorescent substances glow or emit light not only while they are being bombarded, but also for some time afterwards. The bombardment causes their molecules to be set into vibrations sufficiently rapid to produce light, and these vibrations, like the to-and-fro movements of the string of a musical instrument which has been struck, continue to vibrate and emit light for some time after the bombardment ceases.

When any solid body is gradually heated so as to become luminous, when it first begins to glow, it emits a dark red light. As its temperature increases, this red light assumes an orange tint; or, in other words, it is accompanied by orange light.

At still higher temperatures, yellow light is given off by the heated body which is now also emitting red, orange and yellow colored rays. As the temperature is still further increased a greenish light is emitted along with the others, then a bluish light, then a dark blue or indigo light, and finally a white colored light. The glowing solid is now emitting a great variety of colored rays; i. e., the red, orange, yellow, green, bluish, indigo and violet. In other words, if its temperature is sufficiently high it emits a dazzling white light not unlike sunlight in color.

The different colors in the white light of the sun or other highly heated solid cannot be detected by the unassisted eye, since they produce the sensation of white only. If, however, a narrow slice of white light, such as that of the sun, is permitted to enter a dark room through a narrow rectangular slot in a shutter, shown in Fig. 48 ("Elements of Natural Philosophy," Houston), falling on the floor at (K), it will produce a bright spot of light of approximately the dimensions of the opening. If, now, a prism

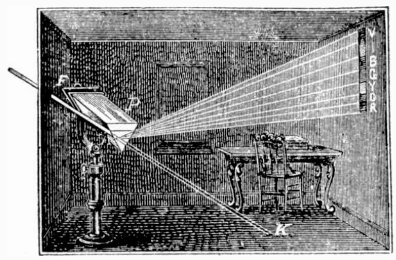


FIG. 48. SEPARATION OF LIGHT COLORS BY A PRISM.

(P) is placed so as to cause the light to pass through it, the light will be turned out of its course by refraction, and instead of falling on the floor will now fall on the wall opposite the opening. But instead of being merely refracted or turned out of its course, the light is separated into its different colored rays, and is spread out in a lengthened band of colored lights called a spectrum. As shown in the cut, the colors of the spectrum are represented by the initial letters (R), (O), (Y), (G), (B), (I) and (V). As will be seen the different colors are refracted or turned out of their course to a different degree, the red light being the least and the violet the most refracted.

It must not be supposed that there are only seven different colors in the solar spectrum. On the contrary, there are thousands of different tints of red, orange, etc. The common names, red orange, etc., are merely given to the collections of reds, oranges, etc., as a matter of convenience.

Now when light is produced by gradually heating a solid substance the reds are the first to appear. As the temperature of the solid increases the different colored rays of orange appear, then the yellow colored rays and so on up to the violet, when the conductor becomes white hot. If, therefore, a solid conductor, such as the filament of an incandescent lamp is to be employed for converting electric energy into luminous energy for the purposes of illumination, it is necessary to raise its temperature as high as possible, so as to obtain all the colors that are present in sunlight. Unless the light employed for artificial illumination contains the same colors that are present in sunlight, it will not be possible correctly to reproduce the true color values of colored objects.

The most marked luminous effects produced by an electric discharge are seen in the lightning flash, which, as is well known, consists of an electric discharge passing through the air that lies between a neighboring cloud, or between a cloud and the earth. As the electricity passes through the molecules of air that lie in its path, they are set into the rapid to-and-fro motions capable of producing light. The blinding flash of the lightning discharge is due to the high temperature so produced. Especially heavy lightning flashes may produce a greater quantity and a more dazzling light than others, since the greater quantity of electricity discharged may not only pass through a greater number of air particles, but may also raise them to a somewhat higher temperature.

The incandescence of air molecules only continues while the discharge is passing. The highly heated particles rapidly lose their temperature when the discharge ceases to pass, and soon become non-luminous. It is a mistaken, though common, belief, that a lightning flash is instantaneous. Time is required for the discharge to pass through the air from cloud to cloud, or from a neighboring cloud to the earth. It is true this time is quite small, probably only something in the neighborhood of 1-100,000 of a second. The light continues for at least this time, and, indeed, for a trifle longer, since some time is required for the glowing air in the path of the discharge to cool below incandescence.

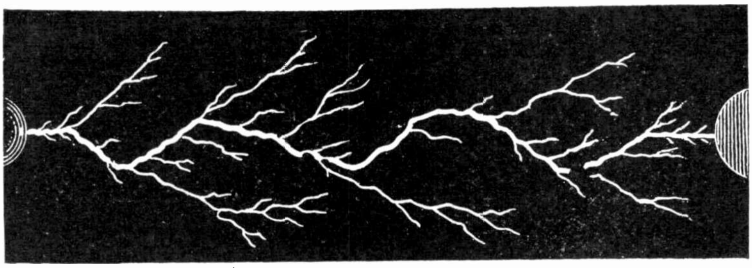


FIG. 49. BRANCHED ELECTRIC DISCHARGE.

The electric spark, or the flash of light produced by an electric discharge passing through the air, is of the same character as the lightning flash, with of course a ridiculous difference between the distance through which the discharge passes, as well as the amount of electricity that forms the discharge. In the lightning flash the amount of the discharge and, consequently, the temperature of the air particles that lie in its path, are almost always sufficiently great to produce a dazzling white light. In small spark discharges that pass say through only the fraction of an inch, the quantity of electricity may be so small that the light produced is only of a bluish or purplish color. In such cases, however, if the amount of the discharge is increased, say by accumulating the charge in a Leyden jar or a battery, the temperature is increased and the spark assumes the dazzling white light of the lightning discharge.

When the distance through which a disruptive discharge passes is small, the path of the discharge is nearly straight. Sometimes, however, the discharge takes the branched path. This shape is especially apt to occur when the discharge passes between bodies that have large areas and are somewhat further apart as represented in Fig. 49 ("Electricity in Everyday Life," Houston).

In the cases already mentioned, the

light is produced only in the particles of air that lie in the path of the discharge. The metallic conductors lying in this path, although heated by its passage, are not sufficiently heated to make them luminous.

In the apparatus shown in Fig. 50 (Guillemin), a glass plate, supported in a vertical position, has one of its faces partially covered with a long narrow strip of tinfoil attached to it in a zig-zag path. When a discharge from an electric machine is passed through this strip, it

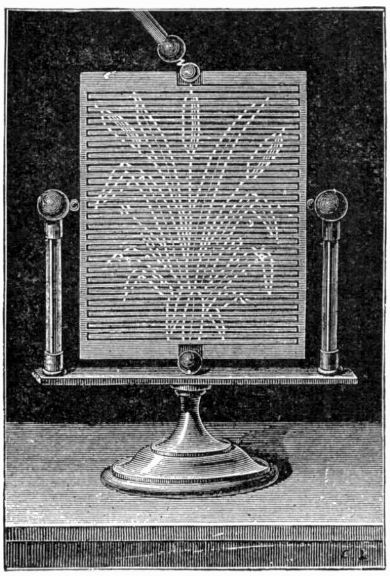


FIG. 50. DESIGN PRODUCED BY ELECTRIC DISCHARGE.

produces no luminous effects. If, however, portions of the tinfoil are removed, so as to leave minute breaks that follow one another in such a manner as to produce a design, such as shown in the figure. as the discharges passes, it jumps across the air spaces, practically instantaneously and produces a luminous picture.

The shape of a luminous electric discharge occurring in air is of course that of the air particles through which it passes. If the length of the discharge between the two conductors represented in Fig. 51 (Guillemin) is comparatively small, the discharge assumes a nearly straight shape there shown. As the distance increases the discharge assumes an irregular, apparently zig-zag path. If the distance is still further increased, as in Fig. 52 (Guillemin), the discharge assumes the more complicated shape of the branching brush there shown. If the distance becomes still greater, a form of discharge known as the brush discharge occurs. This discharge presents the appearance shown in Fig. 53 ("Electricity

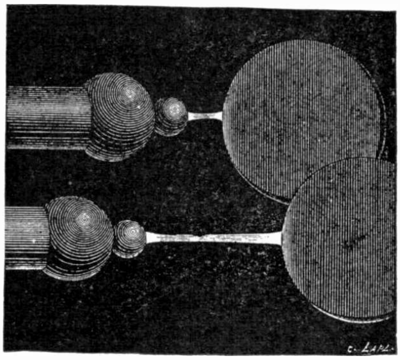


FIG. 51. A STRAIGHT DISCHARGE.

in Everyday Life," Houston). It possesses certain curious properties that will be afterwards referred to under the mechanical effects of the discharge. The discharge is then called a convective discharge, from the currents it sets up in the surrounding air.

The color of an electric discharge varies with the nature of the gas through which it passes. It is of a reddish violet color when passed through hydrogen; green, through carbonic acid gas; bluish

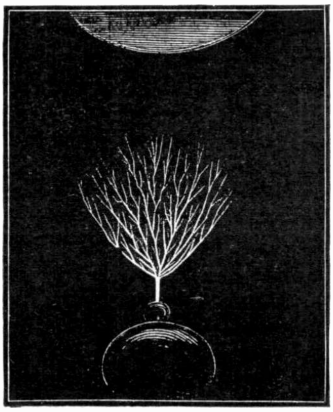


FIG. 52. BRANCHING BRUSH DISCHARGE.

or purple, through nitrogen; reddish green, through marsh gas; whitish, through hydrochloric acid gas, and bright green through the vapor of mercury.

The passage of an electric discharge through a vacuous space, produces colors that vary not only with the character of the residual gas that fills the space, but also with the degree of the vacuum and therefore of the path of the dis-

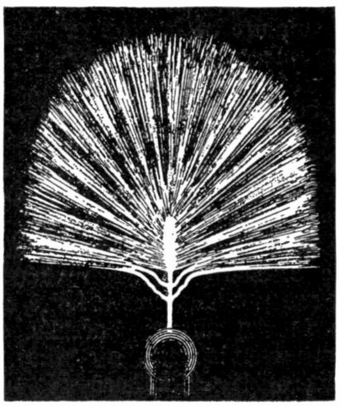


FIG. 53. BRUSH DISCHARGE.

charge. These appearances differ greatly from those produced when the discharge passes through air under ordinary pressures.

A variety of apparatus may be employed to show these different luminous effects. One of the simplest is an egg-shaped glass globe, which is provided at its lower extremity with a stop-cock and means for attaching it to an air pump. Polished metallic balls, supported on rods, are placed inside the globe. One is fixed in position but the other may be moved towards and from it through sliding supports.

If one rod is connected with a frictional electric machine, and air at ordinary pressure fills the globe, the discharge will pass between the two balls as irregular, thin sparks.

The vessel is now connected with an air pump and exhaustion begins. The discharge is observed to pass more readily as the air is gradually removed. The ball connected with the movable rod can be moved further upwards. The electric discharge greatly alters in appearance, becoming thicker, until at last it assumes an ovoidal shape and may eventually fill the globe.

The above experiment shows that the conducting power of air or other gas for electricity rapidly increases as the pressure decreases. As more and more of the air is removed the discharge is able to pass when the ball electrodes are further apart. This increase in conducting power, however, does not go on indefinitely. On the contrary, if the exhaustion is carried too far, the resistance of the residual air will increase, and at last will become so high that the discharge fails entirely to pass.

More convenient forms of apparatus for demonstrating luminous effetcs by electric discharges through vacua are found in what are known as Geissler tubes. These consist of glass tubes filled with different gases and vapors. When exhausted the tubes are hermetically sealed by the fusion of the glass. In order to permit the passage of electric discharges through their residual atmospheres, short pieces of platinum wire are sealed through the walls of the tube by the fusion of the glass around them.

A type of Geissler tube is shown in Fig. 54 (Ganot), where a tube of the shape shown is suitably mounted in a horizontal position. On the passage of the discharge of an electric machine, or still better of a device known as the Ruhmkorff coil, the vacuous space between the electrodes is filled with the luminous discharge.

The passage of the electric discharge through the highly attenuated air existing in the space above the mercury in a barometer tube is attended by a faint

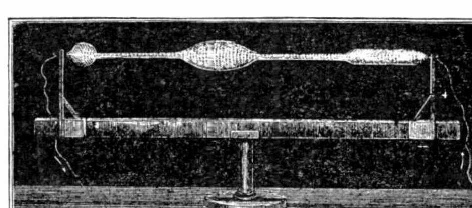


FIG. 54. GEISSLER TUBE.

glow of light. If for example, in Fig. 55 (Guillemin), a long glass tube bent as shown into two vertical arms is filled with mercury, and inverted in two glass vessels containing mercury the space above the barometric columns, contains a vacuum known as the Torricellian vacuum. If now the discharge of an electric machine is passed through this space by wires dipping into the mercury cup as shown, there is produced a feeble bluish light that fills the space. This light is due to the incandescence of the molecules of the air particles remaining in the space produced by their mutual collision. The amount of this light may be increased by heating the mercury, since this results in the filling of the space by mercury vapor.

If the vacuum is sufficiently high to

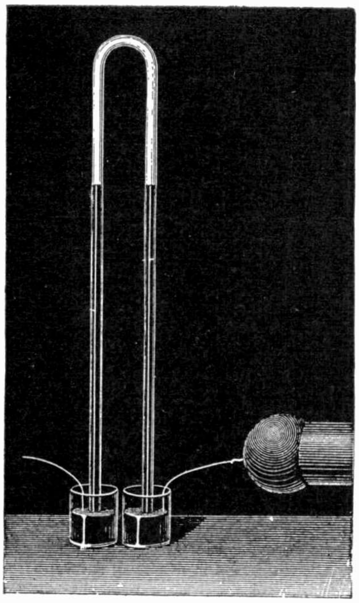


FIG. 55. TORRICELLIAN VACUUM TUBE.

permit the molecules to move across the entire space without colliding, no light is produced until the molecules bombard or strike against the walls of the vessel, or particularly against such fluorescent substances as glass colored green by a salt of uranium, or by a solution of sulphate of quinine, or by any phosphorescent substance such as calcium sulphide. When the molecules bombard or strike against these substances they are set into such vibrations as will cause them to emit light. This is therefore another way in which luminous effects may be produced by electric discharges.

The production of phosphorescent light by molecular bombardment is most conveniently shown by the apparatus represented in Fig. 56 ("Electricity in Everyday Life," Houston). Here an egg-shaped vessel is provided at (N) and (P) with platinum wires that are sealed in the walls of the glass by fusion. The ends of the wires are provided with small metallic discs as shown. The molecular bombardment that follows the connection of (P) and (N) by wires with the terminals of a Ruhmkorff coil will produce a bright light by phosphorescence; for the phosphorescent materials as sulphite of barium or sulphite of calcium, placed in the lower part of the vessel, will not only produce a light while under bombardment, but will continue to emit it for some time afterwards. The color of the light so produced will vary with the nature of the phosphorescent substance.

The luminous effects produced by an electric discharge through vacuous air spaces are produced on a large scale in nature in the aurora borealis of the Northern Hemisphere, or the aurora australis of the Southern Hemisphere. These phenomena are caused by electricity passing through the higher regions of the atmosphere where the decreased density of the air permits it to act as a good conductor.

This phenomenon is called the aurora or morning hour by the reason of the appearance given to the heavens during its prevalence. At the beginning of the phenomenon the faint glow of light appears on the northern horizon, and a globe known as the auroral arch or crown is seen slowly rising above the horizon, as represented in Fig. 57 ("Electricity in Everyday Life," Huston). As the aurora

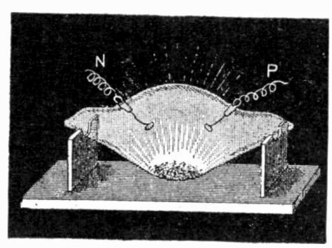


FIG. 56. APPARATUS FOR PRODUCING PHOSPHORESCENT LIGHT.

progresses, streams of light, varying in color from white, red and purple, with sometimes yellow and green, suddenly dart up through the arch giving to the corona and appearance of a huge dark sun rising in the North.

The auroral rays are not fixed, either

as regards their position or their length. They vary in size and brilliancy, moving rapidly across the heavens. Sometimes instead of seeming to emerge from the center of the corona, they move across the face of the sky assuming the appearance of a drifting storm of snow or rain. Sometimes they take the form of a series of parallel rays, closely resembling a luminous curtain known as an auroral curtain, an example of which is shown in Fig. 58 (Ibid). The appearance presented by the aurora that occurred on the 24th of October, 1870, during the siege of Paris, is quoted as follows from Guillemin:

"On Monday, October 24th, about six o'clock in the evening, a ruddy glow rose from the northwest horizon. Little by little the glow spread, rising in the form of an immense arch, covering all the northern part of the sky from east to west. Suddenly some brighter streamers of a pale red color furrowing across the darkest depths of the sky removed all doubt as to the nature of the phenomena; it was a magnificent aurora.

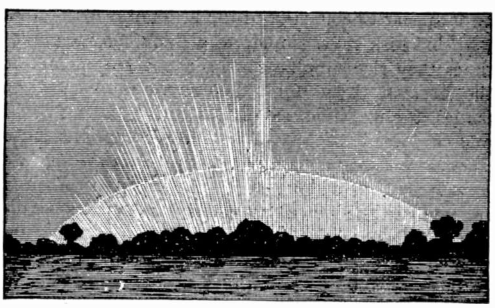


FIG. 57. AURORA BOREALIS.

"During the day the sky had been overcast with clouds brought up by a strong west wind, but towards evening it had cleared, and when the aurora began the stars were shining almost from one end of the sky to the other. The luminous arch continued to increase in brilliancy and to expand until about eight o'clock, when it reached and crossed the zenith. The red tint was very vivid above and in the easterly and westerly horizons. In the north the color was less marked, and beneath the luminous arch lay the dark segment often seen in auroras.

"Except the streamers, which here and there at irregular intervals crossed the base of the arch. and which were of a pale red or pale orange tint, the whole aurora was of a uniform ruddy color. This color, however, varied somewhat in tone, it was sometimes rose red, at other

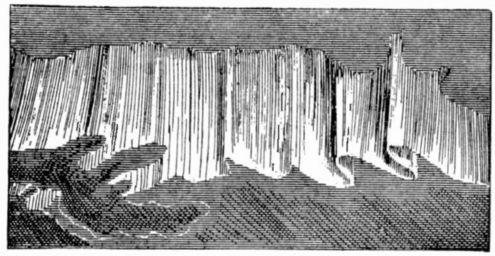


FIG. 58. AURORAL CURTAIN.

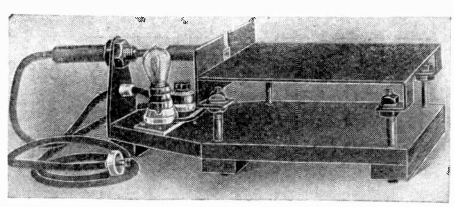
times blood red, and, again, of a deep crimson; but all through it was perfectly transparent, allowing even stars of the third and fourth magnitudes to be seen distinctly. The Great and Little Bears, Cassiopeia, Aldebaran, and the Pleiades were all distinctly visible. At the moment when the arch reached the zenith, the whole of its outer edge was bordered with a milk-white tint, resembling in color the Milky Way, but much more regular and uniform. Then the display began to fade, though it was still visible after eleven o'clock. The greatest brilliancy was between eight and half-past."

(To be continued.)

AN ELECTRIC BRANDING IRON.

Photo-engravers, electrotypers, advertisers, etc., who produce thousands of mounted plates each year, have now at their command an electric device for branding their names or trade marks on each block that leaves their hands, thus stamping their identity on their work.

With the Vulcan electric brander, a name one and a quarter inches long by



ELECTRIC BRANDING IRON.

five-eighths inches high, or smaller, can be imprinted on the edge of the block in less than a second.

THE MANUFACTURE OF ELECTRIC LAMPS.

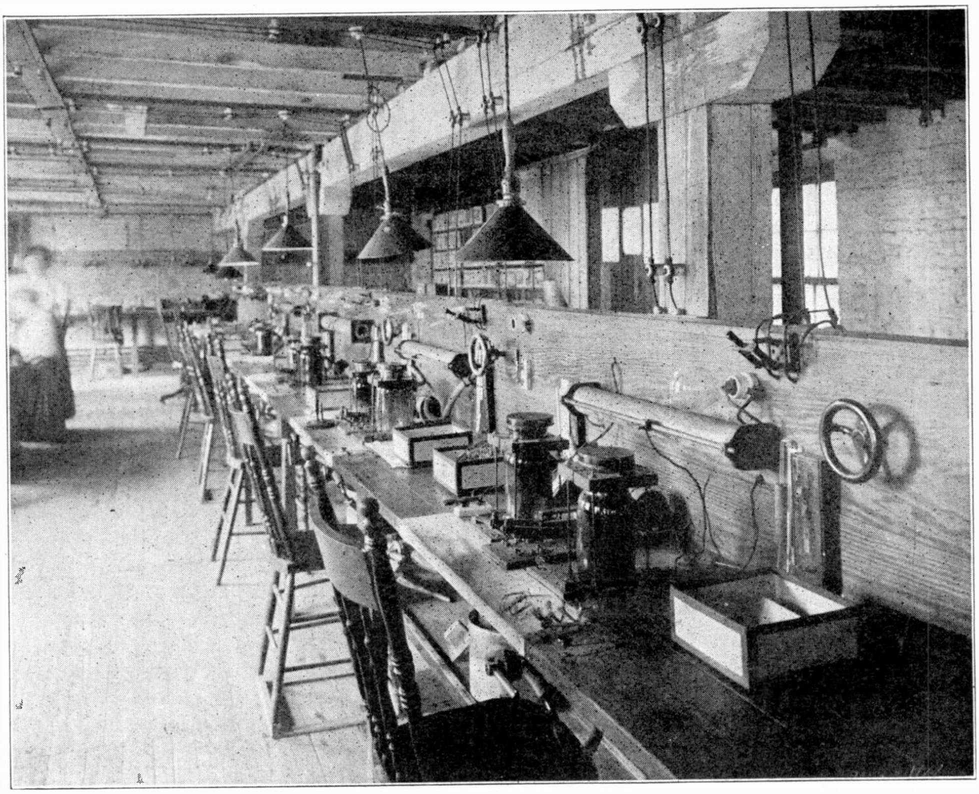
BY FREDERIC BLOUNT WARREN.

An Account of the Workings of a Plant in Which Nearly All the Operatives Are Women. These Women Are Among the Highest Paid in the World, Their Work Requiring Unusual Skill and Dexterity.

Taking into account all forms of factory labor in which women are employed, the 200 young Philadelphians whose work is here described are among the best paid "'factory girls" in the world. Their work—which is clean—requires the greatest skill; and it is manifest, also, that the operatives exhibit unusual zest in completing plain, long-necked bulbs into finished, tested incandescent lamps.

Sixty-four separate handlings for the 7,000 bulbs produced each day means that the operatives handle three bulbs a minute. And they do this naturally, quickly and without the presence of the "speeder-up," so often employed in big industrial plants at a higher wage to force laggard or slow-witted workers to greater exertion.

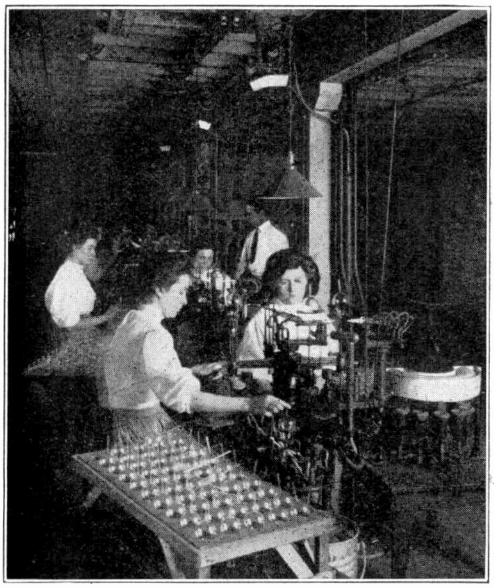
Even as the superintendent was speaking, girls on every hand were picking up bulbs between their fingers and manipulating them while one end of the glass was actually molten and dripping. An ordinary person could not have picked up the bulb at any point without blistering his fingers. But the girls who held and so deftly handled them seemed oblivious of their warmth.



"FLASHING" OR FILAMENT TESTING MACHINES.

Very few persons out of the great number who are familiar with the appearance and many of the uses of electric bulbs know how they are made. It seems impossible even to credit the statement that so simple an article requires that 64 separate things be done to it before it reaches its completed state. There is no intention of detailing each of these three score and more operations—it would make too ponderous reading for this article. Many of the relatively unimportant details will be omitted.

The bulbs come to the plant from a glass factory in almost the same shape in which they are seen in the lamp, but



SEALING MACHINES.

without the little point at the center of the big end and with a three-inch neck at the small end. These bulbs are blown at the glass factories in molds made of iron. When they reach the factory 50 of them are placed neck down in a tray with a hole to support each bulb and then they are dipped into an acid bath for cleansing. After this they are steamed and allowed to dry.

Then they are ready for conversion into lamps. The first thing done to a bulb is to place it neck down in a holder at a machine, where a thin tongue of flame melts a small hole in its top. Into this hole is inserted a little glass tube about two inches long and then they are melted together so that the bulb has two open ends—one through its neck and the other through the tube.

When this detail has been performed the bulb goes to two girls seated before a machine which focuses jets of air-blown gas to a common point. There must be just so much air, and no more, for the glass is what is known as lead glass, and if there should be too much of the oxygen-bearing air in the flame it would blacken the glass wherever the flame touched.

At this table the neck is cut off, not by a tool but by the jets of flame. One of the girls sees that the neck is melted just enough and then turns the revolving holder for the girl sitting opposite to get the bulb with the melted neck. This girl takes it from the holder and, blowing through the tube in the other end, produces a thin glass bubble as large as a small orange and lays it down. This is done to make the end ready for the stem that holds the filament to be inserted.

The making of this stem is quite as interesting as any other detail of electric bulb construction. First, a little tube

LOADING THE GLASS STEMS WITH FILAMENTS.

about half an inch in diameter and nearly two inches long is picked from a box by a girl, who puts it into a revolving holder carrying several of the tubes at once. The end of the tube is carried by the holder into one of the focused sets of gas jets and its end is heated until it is just ready to melt, but has not melted.

Taking the tube from the holder in her fingers, the girl, using a pointed tool, turns a rim upon the metal end and then drops it into a box. While she was shaping the rim the other tube in the holder was being heated and is ready for her.

Then this tube goes to two more girls seated at another machine and the opposite end of the tube is melted. Two copper wires, as thin as thread, each having upon its end a quarter of an inch of platinum wire, are passed through the tube, and then the tube, with the wires held in the center, is pushed upward by the machine into a clamp that mashes the molten glass in and around the wires, holding them in their positions.

Platinum wire is the best material to which the filament should be attached, but is very expensive. Its cost is seldom less than $27 an ounce and it sometimes advances as high as $42. Gold is worth only $16 an ounce. Platinum is not easy to melt. It has more power of resistance to heat than almost any other known metal. It is brought from Russia, and Newark, N. J., is the principal point of manufacture for its conversion into wire.

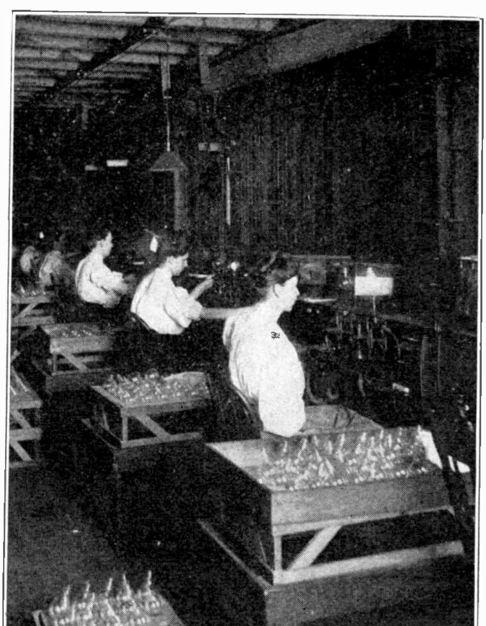
With hundreds of these small pieces of copper wire around the thumb of her left hand, a girl will hold the end of one strand into a flame-jet until its melts. With a very fine pair of tweezers in her right hand she picks up one of the little fourth-inch pieces of the platinum wire and inserts one end of it into the melted end of the copper wire. She works with incredible rapidity at a task that seemingly requires almost microscopic sight.

TESTING THE FILAMENTS.

The filament that is attached to these platinum ends of the copper wires is made by girls in another part of the factory. Cotton fiber forms its basis. It is treated in such a manner that the silicon in the cotton is removed, and this leaves a residue of cellulose. The cellulose is next treated for carbonization. Two girls perform this work and it requires the greatest skill in the handling of these filaments that are so delicate that they are almost impalpable.

Each strand is handled separately and is placed in a small glass jar. Another glass jar close at hand contains gasolene. By electric action this gasolene is vaporized and the carbon is carried in such a manner that it will deposit itself upon the cellulose. The operator knows just how long a time is required for this deposit, but it is one of the most difficult problems known to the lamp manufacturer to procure filaments with exactly the same amount of carbonization.

The difference of 1-30,000th part of an inch in the diameter of the filament will change its electric valuation and requires a classification to be referred to later in the article. Some filaments have but three and one-half circular mils cross-sectional area. A circular mil is a unit of measurement used almost exclusively in electric wire measurement.



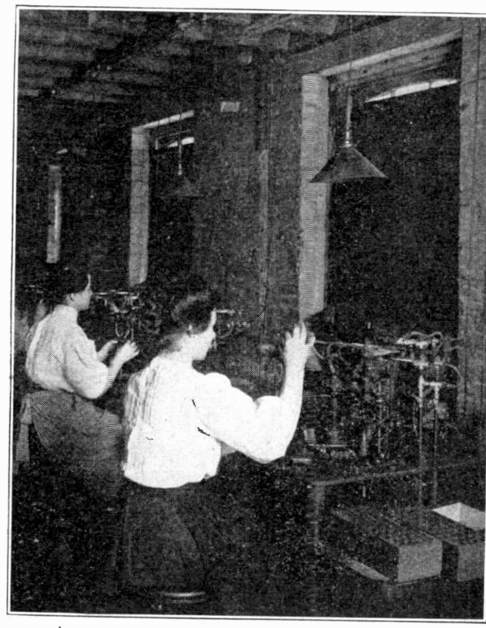
EXHAUSTING MACHINES.

It equals the area of a circle 1-1000th of an inch in diameter.

Therefore, a filament of 3½ circular mils would mean that it would only have a cross-sectional area of 2¾-1,000,000ths of a square inch. The average size of a lamp filament, however, is six or seven circular mils.

When the filaments are carbonized they are attached to the platinum ends of the wires that are inserted into the stem. This is done by simple twisting, but once again this constitutes a very delicate operation and the girls who perform it must have a deft and light touch. Then the stem with its wires and filaments is ready for insertion and sealing into the bulbs.

There are various manners of coiling



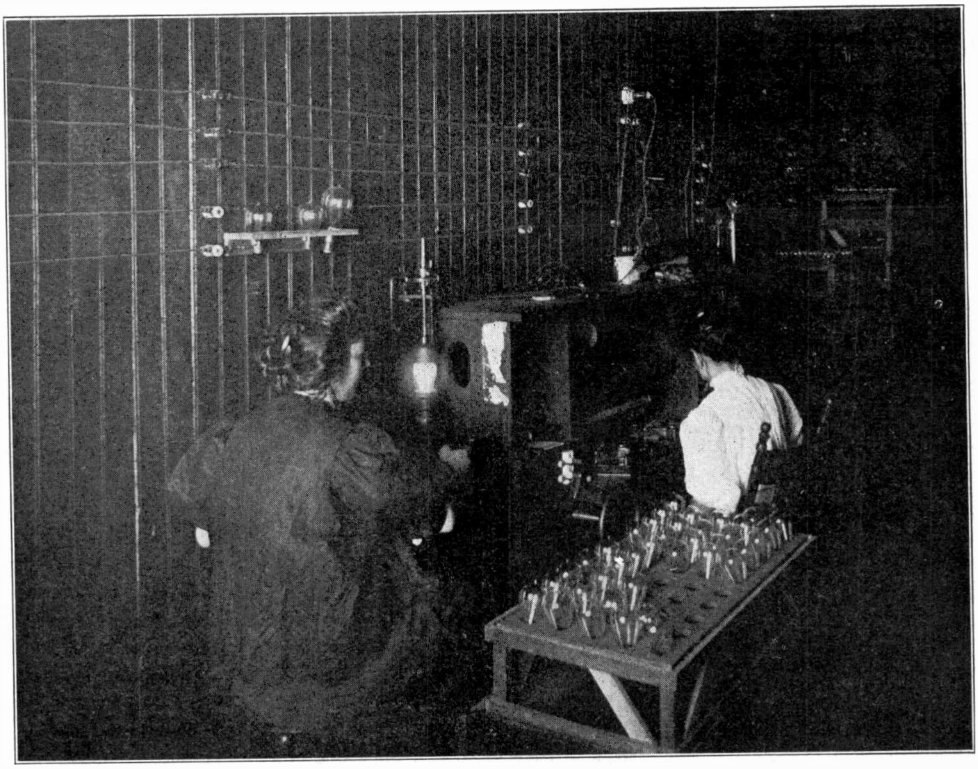
STEM MAKING MACHINES.

the filaments so that they will present a great deal of surface within the globe. Sometimes they are curled into one or more circles, and in many instances the form of arrangement necessitates the fastening of the coils, one upon the other, by a tiny bit of cement. When this must be done the task is made even more delicate than is usually the case in the making of the average lamp.

After bulbs and stems are ready to be assembled the girls insert the stem and again the neck of the bulb is subjected to heat and neck and stem are melted together. Knowing to a nicety how much to melt away and the shape the molten glass will assume when it cools, the union of the stem and bulb is skillfully made by the young operatives.

Next the bulb goes into a tray and is taken to a girl seated alone on one side of what is called the vacuum room. Before her is an earthen pot in which there is a bubbling liquid—phosphorus in a liquid state—which is kept stirred by a jet of water. The girl takes the bulb and with a brush not much larger than a knitting needle coats the inside of the little tube at the large end of the bulb with the phosphorus solution.

When this has been done the bulb is ready for the exhaustion of the air within, and final sealing. Already the bulb has been freed of air two or three times in placed in position for exhausting the air the wires running through the neck are connected with an electric current which causes the filament to glow. If it were allowed to glow or burn more than a few seconds with the oxygen present in the air the filament would burn up and collapse. So, while the tube is connected with the vacuum pump, the girl holds it to a blue flame jet, which melts it apart, and the melted end next to the bulb draws up and closes automatically, leav-



PHOTOMETER ROOM WHERE THE BULBS ARE TESTED.

the process of manufacture, but each previous time it has been left unsealed. At one time the bulb is tested for the tightness of the joint of neck and stem by mercury gauges. This time the test is to be final. The tube at the big end of the bulb—through which the air is withdrawn by an ingenious pump, the creation of an Italian inventor—is to be sealed by melting.

But the pumping and sealing are not all that is done in this handling. Reference was made to the lining of the tube with phosphorus. When the bulb is ing the little point seen in the finished bulb over our desks and in our homes.

Before the sealing is completed the light from the bulbs is very bright and light blue in color. This reveals the fact that all the oxygen has not been withdrawn from the bulb. It is then that the phosphorus within the little tube plays its part. The heat upon the tube converts the phosphorus into a phosphorescent gas and this gas, entering the bulb, neutralizes the oxygen in the bulb and the color of the bulb almost instantly changes from blue to white. In this manner the operative learns that the effect of the oxygen has been destroyed.

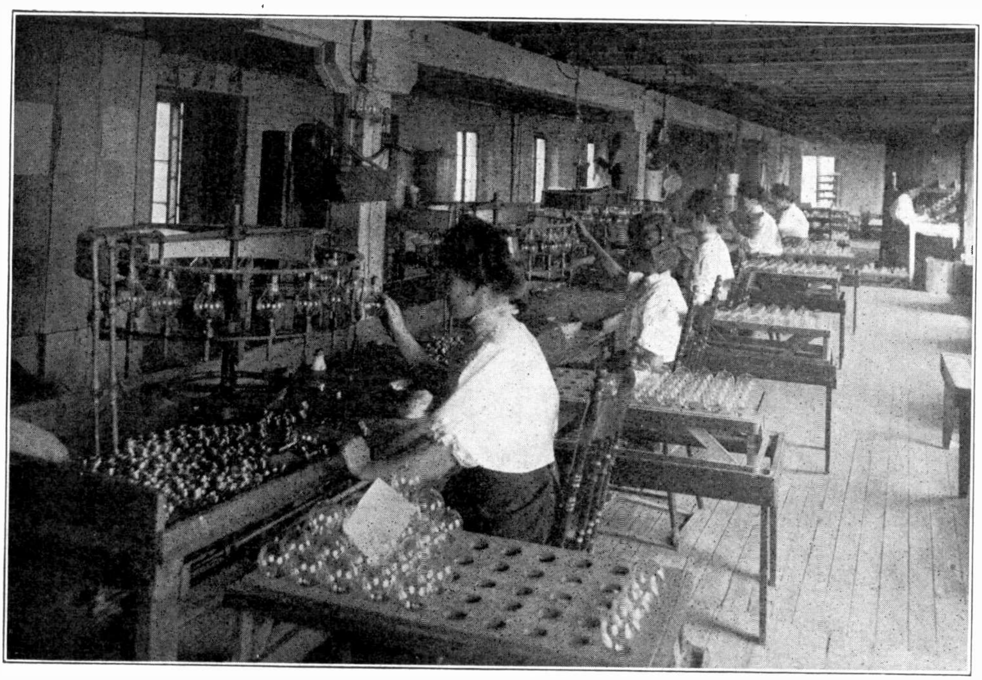
And now comes the final test of the bulb, which is taken into a dark room that is divided into several small stalls. In each stall there is an induction coil. The bulb is held a foot or two from the coil. From this process wireless telegraphy was evolved. The current from the coil passes through the body of the girl worker to the bulb and causes the filament to glow faintly. If the glow is a bluish gray it shows that there is still a leak in the bulb or its fittings, although it may be so infinitesimally small that it can scarcely be measured even by mils. If the glow should be of a purplish hue it would disclose the presence of air still within the bulb and it would have to be again exhausted. This means an operation involving many handlings before completion. However, a very small percentage of the bulbs fail to pass these tests. The next process is their measurement for voltage. The diameter of a filament of given length determines its capacity for resistance, and the difference of one, two or more volts is easily effected.

This process of measurement is one of the greatest possible delicacy. Two girls, working together, do the measuring. One places the bulb in connection with a current that lights it and the light from it shines through a small aperture upon a white paper screen. In the center of this screen is a faint star-shaped spot. It requires a certain amount of voltage in the bulb to bring out this spot.

At an equal distance from the screen upon its other side a light from a lamp of standard measurement shines upon the screen. Back of the screen are two small mirrors placed at angles of 45 degrees to the screen.

The second girl sits directly in front of the screen and sees both sides of it reflected in the mirrors. The standard light will not reveal the spot in the screen. If the spot is revealed by the light being tested the operator knows that its voltage is greater.

By comparative calculation of the density of the spot, together with the record of voltmeters before her that register the voltage of each light, she determines the voltage of the light that is being tested and records the amount opposite the number of the tested bulb. It is in this manner that the bulbs are classi-



CAPPING ROOM WHERE THE BRASS CAPS ARE JOINED TO THE BULBS.

fied as being of certain voltage and separated into groups accordingly.

Should the bulb pass the test and measurements successfully it is then ready for the appliances with which it is attached to the current-carrying fixture in general use. It is taken to another part of the factory where a girl places it in a tray. The threaded brass collar is placed about the neck and the space between the collar and the neck is filled with plaster cement.

The tray revolves through a heating oven that bakes this cement into a hard and holding mass. The ends of the wires running through the neck are cut off; a small, round brass plate is placed on the end and the wires are soldered fast. The lamp is finished.

But there is also a kind of "farewell test" for leakages that possibly may have been overlooked or may have been developed by the latest handlings. This last test is very quick and simple, the sealed end of the bulb being held against two electric poles. If the light is white and perfect the lamp is then considered ready for the last cleaning of the bulb, classification and packing for shipment.

Throughout the 64 handlings of a bulb, from the time when it is a tube to the moment when it becomes a finished product, scarcely ever is one broken. This is all the more remarkable when it is considered that the bulb is not only picked up and placed in machines, but is also heated and cooled many times. The bulb is, of course, very fragile and can be destroyed by the slightest clumsiness on the part of the handler.

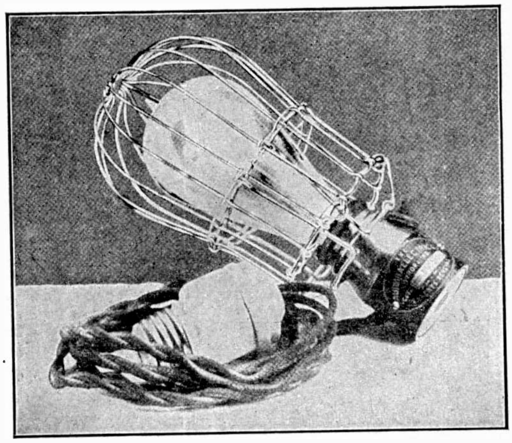
In the big Philadelphia plant where the bulbs are made there are but six male employes and these include the superintendent, manager, bookkeeper, engineer, fireman and janitor or watchman of the works.

ELECTRIC FANS REVIVE FIREMEN.

At a recent fire in New York a new use was discovered for electric fans. The firemen, overcome by gases, were laid on the sidewalk and wires were run from an adjoining building and connected to electric fans placed at the heads of the unconscious men. The firemen were quickly restored so as to be able to renew the fight.

ELECTROMAGNETIC LAMP SOCKET.

A unique method for supporting an electric incandescent lamp while working around iron or steel construction is the Aurora electromagnetic socket. The base to which the lamp is attached con-



ELECTROMAGNETIC LAMP SOCKET.

tains an electromagnet which is energized by the current which lights the lamp.

This magnet is strong enough to support the lamp in any position desired by merely placing it against the iron. It is of particular advantage to structural iron workers, boiler makers, garage and automobile owners, etc. The socket illustrated is applicable to direct current circuits, only, but is made in various types to employ 100-125 volt or 200-250 volt current and eight or 16 candle-power lamps.

EFFECT OF ELECTRICITY ON ANIMALS.

Observations of Dr. E. Mullendorf concerning the effects of electricity on the animal body show some remarkable results. Man has much greater power of resistance, or much less susceptibility, than many other animals. A leech placed upon a copper plate which rests upon a larger plate of zinc is unable to crawl off on account of the feeble electric ac-
off on account of the feeble electric current caused by contact with the metals. of potential. An ox treated for rheumatism with electrity succumbed to a current so small as to be absolutely inoffensive to man.

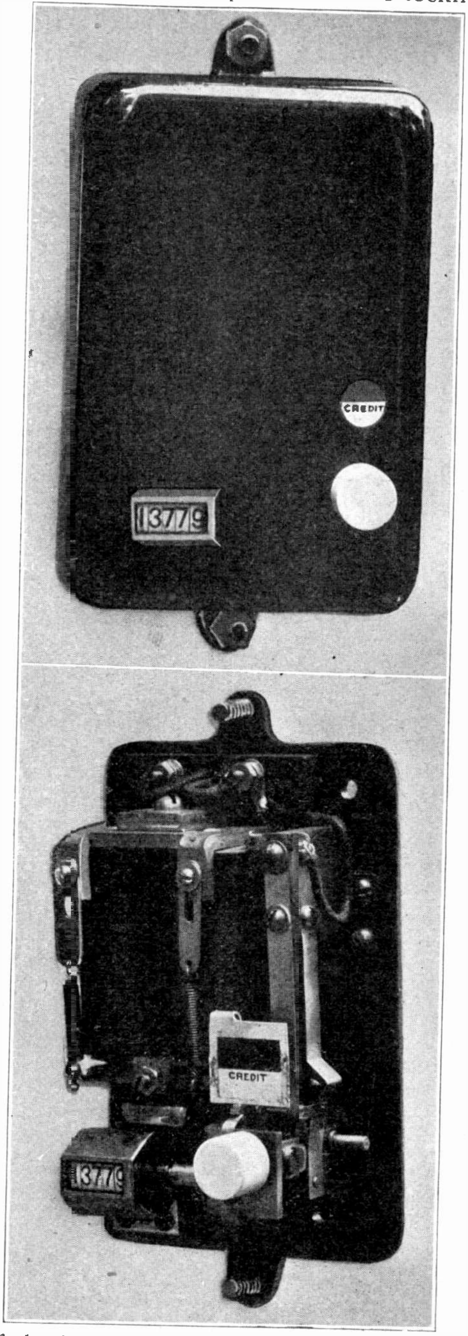
REGISTER FOR TELEPHONE CALLS.

The nickel telephones used in the larger cities are open to certain disadvantages, and are often the cause of dispute between the subscriber and the telephone company. The subscriber would like to do a little registering himself, or at least have a hand in the operation. O. C. Dennis of Chicago has invented a telephone meter which possesses many advantages, and which is said to operate successfully under service conditions. The illustration shows an outside view and the interior mechanism. No change in the telephone wiring is necessary in installing the meter.

To call "central" the subscriber pushes a button on the meter, which registers "1" on a visual meter and makes contact, thus signaling the operator. If the subscriber gets the desired party and holds conversation, the operator sends out from the central office a positive 110 volt current and restores the mechanism to normal ready for the next call. If, however, the operator finds the desired party's line busy, she sends out over the line a negative 110 volt current which restores the signaling mechanism to normal and also sets the registering mechanism in such a position that the next pushing of the button or operation will not register a count on the visual meter, but will permit of a signal being given to the operator.

After an unsuccessful attempt by the subscriber to obtain the desired party and finding him busy, a white visual signal is thrown before a little window in the meter in plain view of the subscriber, which indicates that a credit is due, or in other words that the meter can be operated to signal central on the next call without registering or operating the register one count. This also serves as a check for the subscriber (if he does not obtain connection with the party desired) on the central office operator, to make sure that she has sent out the proper current over the line and that the registering mechanism is set so that it will not register when the button is pushed to signal central on the next call.

A push button locking feature is provided, arranged so that it automatically locks after each call. With this arrangement the subscriber cannot push the button more than once at each call, the button or mechanism remaining locked until restored to normal electrically from central office by the operator. This locking



of the button also prohibits the operation of the meter by different members of the household without obtaining service, should the line be out of order.

A DESERT POWER PLANT.

BY DR. ALFRED GRADENWITZ.

In a plant installed two years ago in one of the northern provinces of Chile, which once upon a time belonged to Bolivia, electrical energy is utilized for the extraction of saltpeter. The mineral from which the latter is derived, is found in a desert, arid district, below a stratum of rubble and gypsum 10 feet in thickness. After being broken up by blasting or by means of steel wedges, the material is taken to the workshops for further treatment, viz.: crushing and lixiviating in boilers, where the saltpeter separates in crystals when the brine cools down.

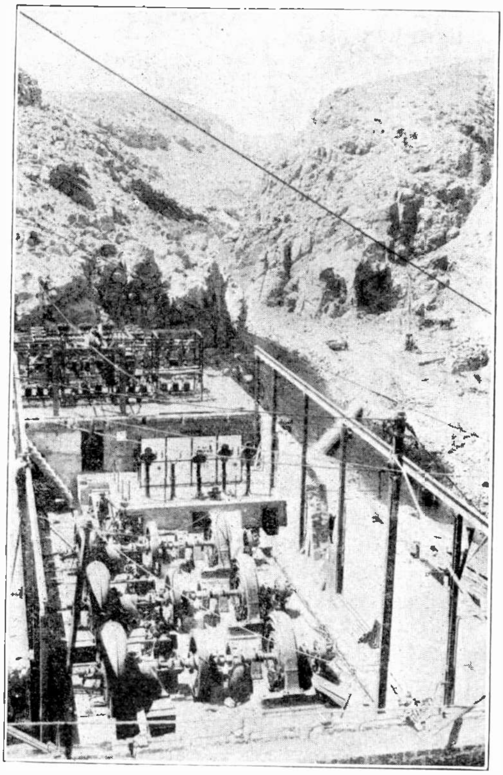
Owing to the special advantages to be derived under local conditions from the use of mechanical operation in connection with this process of extraction, a hydraulic power plant was erected on the Rio Loa, whence the electrical energy was transmitted to one of the factories at 5,000 volts tension. A steam-operated power plant furnishing current of 2,000 volts at that time also supplied current to several other saltpeter factories. Owing, however, to the considerable expense involved by the use of coal as fuel, the owners of these factories eventually decided on also utilizing the water power of the river above mentioned, as, according to estimates, the cost of erecting a hydroelectric power station would be soon repaid by the saving of coal insured by this means of operation.

The power house (see frontispiece) was installed about 10 miles to the north of Rica Aventura, where the valley of the river, owing to the steepness of its banks, was readily dammed. From the embankment thus formed the water is supplied to the power station under a head of 82 to 98 feet.

ERECTING A TRANSMISSION LINE THROUGH THE DESERT.

The power house contains three 455-horsepower turbines, each of which is direct connected to an electric alternating current dynamo. A fourth set will eventually be added. Especially noteworthy in the construction of this power house was the fact that the machinery could be installed before erecting the outer walls and the roofing, any risk of the occurrence of rain being excluded by the climatic conditions of the country.

Three sub-stations erected at distances of about 10 miles have been put in operation, while a fourth is in course of con-



DESERT POWER PLANT IN COURSE OF CONSTRUCTION.

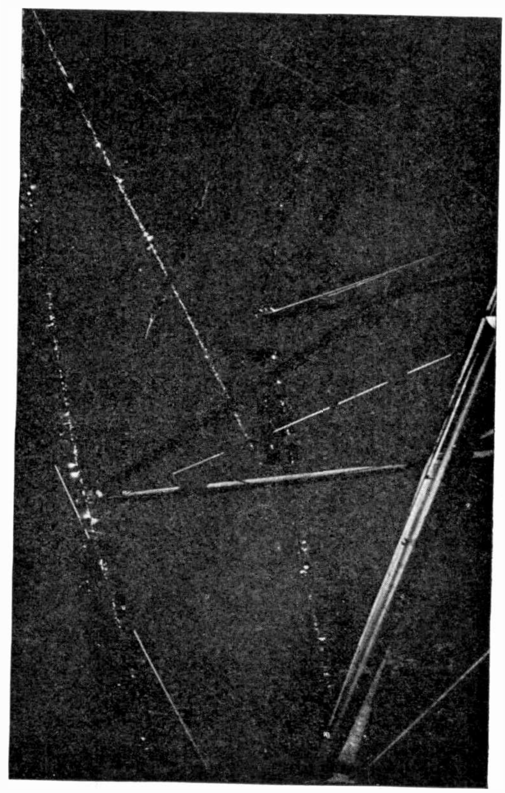
struction at Prosperidad. The transmission line is carried by wooden poles of square cross section. One of the pictures shows a construction crew out in the desert with equipment for erecting the line.

A RECORD IN HIGH VOLTAGE TRANSMISSION.

Once more a new record in high voltage transmission has been established. The Grand Rapids-Muskegon Power Company in Michigan has just placed in service a transmission line operating at 110,000 volts. This is 10,000 volts in excess of anything ever before attempted and far beyond the dreams of even the most sanguine engineers 15 years ago. This particular line is 50 miles long and is a part of the 212 miles of transmission lines now being operated by the company.

The transmission line consists of No. 2 stranded copper wires with a hemp center, that is, the combined cross-sectional area of the strands in the conductor being equivalent to that of a solid No. 2 wire. It is supported on three-legged steel towers 53 feet high and spaced 500 feet apart. The towers are placed on large concrete anchors buried in the ground. From the mast-arms the wires are suspended by means of five-part series porcelain insulators. Each of these insulators consists of five disks hung one above another, the diameter of each disk being 10 inches. The complete insulator will stand a breakdown test of 500,000 volts, giving a large factor of safety.

On dark, cloudy nights the line is luminous, emitting a bluish glow, due to the brush discharge at the extremely



LUMINOUS DISCHARGE FROM 110,000-VOLT LINE.

high potential which is employed. The accompanying half-tone illustration, reproduced through the courtesy of the Western Electrician, is from a night photograph resulting from an exposure of two hours and ten minutes.

CONSTRUCTION OF A TWO-MILE WIRELESS OUTFIT.

BY V. H. LAUGHTER.

Now that wireless telegraphy has become well established as a practical method of communication it is natural that a great many amateurs are experimenting along this line. There are, however, a number of complex problems which arise, even in a small equipment, and give trouble. For the benefit of the readers of this magazine I will describe the method of constructing the principal parts of a set which will operate up to a distance of two miles, and this information will no doubt help many of them out of their difficulties.

The exact size of induction coil necessary to send up to two miles will depend

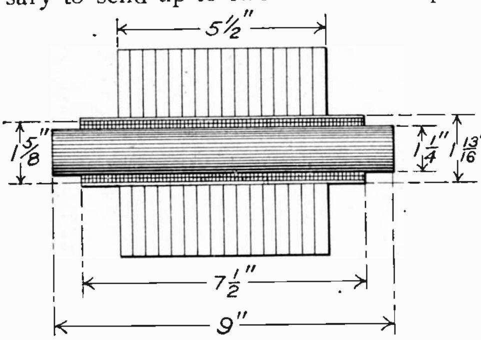


FIG. 1. SPARK COIL FOR TWO-MILE WIRELESS OUTFIT.

to a certain extent on the conditions surrounding the station. For a safe average, however, the two-inch spark coil is recommended, as the writer has sent up to five miles with a coil of this size, although this would be impossible in a city, where the steel sky-scrapers cut down a large portion of the wave energy. In selecting a coil for wireless work not only the spark length but the general construction must be considered. To say that two-inch spark coil will send a certain distance is only an approximation, for it is not the spark length that counts so much as the spark volume and strength.

The difference in energy of spark coils is due to the size wire used in winding the secondary. The majority of coils are wound with very fine wire in the secondary, usually No. 36, which gives a long, thin spark across the secondary terminals and proves excellent for X-ray work, but fails to give good results for wireless use. If this secondary be wound with No. 32 or 34 wire the spark length will be cut down from one-half to three-fourths of its first length, but a hot, fat spark will be the result, which is capable of sending to a much greater distance than the long, thin spark. Thus we see that for wireless use a short, fat spark of large current strength is desired rather than a long, thin spark of high voltage.

The coil shown in Fig. 1 is especially designed for wireless use and will give an approximate spark of two inches and prove capable of sending up to five miles under ordinary conditions. By winding the secondary of the coil with No. 36 wire, no doubt a full three-inch spark could be obtained. However, as stated before, a short, fat spark is desired for wireless use. The exact dimensions of the coil are as follows: Core, 1¼ by nine inches; primary two layers of No. 16 B & S gauge double cotton-covered wire wound to within ¾ inch of each end of the core; insulating tube, to use between primary and secondary, of hard rubber 1⅝ inches inside diameter, 1 13-16 inches outside and nine inches long;

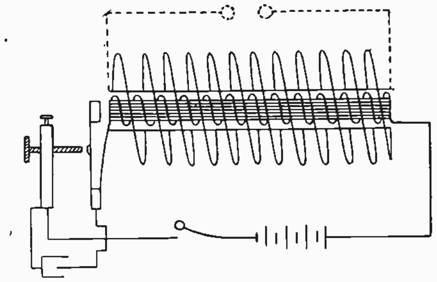


FIG. 2. WIRING DIAGRAM OF SPARK COIL.

secondary winding, three pounds No. 32 double cotton covered magnet wire wound in 16 sections which are run through boiling parraffine wax and boiled for one hour in linseed oil. The individual sections are so connected that one continuous winding is formed, the sections, however, being insulated from one another with six sheets of parraffine paper. The wiring diagram of the core is shown in Fig 2.

The condensor for a coil of this size should contain approximately 800 square inches of tinfoil or 28 five by six inch sheets, which allows 40 inches over for loss in conecting, etc. The condensor is built up with thin bond paper previously prepared by boiling out in parraffine wax and cutting to sheets six by eight inches which gives a one-inch margin around the edges. Build up by first placing down a sheet of the bond paper and in the exact center a sheet of foil. Roll the foil down with a glass bottle or print roller. At the left end a connecting foil strip one by 3 inches is placed so that one inch rests on the foil sheet and one-inch clear of the paper. A second sheet of paper is now placed on, also a sheet of foil, being rolled down as before. The connecting strip, however, is led out to the right instead of the left. This method is followed throughout the construction, alternate layers of foil and paper with the connecting strips on the left running in the odd numbers such as 1-3-5 and those on the right in the even numbers as 2-4-6. The condensor should be built up in four different sections as follows: 14 sheets for the first, seven for the second, four for the third, three for the fourth. This is done in order that the capacity can be quickly regulated by throwing in more or less of the sections on the circuit, which is necessary to get the maximum spark length.

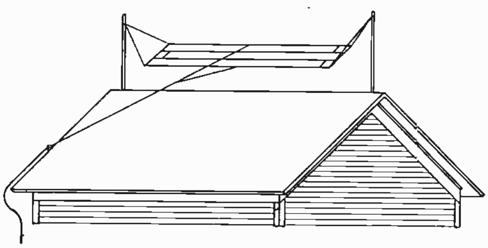


FIG. 3. ANTENNA FOR TWO-MILE WIRELESS OUTFIT.

It is not necessary to use the tuning coil for experimental work over this distance; in fact, those who are just taking up the study of wireless telegraphy can get much better results from an open circuit set. However, if the tuning coil is used, refer to "Wireless Telegraphy Made Simple," in the July issue.

The plan of working a sounder in conection with a decoherering device is next to impossible and no satisfactory results can be had. The sounder is sluggish in action and when connected in series with the decoherer, usually a common electric bell and which gets its action from the current flowing through the electromagnets, an intermittent current is the result, which is not of sufficient period or strength to magnetize the coils of the sounder and attract the armature. If any action at all is had it is in the form of a chatter.

The antenna shown in Fig. 3 is simple and easy to erect. For a more complete description and points on the construction and elevation of aerial arrangements refer to "Wireless Telegraphy Made Simple" in the August issue of Popular Electricity. It is not necessary to use insulated wire from the instruments to the antenna but all lead-ins should be well insulated with tape and porcelain tubes.

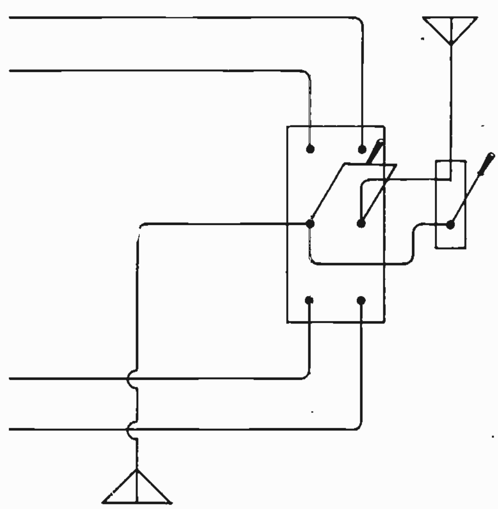


FIG. 4. CONNECTIONS FOR LIGHTNING ARRESTER.

The best means for protection against lightning is to connect the aerial wire directly to the ground. The simplest plan is shown in Fig. 4 in which a single pole switch is connected to the two terminals and left closed when the set is not in use.

CABLE HAULING ON THE NEW MANHATTAN BRIDGE.

The four huge cables that will support the new Manhattan bridge, connecting the boroughs of Brooklyn and Manhattan, New York, are now being hauled into place. Each cable will contain 37 strands of 256 wires each, a total of 9,472 wires in each cable, which must be strung wire by wire. The enormous amount of work involved is done by machinery driven by electric motors.

The stringing of the wires in each cable is accomplished by means of two traveling sheaves carried on opposite legs of an endless steel rope. Each sheave, Fig. 2, consists of a three-foot grooved wheel fastened to the hauling rope by means of wrought iron brackets. The hauling rope is three-quarters inch in diameter and runs above the position of the bridge cables on heavy rollers supported on uprights on a temporary foot bridge. There are five of these hauling rope supports on the center span, two on each end span and one on each tower.

The hauling sheaves move back and forth across the bridge from anchorage to anchorage, a distance of 3,223 feet. They are attached one to each leg of the hauling rope so that they move in opposite directions, one crossing the bridge as the other returns.

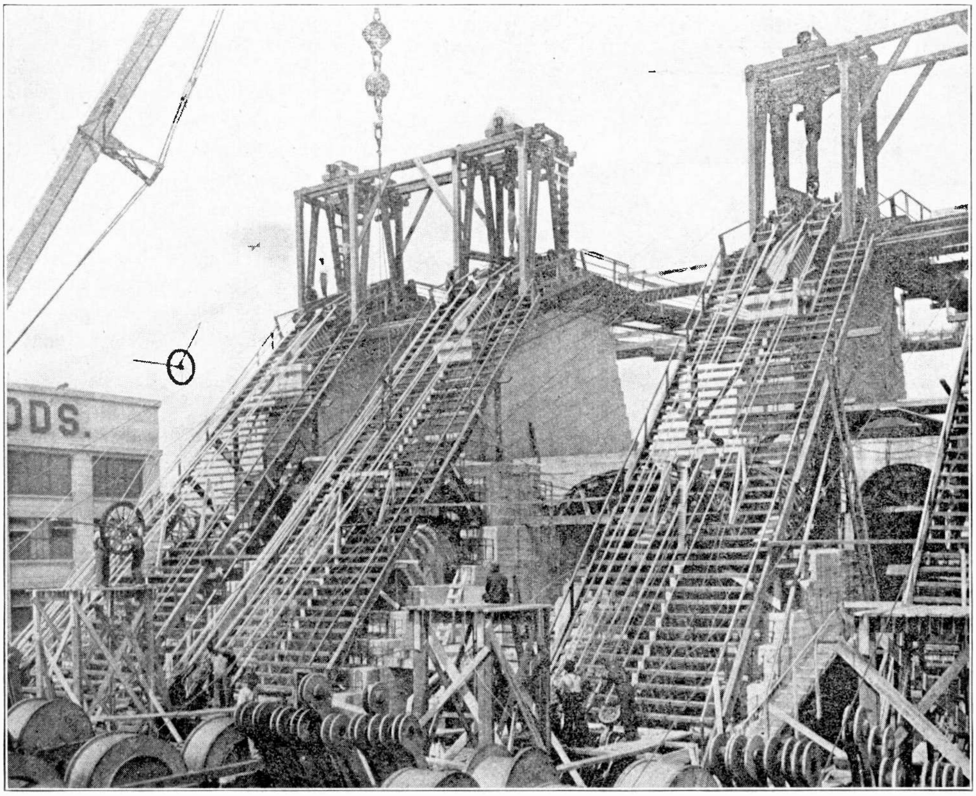


FIG. 1. UNREELING THE WIRES

The wire is delivered to the bridge on enormous reels or spools, weighing three tons each. Half of these reels are placed at each end of the bridge, see Fig. 1. The end of the wire from a reel at each end of the bridge is put over the hauling sheave at that end and fastened to the anchorage. The machinery is then started and the sheaves move across the bridge, unwinding one wire from each reel. Two wires are thus strung by each sheave every time it crosses the bridge. When the sheave reaches the opposite side of the bridge the bight of

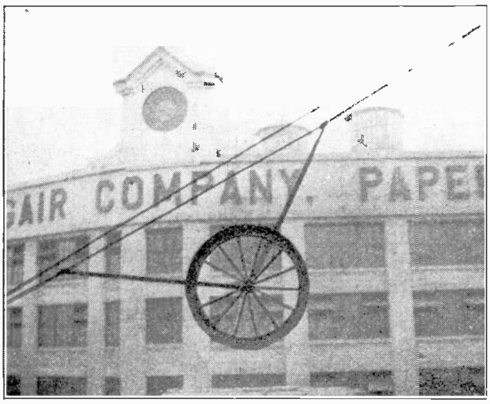


FIG. 2. TRAVELING SHEAVE.

the wire is taken off and made fast to that anchorage, and a new wire hauled from that side on the return trip.

The wires are laid in temporary saddles of four grooved pulleys at each anchorage. As the hauling of each strand of 256 wires is completed the wires are bound together at intervals, and the strand is lifted from the temporary saddle by means of a chain hoist and laid in its proper place in the permanent saddle.

There is a separate hauling mechanism for each of the four bridge cables, so that they are strung independently of each other. Delays are therefore not cumulative. The delays in one cable affect that cable alone, and the work proceeds on the others. This results in a very considerable saving of time.

Each hauling rope is driven by a 50-horsepower, 220-volt motor. This is the type of motor designed by the Crocker-Wheeler Company, for rolling mill duty, and is well adapted to work of this kind where sudden overloads and frequent starting and stopping are likely.

The driving mechanism is shown in Fig. 3. Each motor is geared to a countershaft at a ratio of 5 to 1, and the countershaft is bevel geared to the driving shaft at a 5 to 1 ratio. On the driving shaft, above the gears is a wood lined, grooved, six-foot traction wheel, which drives the hauling rope. A five-foot idler wheel is also provided so that the hauling rope passes the traction wheel twice, to produce the necessary grip.

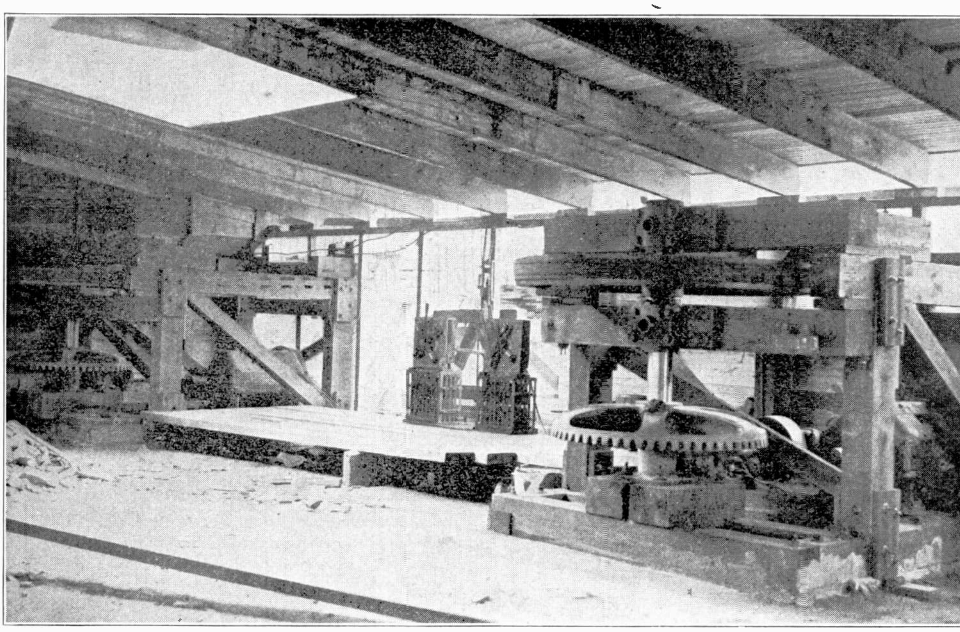


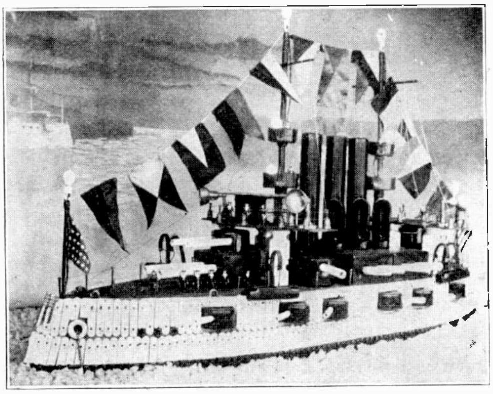
FIG. 3. MOTOR OPERATED DRIVING MECHANISM.

The hauling rope moves at a speed of approximately 480 feet per minute. It carries the sheaves across the river in about seven or eight minutes. Allowing for the time used in attaching wires at each end, about three trips are made per hour. It is estimated that at this rate the work of hauling will occupy four months, some time being consumed in fixing guide wires for each strand and in adjusting the wires after they are hauled.

The hauling equipment for this bridge differs from any previous attempt. It will be remembered that in hauling the cables for the Williamsburg bridge two steam engines were used, connected to the same driving shaft. It later became necessary to cut this shaft and use the engines independently to avoid cumulation of delays. Even with that arrangement only two cables could be hauled simultaneously. This plant has double the capacity besides being electrically instead of steam driven, with the consequent ease of manipulation and control.

UNIQUE WINDOW DISPLAY.

Recently there appeared in the window of the Northern Electrical Company of Minneapolis, Minn., a really remarkable display of ingenuity in representing a moonlight scene of a battle ship in San



BATTLESHIP MADE OF ELECTRICAL MATERIAL.

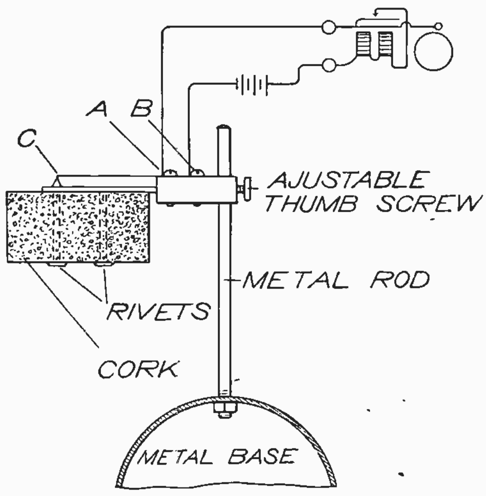
Francisco, with the Golden Gate in the background. The blue waters of the bay consisted of blue vitrol solution and the remainder of the scene, including the battle ship itself, was made up of over 500 pieces of electrical material. The illumination effects were of course obtained by electric lamps.

The sides of the ship's hull were armored with porcelain cleats; the guns consisted of porcelain tubes mounted in turrets made of outlet boxes; the funnels were of fibre tube; the searchlights were incandescent lamps, and so on, all of the construction material used, being devices used every day by the electrical contractor.

ELECTRIC WATER LEVEL INDICATOR

In cellars, ice pans, boats, tanks, etc.. where it is desirable that an alarm be given when the water rises to a certain predetermined level, a simple electric alarm may be constructed as shown in the diagram.

A metal base with vertical rod attached forms the standard, upon which is a sliding member held at any desired



WATER LEVEL INDICATOR.

height by a thumb screw. Extending out horizontally from the sliding member are two metal strips or springs, the lower one being movable vertically and carrying a piece of cork on its under side.

The two springs are insulated from each other, one being held by screw (A) and the other by screw (B). The two terminals from a bell and battery circuit are connected to these two screws. When the water rises sufficiently to float the cork, connection is made between the two springs and the circuit closed, ringing the bell.

AN 800-TON, MOTOR OPERATED BASCULE BRIDGE.

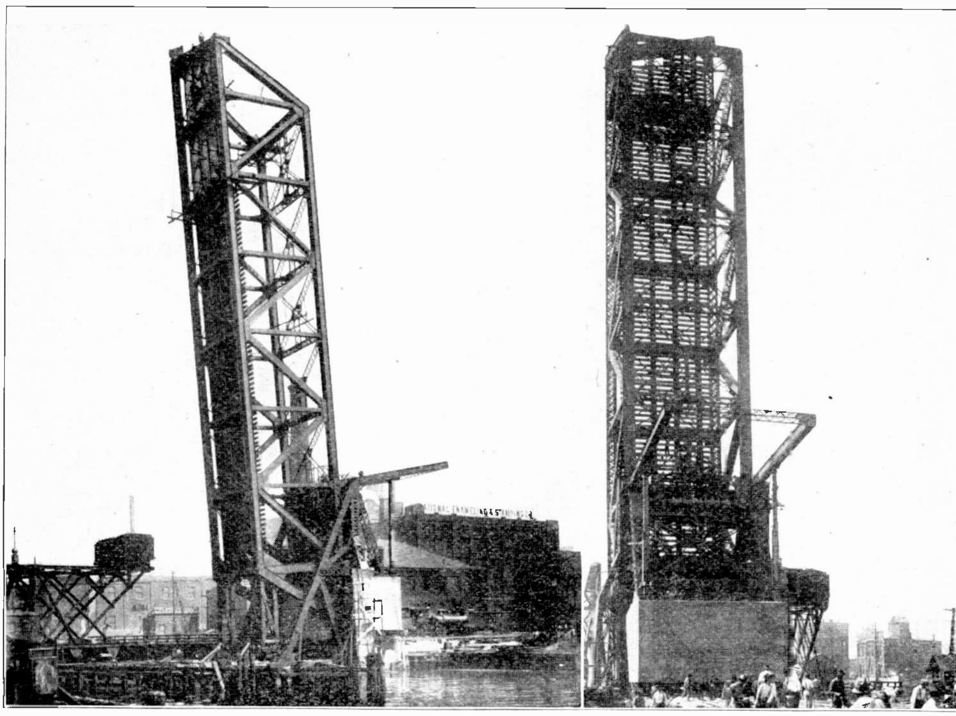
The largest double-track, single-leaf bascule bridge in the world was recently put in commission in Chicago. It was constructed by the Chicago & Northwestern railroad at a cost of $425,000 and spans the North Branch of the Chicago river just above its junction with the main stream. Perfectly balanced by a huge counterweight of concrete and pig iron, this great steel structure weighing 1,600,000 pounds may be raised and lowered by two men operating a handwinch. This work is not to be done by hand, however, except in case of emergency, electric motors being used for the purpose.

The bridge is of steel cage construction with a clear span of 170 feet. It is supported at one end on steel trunnions 21 inches in diameter. The counterweight, which weighs 1,400,000 pounds, balances the bridge on these trunnions like a "teeter board."

Two direct current motors of the street car type operate the bridge. They are of 50 horsepower each, although this is in excess of the power actually required. The motors are provided with geared pinions which operate on a toothed rack to raise and lower the bridge.

In addition to the two motors above mentioned, a third, of three horsepower, operates wedges which lock the bridge in place when it is down.

So perfectly was the bridge designed and constructed that on the first trial, when it sank slowly into position, the ends of the tracks met within half an inch.



AN 800-TON MOTOR OPERATED BASCULE BRIDGE.

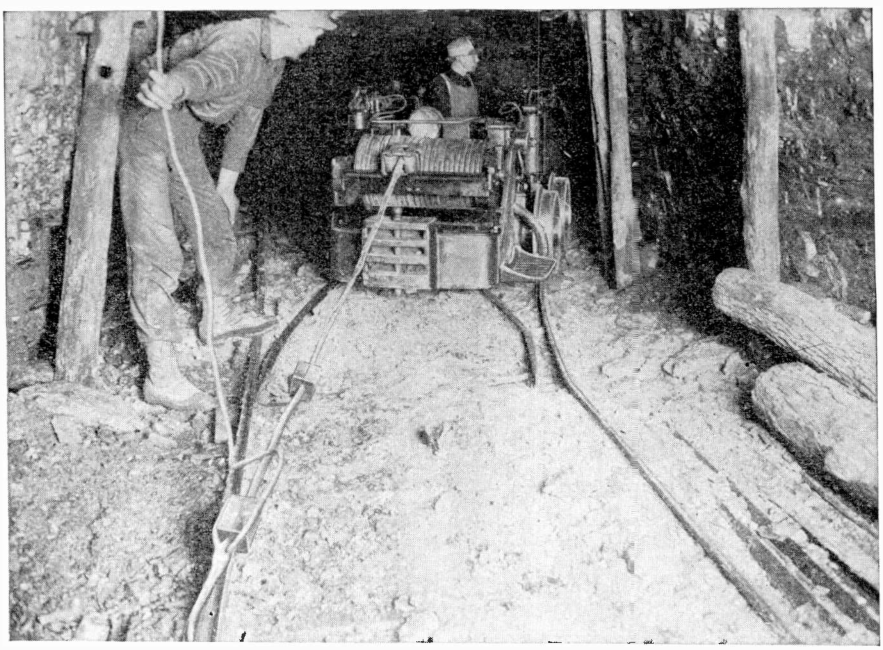
THE ELECTRIC HYDROSCOPE.

The electrical hydroscope of J. Poenchon, as described to the Paris Academy of Science, is so extremely sensitive that it indicates the variations in moist vapor emanated from different parts of the hand. The back of the hand at half an inch from the instrument causes the spot of light reflected by the galvanometer to be deflected about two inches on the scale, while the end of the finger gives much stronger action.

ELECTRICITY IN COAL MINING.

PART II—GATHERING LOCOMOTIVES.

Advent of the electric locomotive for operation in the main haulage ways in mines, while it greatly increased production and widened the extent of working areas, did not at first eliminate the mine mule. It merely forced him to the extremities of the system, there to do the "detail" of feeding and serving the main haulage. It was soon recognized, however, that the problem of transportation was thus only half solved and that haulage wholly mechanical was necessary to ideal operation, which led to the development of the gathering locomotive.



GATHERING LOCOMOTIVE ENTERING MAIN PASSAGE WAY.

Gathering the coal from the workings and delivering it to the main passage ways where it is taken by the heavier trains, involves features of a peculiar character which have led to the design of special types of locomotives. There are three general methods of gathering to be recognized:

1. Entry gathering, wherein the locomotive does simple switching work, picking up loads pushed out from the rooms by the miners and dropping empties for the men to push to the face. This calls only for a plain haulage locomotive of suitable weight for the maximum number of cars to be hauled at one time and requires no auxiliary conductor cable unless for occasional use in working beyond the end of the trolley wire in the entry. The frequent switching, however, makes desirable a locomotive under best possible control as to quickness in starting and stopping. Flexibility of wheel base is also an essential of a locomotive for practical service in side entries, where tracks are usually of light rails, laid in only temporary fashion and not well maintained.

2. Face gathering, under conditions such that the locomotive may go into the room and up to the face to leave an empty or get a loaded car, deriving power from the trolley wire on the entry through an auxiliary conductor cable paid off from a reel carried on the locomotive. Besides requiring all the features of the simple entry gathering locomotive, including quickness in handling and flexibility of wheel base, the locomotive for face gathering must be able to operate

in very close quarters and on sharp curves—in fact, be no larger than the mine car itself and at least equally free in running anywhere about the mine.

3. Face gathering in a pitching seam, where the entry is on haulage level and rooms run down the dip, the locomotive remaining on the entry opposite the room and dropping an empty in or pulling a load out by means of a steel haulage cable attached to a power-operated drum incorporated in the design of the locomotive itself.

In actual service these three elementary methods may sometimes be applied separately, but more often in combinations of two or of all three together.

One of the illustrations shows a gathering locomotive bringing a load out of a room into the main passage way. The locomotive derives its current from the coil of two-conductor cable which winds and unwinds on the drum as the locomotive approaches or leaves the main passage. One conductor of the cable terminates in a hook which anchors it firmly to the track and forms the ground connection of the motor circuit. The end of the other conductor terminates in another hook which is hung over the trolley wire over the main track. There is consequently no necessity of a trolley wire in the lateral where the gathering locomotive is working.

The second illustration shows a gathering locomotive "reeling" its way out of a room with a train of loaded cars.

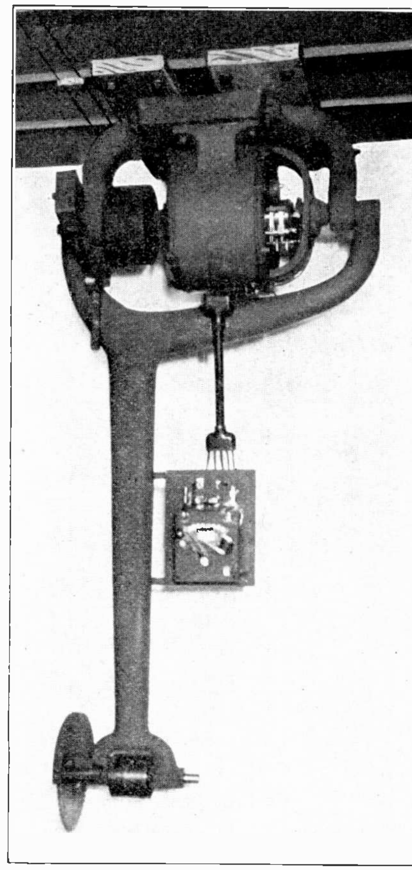
POWER WIRES NOT DANGEROUS TO HOSEMEN.

The idea is more or less prevalent among firemen that a stream of water when played against a live wire will conduct enough electricity to endanger the hoseman. As a matter of fact water is a poor conductor of electricity if it is reasonably free from impurities and a dangerous shock is hardly possible. A series of tests was recently carried out at the Pennsylvania railroad shops at Altoona, Pa., a short time ago to prove this.

A naked wire was played upon by a hose with a brass nozzle, the operator practically standing in a pool of water. The nozzle was connected by a wire to a voltmeter which registered the exact voltage of the current which was conveyed over the stream to the nozzle. Although the potential at the wire was 4,600 volts, only 20 volts were measured at the point where the operator held the nozzle and he was none the worse by the experiment.

ELECTRICALLY DRIVEN SWING SAW.

A new application of motor drive to wood-working machinery is presented by the Reliance swing saw



shown in the picture. The saw is mounted on a swinging arm and driven by a belt from the motor, which is mounted on the cast iron base from which the saw is suspended. The motor rheostat is mounted so as to be always at the hand of the operator. The saw is counterbalanced and returns automatically as soon as the handle is released. The device may also be mounted on supports attached to a work bench so that the bench and tool may be moved from one part of the shop to another.

DENTISTS' ELECTRIC FURNACE AND PYROMETER.

There are differences of opinion as to what constitutes a proper glaze for dental porcelain. What one operator considers just right would be underfused in the opinion of another. One would carry the fusing only far enough to develop the color; another would continue the heat until the sharp edges begin to round. Somewhere between these extremes every man finds his ideal of fusing. With the aid of an electric furnace and pyrometer such as is illustrated herewith, a given result can be duplicated time after time by following the same procedures.

The Hammond furnace consists of a muffle of double construction and an outer envelope inclosing the inner muffle proper, which carries the heat wires, with a fire-clay door to close the opening. Both units are of a specially refractory composition and they are held together by refractory fillings and plugs, and a thin, tight-fitting steel jacket incloses the whole. The heat wires pass around and around the inner muffle, imbedded within its substance deep enough to avoid accidental short-circuiting, but not so deep as to interfere with the free radiation of heat into the chamber. There is thus a uniform temperature throughout the chamber which is easily regulated to the porcelain used by a rheostat governed by a control lever working over a series of 13 contacts.

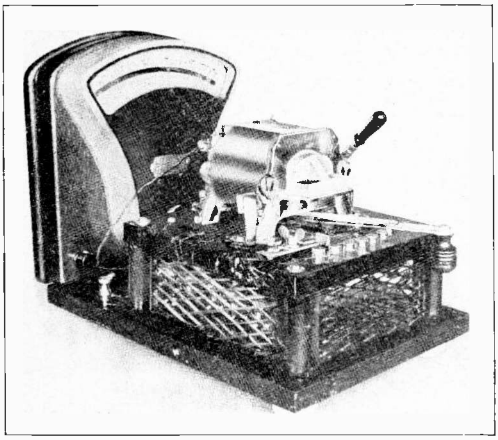


FIG. 1. ELECTRIC PYROMETER AND FURNACE COMPLETE.

The pyrometer is based on the principle that two dissimilar metals joined together and subjected to heat form what is technically called a thermo-electric couple and generate an electric current exactly proportioned to the amount of heat applied. Such a couple, composed of two high-fusing metals, is inserted within the furnace muffle whose temperature it is desired to determine, and a sensitive measuring instrument indicates accurately the current used. Since the heat is proportional to the current, the instrument really indicates the exact temperature condition in the furnace. In this way the operator can regulate the temperature by observing the instrument and moving the handle of his rheostat till the desired results are obtained. These results may then be duplicated at any time by bringing the indicator of the instrument to the same position on the scale.

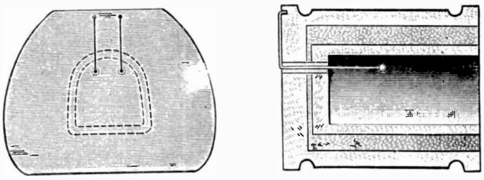


FIG. 2. APPLICATION OF THE THERMO-COUPLE.

Fig. 1 shows the instrument complete. Fig. 2 shows the application of the thermo-couple. The couple terminates in a small bulb located at the center of the heat area in the muffle. An inlay or crown to be fused is placed as near the bulb as may be. It is obvious that being thus at the center of the heat area the piece will be exposed to the full power of whatever heat is developed in the muffle and under the most favorable conditions for uniform action. On this fact, and the further fact that the pyrometer will indicate unerringly what that heat may be, is based the use of the instrument as a guide to proper fusing.

ELECTRICITY A PROTECTION AGAINST TEREDO WORMS.

An interesting discovery is stated to have been made by a wharf builder of San Francisco who was rebuilding an old wharf in which the piles had been badly destroyed by borers—teredo. One pile was found to be thoroughly sound, and a careful investigation of the cause of this exception revealed the fact that the pile had been used to support a live wire. He then carried out experiments with electricity upon wooden piles, and discovered that the teredo would not bore into a pile in which a very small current was maintained.

A SMALL WIRELESS TELEGRAPH OUTFIT.

One of the smallest wireless telegraph receiving outfits ever constructed was recently completed by D. J. F. Willett of Avalon, Santa Catalina Island, Cal. The main mast for the aerial is composed of bamboo rods, which, when assembled, reach a height of 30 feet, as shown in Fig. 1. When not in use this mast may be taken apart and folded up, being no heavier or more bulky than an angler's outfit.

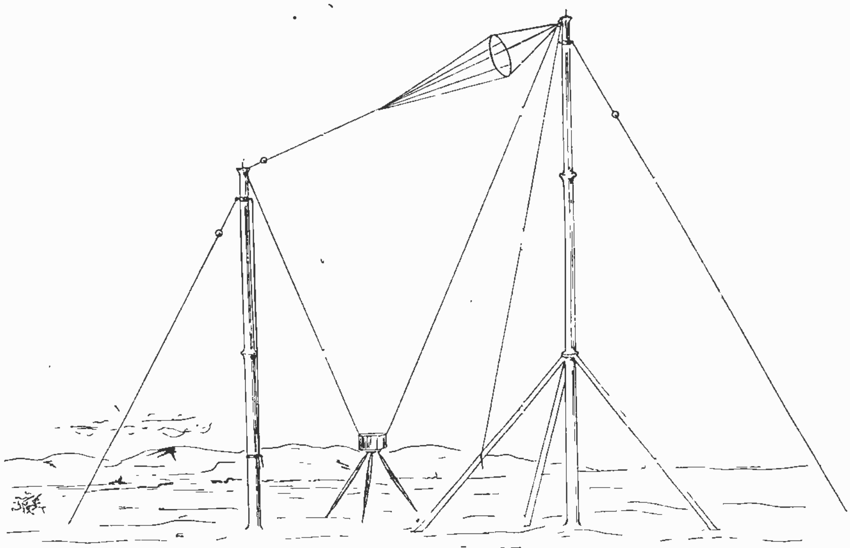


FIG. 1. UNIQUE WIRELESS TELEGRAPH MAST.

The receiver, Fig. 2, is of the silicon type. A silicon button is set in a brass bed connected with one of the binding posts, from which a wire leads to a condenser which acts as a ground. A brass point, regulated by a screw and tension spring, rests against the silicon button and is connected to the aerial wire through the other binding post. A telephone receiver is connected between the aerial and ground, forming a shunt around the detector. The very slight current necessary to actuate the receiver is set up by what is known as a thermal effect. This phenomenon is evident when two dissimilar metals are in contact and are heated, the result being a flow of electric current. Therefore, when the wireless waves come in over the aerial and travel to the condenser through the brass-silicon contact, although they are too slight to be detected in the telephone they are sufficiently strong to produce slight changes of temperature at the point of contact between the silicon and brass. These changes of temperature, which rise and fall in unison with the incoming waves, then set up little fluctuating currents, locally around through the receiver, which clicks in accordance with the incoming waves.

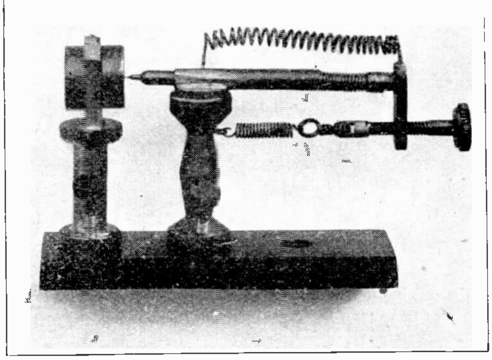


FIG. 2. SILICON RECEIVER.

EYE MAGNETS.

Eye magnets are now an important part of the surgeon's equipment and prove very valuable in removing steel or iron particles from the eyeball. These magnets are what are termed electromagnets; that is, they are energized by direct current electricity which is passed through a coil of wire surrounding the iron core of the magnet. As long as the current flows the magnet will exert a powerful pull, but as soon as it is switched off the core has no magnetic effect except a very little known as residual magnetism.

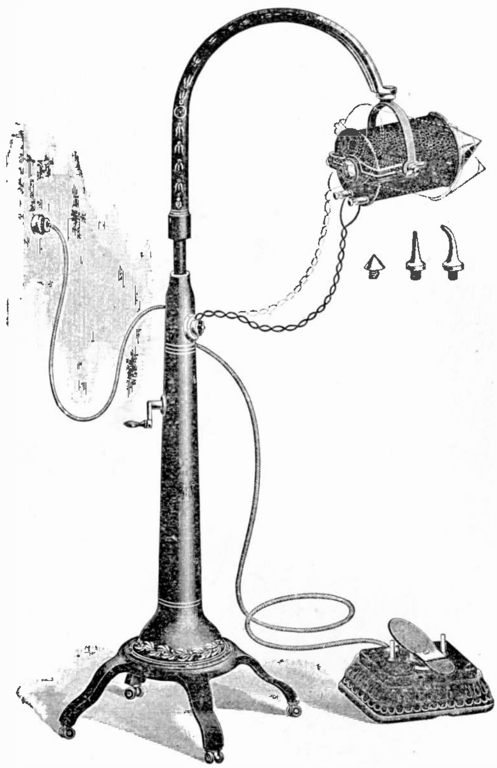


FIG. 1. EYE MAGNET AND CRANE.

The eye magnet shown in Fig. 1 is mounted on a portable crane. The magnet alone weighs about 60 pounds, but is so perfectly poised that it may be controlled with very slight effort on the part of the operator. It measures 10 inches in length and five inches in diameter, and it is capable of exerting a pull of approximately 400 pounds to the square inch.

The patient is laid on a couch or table and the crane moved up to his side. Then the point of the magnet is held down close to the eye and the current turned on. The magnetic substance in the eye will then come out in a hurry and attach itself to the magnet. Current is turned on and off by the pedal arrangement.

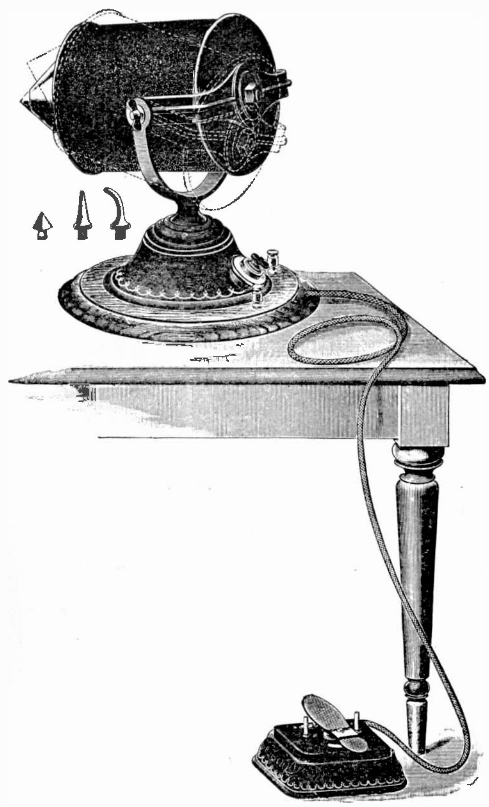


FIG. 2. EYE MAGNET ON SWIVELED PEDESTAL.

Fig. 2 shows the same type of magnet mounted on a swiveled pedestal so that it can turn about freely in all directions.

This same magnet may also be provided with a flexible tip as shown in Fig. 3, providing for more careful and accurate manipulation. This flexible tip consists of tightly woven steel wires and is attached to a special holder on the face of the magnet. When the current is applied the tip becomes magnetic the same as the magnet itself.

In extracting magnetic bodies that have actually penetrated the body of the eyeball, the full strength of the magnet is required to attract and draw the mag-

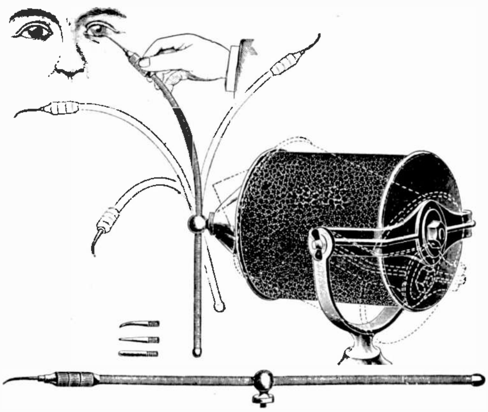


FIG. 3. EYE MAGNET WITH FLEXIBLE TIP.

netic particle forward, then the flexible tip may be brought into play for the manipulation usually necessary before the particle can be withdrawn.

THE FUTURE OF ELECTRICITY.

Professor Charles P. Steinmetz, one of the best known electrical engineers of the day, recently delivered a lecture under the auspices of the New York Electrical Trade School on the subject of "The Future of Electricity." Some of the observations which he makes regarding the possibilities of electricity in producing the two great necessities to life—heat and productivity of the soil—are very interesting and the following paragraphs set forth his ideas on these subjects:

When we reach the end of our resources in coal, in the not very far distant future, then the only remaining source of power, the only thing which will keep us from freezing will be the water power, which we will have to utilize electrically. At the present time, with all our so-called development of water power, the available supply is hardly touched. In a single New England state water power is running to waste many times greater than the power of Niagara. The water power that we use now is power that is collected in the waterfall, and as electric current it is sent out, but we have not yet started to collect the power.

We are gradually extending the use of water power, but what we have done so far is very little. Consider the case of the Hudson river. We probably use up altogether from its falls something like 150 feet head. We do not make an attempt to get the enormous power which runs to waste through the spring floods, or in all the creeks and the rivers that feed into the big stream. Practically all that water comes down from elevations of two to three thousand feet above the ocean level. And of that power, practically all is wasted in all the little creeks and rivers which go to make up the big stream; all except 150 feet head. We cannot use that power at present, but methods will have to be developed, new ways of collecting the joined powers of all these little streams, creeks and rivers so as to gather the power together. We will have to do all this when we are at the end of our resources, when the escape from freezing and starvation depends upon our getting the power.

There is an enormous field for the electrical engineer, and without him there would be hard times coming for future generations, much harder than we dream of now. We will then have to develop all that power that is now being wasted. We can see in which direction it can be done, only at present it would not be worth while doing it, because we can still use our capital in coal; but we will not always be able to use that. When that time comes we will have to economize; we will not be able to go haphazardly; we may even have to collect the rays of the sun, whenever it shines, to get the heat, because it takes a lot of electric power to produce very little heat.

There is still an enormous, far vaster problem, confronting the nations of the earth, which at the present time only electricity seems to be able to solve. In bygone ages all civilization started in the far East, in the big river valleys of Asia, in countries which are deserts now. These large, dense populations earned their living by tilling the soil. That soil does not bring any crops now. It is exhausted and was exhausted a long time ago. You cannot get any crops there without putting back in the soil in some way whatever was taken out in crops. There is no capital any more in the soil there; and it is the same all over Europe In America we have been more fortunate. We have had an enormous capital in the soil here; first, in the eastern states. But, New England is a farming country no more. It was once, but the farms are exhausted. There is still the West, with its vast resources, but it is only a question of time when all those farms of the West will reach the same end as the farms of New England, as the farms of Europe and of the Euphrates valley, and when that time comes we will not be able to do as we have done in former ages—go west. No, for as we get farther west we meet the Pacific ocean, beyond which are the countless millions of China, whose lands have all reached that stage long ago. So the last capital is just being used up now. When that is gone whatever we take out as crops will have to be put back in the soil as fertilizer. For ages there were accumulating stores of fertilizer on earth. There was guano, bird manure. We have long ago used this up. It is not now available as fertilizer, because it is gone. There is saltpetre. Saltpetre in Chili is still available, but the supply will be exhausted in less than ten years. It is already so far exhausted that the price is beyond reach for general use. There is nothing further in view. The capital is gone in that direction. We have to produce fertilizer now.

All that we take out of the soil as crops we now dump in the rivers to pollute the streams. But soon it will not be a mere sanitary question any more of polluting the rivers. We are sending millions and millions worth of fertilizer down to the sea lost forever, but in the future we will have to use that waste to keep from starvation, and all that refuse, all the waste of the cities and towns and farms must go back to the farm, to the soil from which it was taken. But all that which we now waste, when collected and returned to the farms will not replace what you take out, because there is a very large unavoidable loss in the spontaneous self-destruction of nitrogen compounds, and electric power apparently is the only efficient means which at present seems to be able to combine these elements of the air—nitrogen and oxygen—which are necessary as a fertilizer, and which cannot completely be recovered.

At present we do not use electric power for this purpose, to any extent, because we still have our capital of virgin soil, and the cost of electric power is too high, but every year we can see the necessity increasing of producing by electric power a method of restoring the capital to our farms. That problem is a very urgent one, and will have to be met within our lifetime.

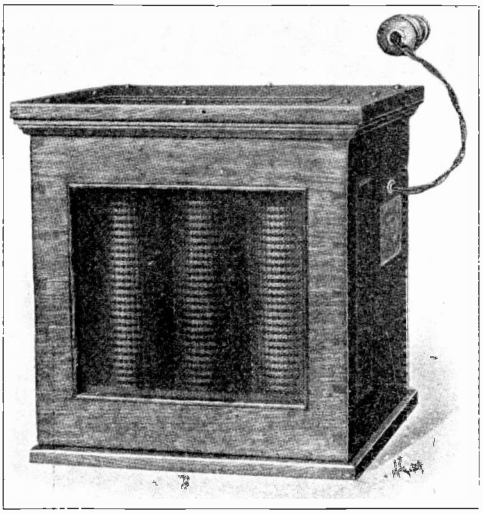
But now that we have so many uses for electric power, and the only available supply is from water power, what we will need is a method of completely and successfully collecting all the power which there is in the water courses of this country. When that is done there will be no more rapid creeks and rivers, and these streams which furnish electric power will be slow-moving pools, connected with one another by power stations, and the creeks will be empty, because their water power will be needed to maintain our life. There will then be no more question of saving the beauty of nature when it becomes a question of saving our lives, and that takes precedence over the beauty of nature. We will need electric power then for heating, cooking, keeping ourselves warm, and for restoring the fertility of our farms.

ELECTRIC AIR PURIFIER.

One of the necessities of the human system is pure air. Nature constantly vitalizes the out-door air by sunshine, winds, rain, snow and electrical discharges. The peculiarly fresh and invigorating air after a thunderstorm is due to the ozone produced by the lightning discharges. Ozone is a colorless gas with a pungent odor like that of chlorine. It is formed variously, as by the passage of an electric discharge. It is regarded as a form of oxygen containing three atoms to the molecule (O_3). This gas is both an antiseptic and a deodorizer. When inhaled it fills the blood with oxygen more rapidly than does ordinary air.

The Ozone Pure Airifier is an ozone producing apparatus for purifying the air of dwellings, offices, hospitals, schools, vessels, public buildings, lodge rooms, etc. It is run by electricity. By merely turning a button you are able to produce in your bedroom, office or workshop all the life sustaining powers of fresh mountain air. The health giving breezes of the piney woods can be summoned to your bedside at will. At the ordinary temperature of your living rooms, large quantities of ozone are produced, the foul air is revitalized and filled with pure life sustaining atmospheric ozone. The apparatus is noiseless, simple to operate as an electric light, and requires only the same current.

The electrodes used are such as to produce the maximum of pure ozone from a given current of electricity—at lowest cost. The machine is made of any required size to suit different purposes, and can be furnished for use with either an alternating or a direct current.



ELECTRIC AIR PURIFIER.

The electricity can be taken from the ordinary house wire in the same manner as for lighting, and is as easily attached as an electric fan.

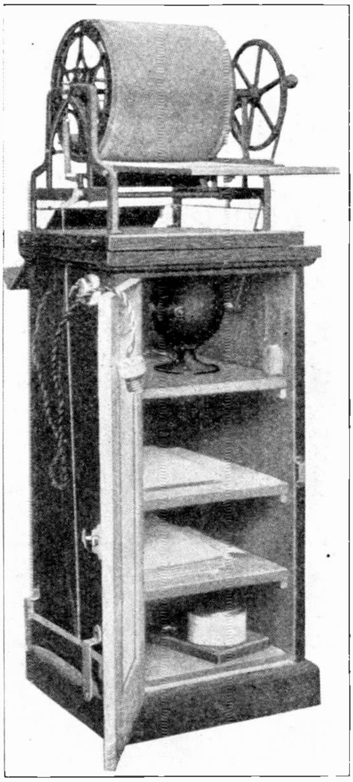
FIRE HOSE TELEPHONE.

Harry Groswith of Philadelphia, Pa., is the inventor of an improved method for making electrical contact in fire hose couplings, so that a telephone circuit may be established through the length of the hose. In this way the fireman can be provided with small portable telephones and be placed in direct communication with their chief, who may be stationed a block away and out of hearing amid the din and commotion.

The apparatus embodies two insulated wires embedded in the walls of the hose lengths. As the ends of the sections are coupled together the ends of the respective wires are brought into contact. Since the hose can be coupled in only one way, the wires cannot get "mixed" and a complete circuit is consequently established.

ELECTRICALLY OPERATED COPYING MACHINE.

In large business offices where hundreds of letters are to be copied before sending out the day's mail, the office boy will do his work more quickly and accurately if he is provided with a motor operated copying machine. A particularly compact outfit is shown in the illustration and in appearance it will do credit to any office. The copying machine is mounted on top of a neat cabinet containing shelves for the motor and for paper and other supplies. The motor requires very little current and no special wiring is needed, as a cord and plug are provided for attachment to a lamp socket.



COPYING MACHINE AND MOTOR.

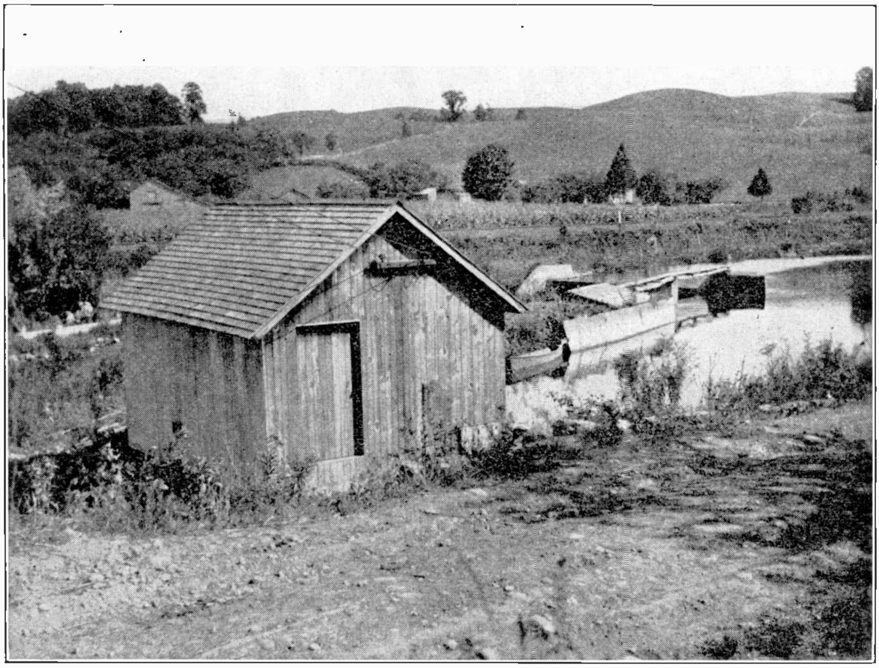
HOW A FARMER BUILT HIS OWN ELECTRIC POWER PLANT.

BY P. J. O'GARA.

Probably one of the finest examples of how waste energy has been turned into useful channels may be seen on the farm of Mr. E. B. Miner, who lives on the outskirts of Oriskany Falls, a small manufacturing town in Oneida county, New York. Here the Oriskany River, a stream having a normal flow of 65 to 70 second feet, has been harnessed, and now does practically all the tasks which formerly required so much hard labor, not only on the farm proper, but in the household as well.

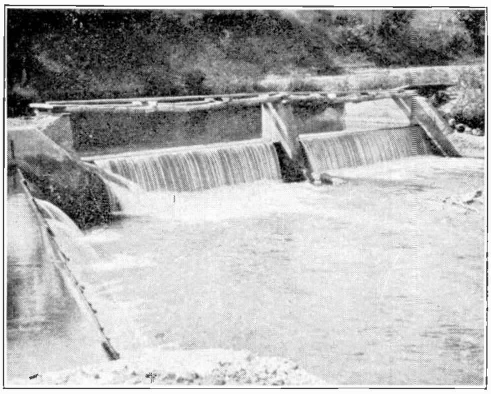
It was in 1905 that Mr. Miner decided to build his hydroelectric plant, so with the assistance of his brothers, Ralph and Harry, both electrical engineers by profession, careful plans and estimates were made and the work begun.

At a convenient point on the bank of the river, where there is an abrupt drop, the excavation for the wheel pit was made and from this point a forebay 10 feet wide was extended up stream about 100 feet to the place where a dam of the flow type was built. The dam as originally built was 3½ feet high and about 36 feet wide, but owing to the difficulty of getting rid of flood water in times of heavy rainfall, it was found necessary to cut a part of the forebay and extend the new dam at right angles to the first one. Both the old part and the new are built of timber and concrete, and a hinged apron can be raised or lowered so as to produce an effective head of 6 feet at the turbine wheel in the power house. The wheel pit is constructed of timber and concrete, and in it is placed a 30 inch Samson turbine, over which a power house 10x16 feet is built. A rack made of iron bars keeps debris from entering the wheel, and a gate, which may be raised or lowered by a windlass, shuts the water from the wheel pit in case repairs are necessary.



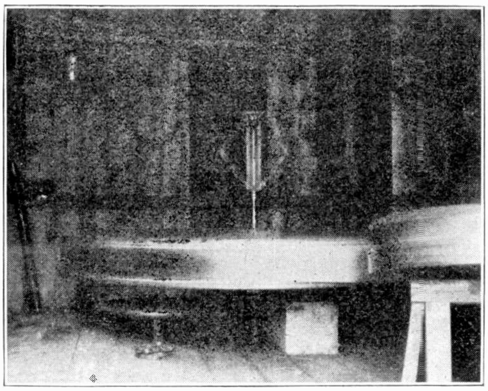
THE POWER HOUSE AND FOREBAY.

Inside the power house the construction is of the simplest and most efficient type. Keyed to the vertical shaft of the 30 inch Samson turbine, which has a speed of 110 revolutions per minute, is a wooden driving wheel seven feet in diameter. A flange in the lower edge of the rim prevents the driving belt from slipping off. The belt passes over an idler pulley, thence by a quarter twist to the dynamo pulley, which has a speed of 1,100 revolutions per minute. Upon actual test it was



THE POWER DAM.

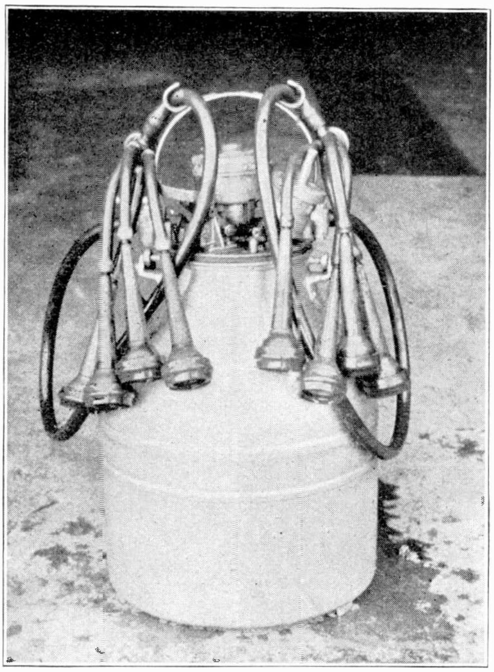
found that the turbine has an output of 25 horse power. The dynamo is a compound wound, 250 volt, 12½ kilowatt Westinghouse machine and its operation is quite noiseless. A field rheostat completes the power house equipment. Before going farther it may be stated that there is no governor on the water wheel, nor is there any means in the power house to keep the speed, and therefore



DRIVE WHEEL AND TURBINE SHAFT.

the voltage, constant. A governor is being built, but it is a question as to whether it is absolutely necessary, since under the present method the operation of the plant is successful in every way. This will be explained at another place in this article.

The transmission line, which is about 1,700 feet long, is strongly built and consists of heavy cedar poles spaced 100 feet, with 4 foot cross arms. An aluminum cable made of seven strands of No. 8 B. & S. wire carries the current from the dynamo to the farm buildings, where incandescent lamps, motors, and other electrical devices, designed for 220 volts, are installed.



THE MILKING MACHINE.

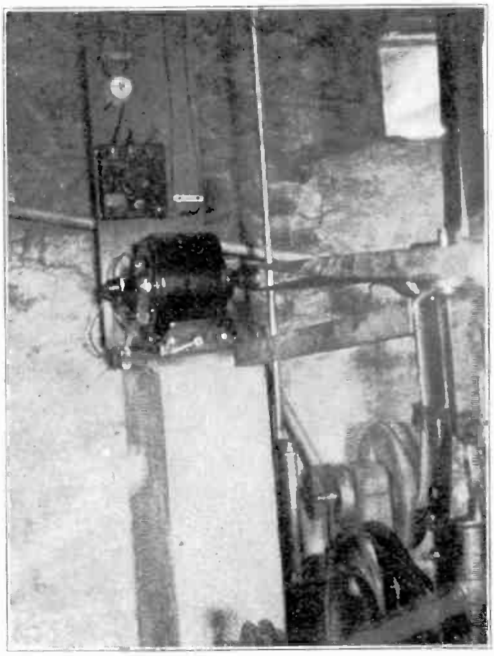
One of the first applications of the electrical energy was, of course, electrically lighting the residence and other farm buildings, where perhaps fully 75 16 candle power, 220 volt lamps are in use. Later motors were installed for various uses.

Mr. Miner has a finely equipped workshop, where all sorts of machine work is done, not only for himself but also for others. In this shop he has constructed his own electric motors, flatirons, heaters, etc. The lathes, drills, and other machines in his shop are operated by a five horsepower, 220 volt motor, which also furnishes power for cutting ensilage, sawing wood and various farm duties. Outside the shop and fastened to the wall is a large resistance coil which is connected in such a way that when the motor is thrown into circuit the coil, or part of it, is cut out. Mr. Miner has built an automatic device for controlling this resistance load. When the motor is heavily loaded then the coil outside receives no current; however, when the motor is running light, the coil takes current to the extent that the load on the generator at the power house is the same, whether the motor is lightly or heavily loaded. It may be said here that the generator at the power house carries its full load day and night, so that when the energy is not used for lighting or other purposes it is being dissipated in the form of heat from the resistance coils, which are put into circuit to take the place of the lights, motors, etc. Of course, this is a great waste of energy, but since Mr. Miner does not have either meter or flat rates to pay, he does not worry about the number of watts lost in this way.

Next to the workshop in point of interest is the dairy barn, where eighteen or twenty cows are milked morning and evening by means of a milking machine. This machine is of the vacuum pulsating type, two cows being milked at one time. The motor and vacuum pump were both designed and built by Mr. Miner. The pump is a double acting machine, and the pistons are operated by planetary gears, altogether making a very efficient piece of machinery. From the pump a pipe passes the entire length of the row of stanchions. and at convenient points nipples fitted with valves are placed. The suction hose from the milking machine is slipped over the nipples and the valve opened. The suction apparatus is then applied and the motor does the rest. Besides doing the milking, this little one horse power motor pumps all the necessary water for the barn.

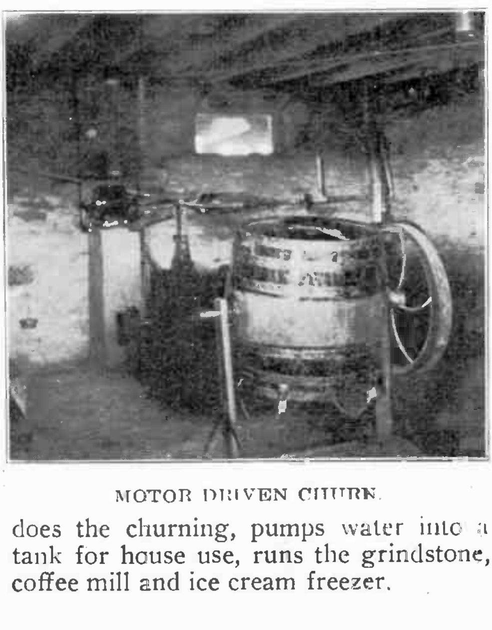
INTERIOR OF DAIRY BARN. MOTOR AND VACUUM PUMP ATTACHED TO CEILING.

In the basement of the residence is to be found a well appointed dairy. Here a one horse power motor operates a cream separator. This piece of apparatus is so designed as to be practically automatic, once the motor is turned on. When all the milk has passed through, the motor is thrown out of circuit, and at the same



MOTOR DRIVING CREAM SEPARATOR.

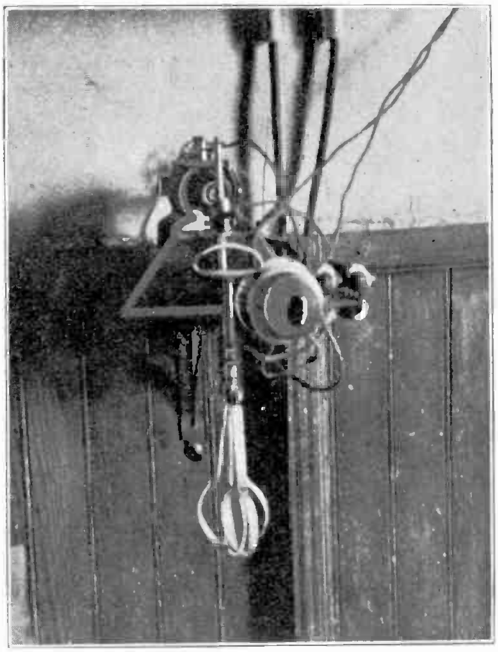
time sufficient clean water is automatically poured into the separator so as to cleanse it before it stops running. The motor, besides separating the cream, also



MOTOR DRIVEN CHURN.

does the churning, pumps water into a tank for house use, runs the grindstone, coffee mill and ice cream freezer.

In the kitchen there are all sorts of cooking and heating devices which are operated by electricity. One kitchen device, designed and built by Mr. Miner's



MOTOR DRIVING EGG BEATER.

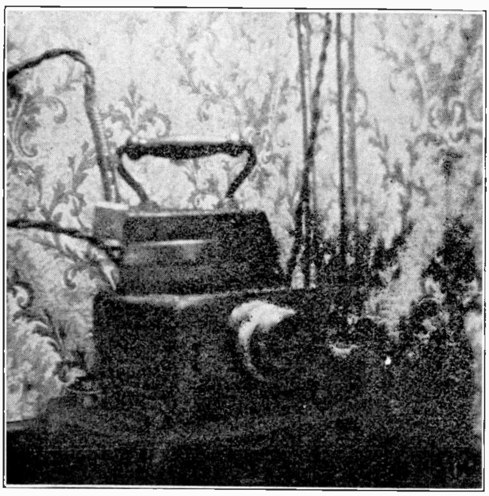
son, must be spoken of in particular. This is an egg beater which is run by a one-eighth horse power motor. Just over the kitchen table a bracket holds the motor with its egg beater attached. Three speeds may be given the beater by a con-

CORNER OF LIVING ROOM SHOWING 400-WATT ELECTRIC HEATER.

trolling device. By simply turning a switch this little motor also automatically plays a mandolin in the parlor. This latter device also sprung from the fertile mind of Mr. Miner's son.

In place of the dirty coal stove, Mr. Miner has installed electric heaters of his own design and manufacture, ranging from 3,000 to 4,000 watts and above. In winter the full output of the power plant may be utilized in furnishing heat, thus saving the expense attached to burning wood or coal.

But in the summer time, when cool rooms are as much desired as warm ones in the winter, electric fans keep the air in circulation. Besides there is a large ventilating fan in the upper story of the house which is thus kept furnished with pure air.



HOME MADE ELECTRIC FLAT IRON.

Laundry day is no longer the dreadful day it used to be, for a motor does the washing and wringing and electric flatirons, built by Mr. Miner himself, do away with the hot stove so necessary on ironing day.

The main switchboard is in the kitchen where a voltmeter indicates the voltage. If the voltage is not high enough for lights or other devices, it may be raised to the proper point by cutting out some of the resistance load, as in the case of the workshop mentioned before. In case the voltage may be too high some resistance load may be cut in, thus maintaining the balance of the entire plant.

The entire plant is so successful and simple in its operation that it gives practically no trouble. Even in winter, when one would expect ice and snow to interrupt its operation, it has kept on doing its duty without an undue amount of attention. The machinery in the power house runs night and day, and often a whole month goes by without its having a single visit from any one. The bearings on both water wheel and dynamo are self oiling, and the brushes, which take the current from the commutator are self lubricating, thus preventing undue sparking and wear on the commutator surface.

Of course, every one who reads this article would like to know how much a plant of this kind would cost. Since Mr. Miner did most of the work and constructed much of the machinery himself, it would be hard to estimate the actual cost outlay. However, it is quite certain that it could not be built for less than $2,000. Of course there is a vast difference between the actual cost of such plant and its real value. It is certain that Mr. Miner would not go back to the old way of doing things for many times the actual cost. Think of all the back-breaking jobs the Oriskany River is doing for him! Think of the cranks that used to be turned by hand now cast into the scrap heap! Think of the many hard tasks of the household now made comparatively free from drudgery! And all this has been accomplished by knowing what to do with otherwise wasted energy, and the investment of a few dollars which have been repaid many times.

PHOTOGRAPHING THE VOICE.

"Now that the aeroplane is an accomplished fact," says the Chicago Journal, "perhaps it might not be wasting time to turn to the parolograph, which has just been added to the long list of wonders of the age by a French government engineer, Devaux Charbonnel.

"By combining a microphone, which multiplies the smallest sound so it can be heard, with an oscillograph, which traces the variations of the sound, the ordinary telephone instrument will faithfully reproduce the human voice on a photographic plate in a series of waves and curves which anyone may easily learn to read.

"Mastering this science will soon be part of the stenographer's duties, and we may expect to see want ads reading, "Wanted—Rapid and accurate shorthand and typewriter, who is experienced with parolograph."

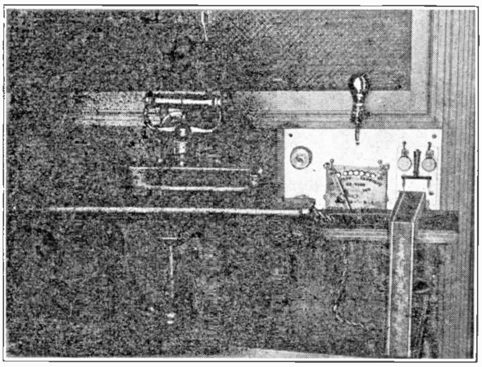
"Coupled with the compound system of telephony which enables any number of messages to be transmitted over one wire, it will only be necessary to put in a number of instruments to do away with the dread "Line is busy." The business man can call up his party and leave his message in such fashion that it can not possibly be transmitted incorrectly by a careless employe.

"Incidentally, while it is easy to distinguish the different vowels and consonants as recorded by the parolograph, the inventor says no two persons in speaking produce exactly the same sound waves. The French police propose to make use of this peculiarity and add the voice picture to the Bertillon records and thumb prints to make assurance doubly sure."

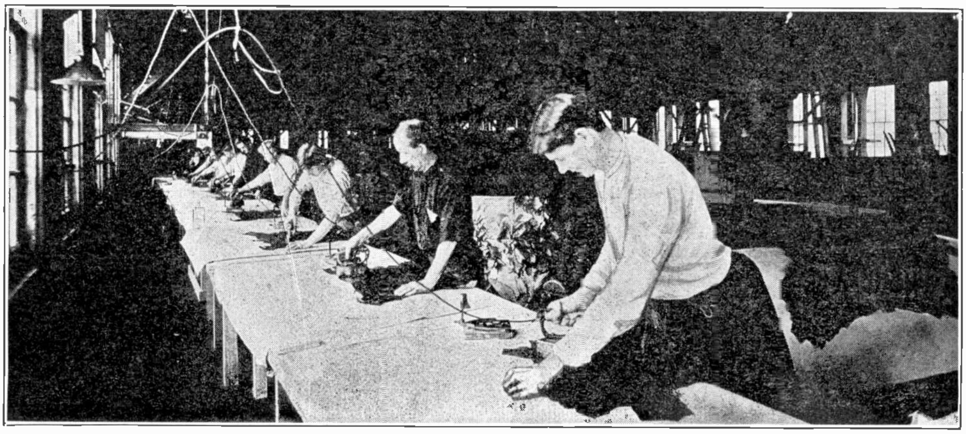
ELECTRIC IRONS IN THE MANUFACTURE OF CLOTHING.

Progressive manufacturing establishments where "ready made" clothes are produced in large quantities as well as the shop of the custom tailor must nowadays be equipped with electric irons to be called strictly up-to-date. The use of the electric iron radically improves the sanitary conditions of the shop, increases the output and reduces the danger of fire. The liability of injury due to soot is eliminated and the temperature of the room reduced. At best, the work of the presser is arduous, and when its must be performed in a vitiated and heated atmosphere attendant upon the use of gas or charcoal heated irons it becomes almost intolerable.

One of the views herewith shows a line of a dozen or more operators all using the latest type of Simplex electric tailors' irons. In this particular instance the irons are used for pressing out leather. The other view shows a tailors' electric machine iron complete with stand, switch and controlling rheostat. Six degrees of heat are obtainable with this outfit. The iron is mounted on a swinging arm or bracket over the board, the latter being forced up against the iron by a foot lever so that the iron need not be lifted.



TAILOR'S MACHINE IRON.



ELECTRIC IRONS IN OPERATION.

One of the most important features in connection with these irons is the automatic regulator which prevents excessive heating when left idle with the current on. This reduces the cost of current supply when the iron is not actually doing service. The principal cause of injury to irons is overheating, and the automatic regulator prevents this.

The regulator consists of a stand to receive the iron, which is so arranged that the current supply is automatically cut down to just the amount necessary to keep the iron at the working temperature, when the iron rests on the stand. When it is removed from the stand resistance is cut out of the circuit so that an additional supply of current flows through the iron, suffcient to supply the additional heat required for operation.

ELECTRICAL METHOD OF ADMINISTERING MEDICINE.

Many endeavors have been made in the course of the last few years to take advantage of scientific methods in applying medicine to the human body, and Professor Leduc of Nantes, France, has devised a novel and promising process, which allows medicine to be introduced externally by the aid of electric currents.

This process is based on the principle that the curative effects of medicine are mainly due to the electrolytic action between the latter and the humors of the body, and as such an action can be controlled more effectually by the aid of electric currents, the new method allows the healing virtues of medicine to be greatly enhanced and regulated at will.

To illustrate this process, some wadding soaked in a solution of strychnine sulphate was applied to the inside surface of the ear of a rabbit. This wadding, after having been covered with a metal plate, was used as a positive electrode to introduce the current, while a solution of sodium chloride serving as negative electrode was placed on another part of the body. When a current of sufficient strength was turned on the animal was seized with tetanic convulsions, rapidly resulting in its death.

Another rabbit was subjected to a similar electrification, except that the strychnine solution was used as the negative electrode, and the sodium chloride as the positive. In this case not the slightest inconvenience resulted to the rabbit.

Penetration of the "ions" (or electrolytic components of the molecule), was illustrated in a striking manner, by using solutions of potassium permanganate as electrodes, applied to each arm. After the passage of the current no appreciable change is noted in the skin of the arm through which the current has entered, while that portion of the arm serving as outlet (or as negative electrode) was found to be covered with brownish dots impossible to remove by washing, the particles having penetrated too far into the skin.

Among the maladies that have been treated successfully by the external electrolytic application of medicine should be mentioned sclerotic deformations of the joints—which are found to disappear very rapidly after the application of a solution of sodium chloride. Neuralgia is likewise treated successfully by the electrolytic application of a salicyl solution, the pain disappearing with remarkable rapidity. Another treatment consisting of brain electrification has been found successful in curing neurasthenia, as well as many other affections of the spinal cord. Even healthy persons are said to have appreciated beneficial effects from an electrification of their brain, experiencing a greater capacity for mental work. A. G.

BOOK REV.EW.

ELECTRICAL CONTRACTING. By Louis J. Auerbacher. New York: McGraw Publishing Co., 1908. 155 pages with 225 illustrations. Price $2.00.

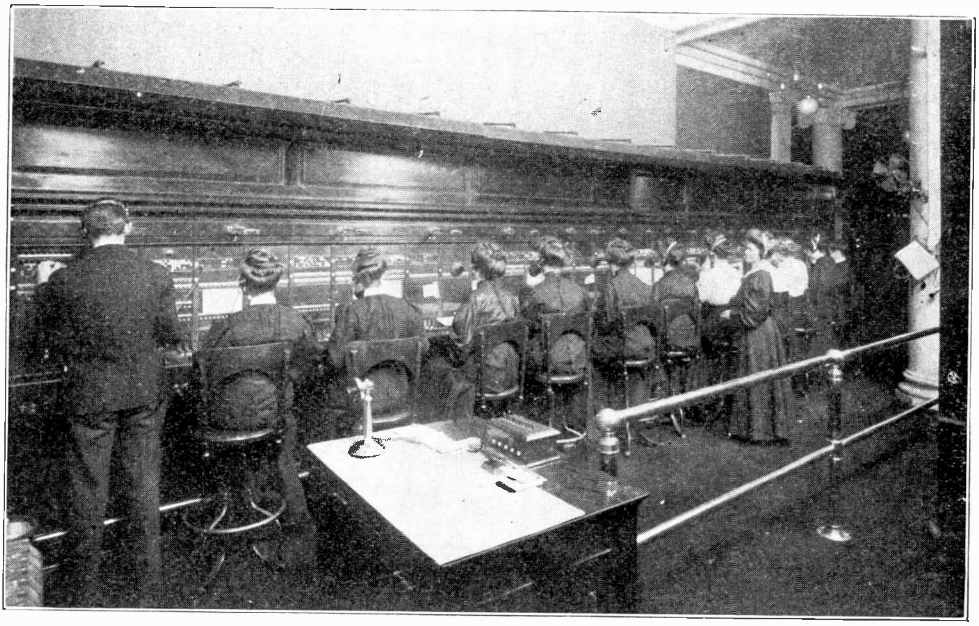
Wiremen and contractors will find many practical hints upon the latest methods of electrical construction in this book. Those who are about to embark in this line of work will also be interested in the simple system of bookkeeping which is outlined and in the many suggestions offered for increasing the income of the business. Reliable information is given in all departments of electrical contracting work, including such subjects as the estimating of contract work, wiring exposed circuits, with wooden moldings and flexible and iron conduit, generators and switchboards. electric signals, special lighting devices, etc.

TELEPONES IN A DEPARTMENT STORE.

Every hour 10,000 people enter the doors of Marshall Field & Co.'s great retail store in Chicago, in the average day. A million articles of merchandise are displayed, involving in some degree almost every process of manufacture known to human ingenuity. Such a store is the meeting place of supply and demand, and as such it must of necessity be equipped with every modern convenience which will increase its efficiency in supplying the public with the necessities and luxuries of life.

Few of the people who daily throng this mammoth establishment, realize that within its walls is a telephone system, complete with switchboard and operators, adequate to supply the needs of a well developed city of 20,000 inhabintants, yet such is the case. In order that the reader may the more easily comprehend the necessity for such an equipment and why this establishment is really a good sized city in itself, the following statistics will be helpful.

The gross area of floor space on the premises is 1,523.017 square feet—over 35 acres—of which 132,000 square feet is occupied by the great basement salesroom, the largest single salesroom in the world. The main aisle is 385 feet long, extended straight through from Washington to Randolph streets. The State street portion of the building is 12 stories high with 219 feet above and 43 feet below the street level. On the floors is laid 371,125 square feet of Wilton carpet. This if rolled out in one strip would reach 31¼ miles. The tea and grill rooms on the seventh floor have a capacity for seating 2,500 people. The delivery system utilizes over 300 wagons and 700 horses and covers a territory of 350 square miles.



TELEPHONE SWITCHBOARD IN DEPARTMENT STORE.

With such a community of interests, therefore, it is not surprising that this institution can utilize a private branch telephone exchange which would serve a good sized city.

A view in this busy exchange is shown in the illustration. During the day 12 operators are kept busy at the 12 positions on the switchboard. The first two at the left handle the incoming calls only, that is, calls from patrons and others outside of the store. These calls may reach as high as 10,000 or 15,000 in a day. The outgoing calls number anywhere from

2,500 to 4,500 a day. Connections are of course, made with outside parties by trunk lines connecting with the regular exchanges of the telephone company.

The third position from the left is for handling long-distance calls and for switching calls from the lines in the retail store to the trunk lines which lead to the company's wholesale store several blocks away. There are 14 of these trunk lines.

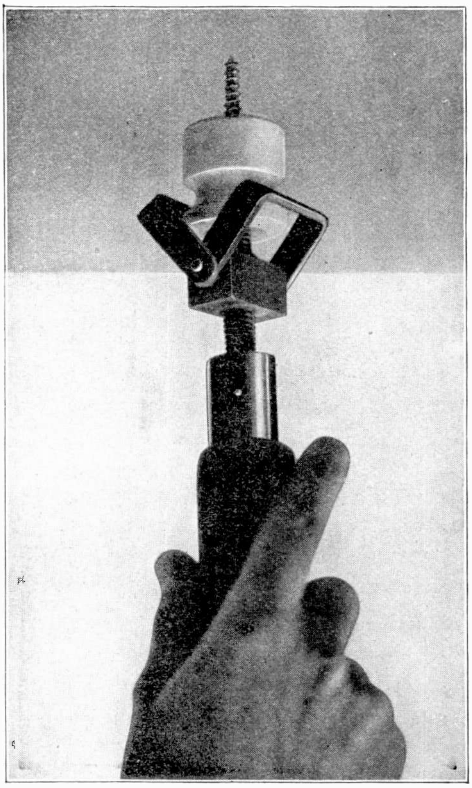
The remaining operators at the board are engaged in making connections between the various departments in the store. These calls originate and terminate within the store and consequently, are not transferred to the telephone company's lines.

Chief among the advantages which accrue from the employment of the private branch exchange are greater convenience to patrons and increased efficiency in carrying on the business within the store. Every department is supplied with telephones which are accessible to the sales persons. These sales persons become in time familiar with the ideas and tastes of many of the people with whom they come in contact regularly, so much so that much of the shopping is carried on over the telephone. Women, particularly, utilize the telephone to do their buying, as they can ocnveniently call up their favorite sales ladies in the various departments, who are familiar with their tastes and whims, and who can pick out for them the materials they desire, thereby saving an unnecessary trip down town. Without the private exchange the installation of telephones so profusely in all the departments through outside exchanges would mean an expense that would be almost prohibitive.

In transacting business between the various departments of the store, the telephone system has become indispensable. Before its inauguration messengers had to be spent from department to department, entailing a great loss of time in an establishment of such proportions. With the installation of a few private telephones between departments and without the switchboard, which plan was first tried, not much was gained, for the called party could perhaps not be located and even when found, might need to walk a long distance to answer the call. Now all these delays are done away with. The manager of a department sits in his office, a telephone is at his elbow by which he may place himself in instant communication with anyone in his department or with the head of any other department in the building. If the party has left the vicinity of his own telephone, he may be easily located by the elaborate system of communication, and brought to the nearest telephone, thereby in the aggregate saving hours of the time of high-priced employes.

HANDY WIREMAN'S SCREW DRIVER.

Wiremen will be interested in the handy screw driver shown in the accompanying cut, which is used for putting up porcelain knobs. By a turn of the handle the knob and screw are locked together, so that it is impossible for the driver to slip



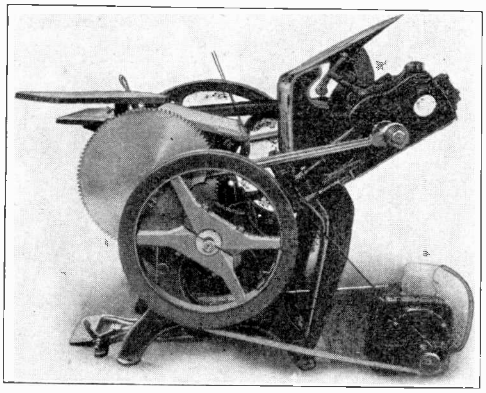
HANDY WIREMAN'S SCREW DRIVER.

out until the knob is screwed firmly in place, when the driver automatically releases itself. Only one hand is required to operate the driver after the knob and screw are locked together, leaving the other hand free. The device can also be used as a plain screw driver when so desired. In driving the screws into hard wood the screw heads are not injured.

A NEW VARIABLE SPEED MOTOR.

More than ordinary interest is attached to the work of Austin Kimble, of Chicago, who under adverse circumstances succeeded at last in perfecting a practicable variable speed motor which would operate on alternating current circuits and in which the current consumed would be in direct proportion to the speed. This was a problem which had puzzled engineers for many years although it had been partially solved by the induction motor.

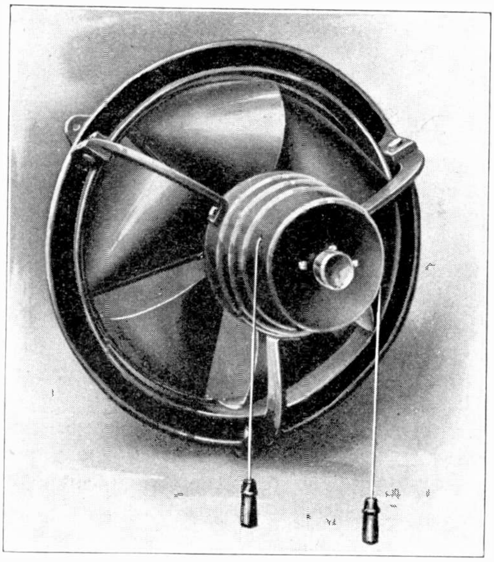
Young Kimble was a stationary engineer, but like many who are of a mechanical turn of mind, he could not let electricity alone. One of the things he was told when he first began to experiment with electricity was that, outside of the direct current motor which is controlled by more or less complicated rheostats and regulating devices, a variable



VARIABLE SPEED MOTOR OPERATING PRINTING PRESS.

speed motor could not be built. He believed that it could, however, and in a small barn 12 feet square he set out to design and construct a motor to fill the requirements, and in addition to operate on alternating current which is furnished nearly everywhere except in the most thickly populated parts of large cities.

The first machine built was constructed out of the remains of an old motor and had a broom stick for the armature shaft. This machine was only used as an experiment in working out the design. The next machine had a steel shaft and worked very well without any form of speed controller which had hitherto been necessary. In short, it was a success, although it cost several hundred dollars. The jeweler who bought it for $20 to run his lathe was well pleased with it, and is running it still. When another motor neared completion a customer was found for it, and this time the selling price was only three or four times less than the cost. Business was looking up. Gradually, however, with perfected methods



VARIABLE SPEED MOTOR OPERATING FAN

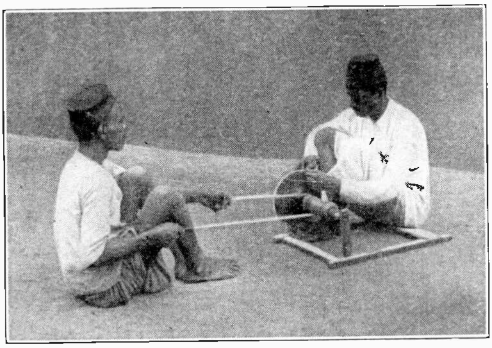
and larger output the machine became a commercial success.

Speed control of the Kimble motor is obtained simply through shifting the brushes, a special winding of the armature permitting this to be done without loss of efficiency or variation of current between high and low speeds.

The illustrations herewith show two applications of the motor. One is driving a job printing press, which type of machine requires frequent starting and stopping and very close speed control. In this case the brush shifting mechanism is operated by a foot pedal, the pressman thus having both hands free. The other view shows one of the motors direct connected to a ventilating fan.

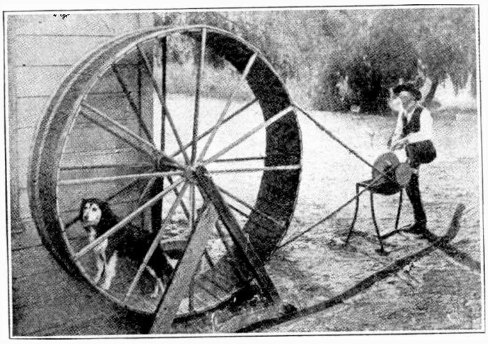
DEVELOPMENT OF THE GRINDING MACHINE.

Grinding was probably the first process employed by man in shaping utensils and weapons to his needs. A stone to rub his first crude tools upon served the purpose very well, no doubt for many centuries. As his mechanical talents de-



PRIMITIVE GRINDSTONE OF THE HINDOO.

veloped, however, it dawned upon him to make a machine which would accelerate the movement of abrasive surface, and the primitive grindstone of the Hindoo was the result. This was a great improvement, but it necessitated the constant reversal of the wheel and besides it was rather arduous work to draw the strap back and forth, so a crank was substituted for the strap and man was again satisfied for a time. But he was



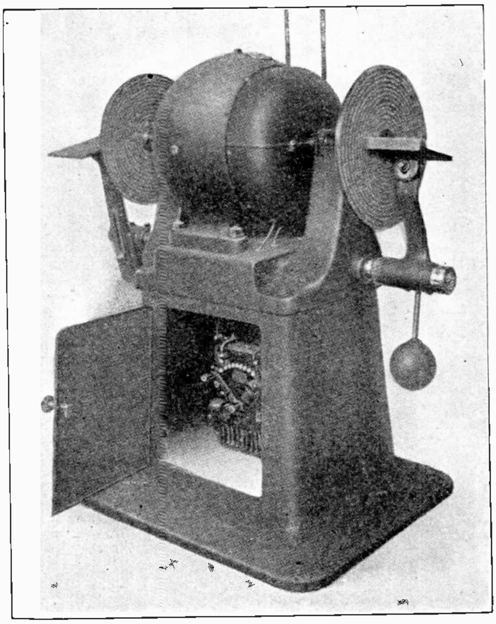
GRINDSTONE DRIVEN BY DOG POWER.

not content to do the work himself, so he brought other power into service and used a belt for transmitting it to his grinding wheel. Dog power, water power, steam power, all were successively utilized, but the grinding machine never reached its full usefulness until electric power came into general use, and along with it the wonderful new abrasive, carborundum.

Now the electric grinding machine is almost universally employed in all the large machine shops. It performs a multitude of operations, from smoothing and shaping rough castings to grinding down the most carefully made machine parts to the thousandth of an inch.

Electrically driven machines are convenient to arrange and to locate and can be placed in the most advantageous position regardless of the limitations of line shaft. When once located, power is brought by means of small wires which can be supported by practically any structure and carried around or through obstructions with a facility undreamed of where power is transmitted by line shaft and belt.

One of the illustrations shows a Northern dust proof spherical motor operating a disk grinder, used principally in fin-



MODERN MOTOR DRIVEN GRINDER.

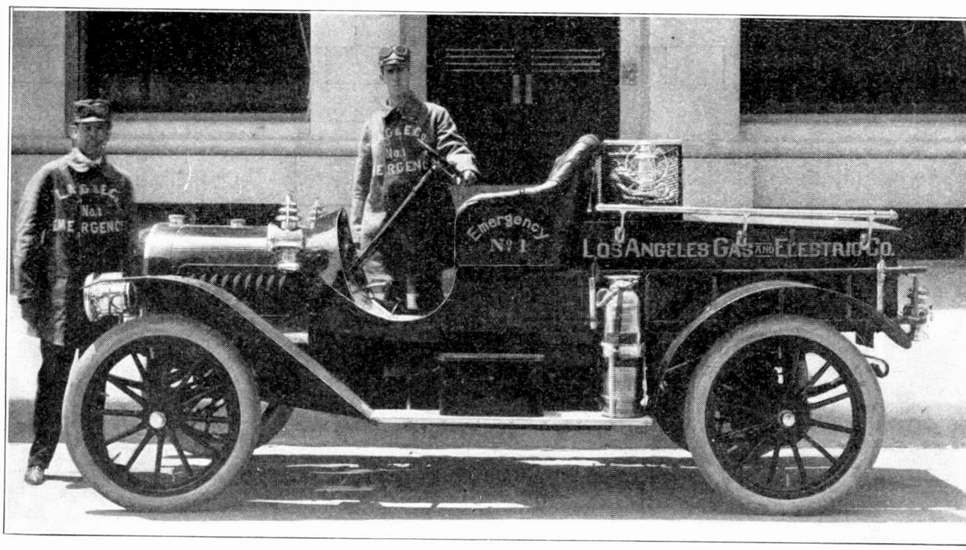
ishing flat pieces. The machine is complete in itself. Not a particle of the metallic dust can reach the interior of the motor and play havoc with the electrical connections for it is all inclosed. Even the starting box is located in a dust tight compartment in the base.

This, however, is but one of the hundreds of types of electric grinders now in use. To say that it is an improvement over the stone rubbing process of ages past in hardly necessary.

AN ELECTRIC COMPANY'S EMERGENCY FIRE AUTOMOBILE.

An emergency fire wagon has recently been placed in service by the Los Angeles Gas and Electric Company, as shown in the accompanying illustration, which will render aid to the local fire department. This auto-fire-car is equipped with a 30-horsepower motor and carries on the rear a load of fire-fighting paraphernalia. It is also provided with a hood to protect the crew from the flames, also a tank of oxygen for use in case of serious accident, so that firemen who are near asphyxiation may be resuscitated by means of the oxygen gas available. This oxygen tank is carried on the side of the car and has a small hose attached ready for service.

The Los Angeles company utilizes this emergency auto-car for quick service in case there is anything wrong with the gas or electric service at the premises of their patrons. In case of fire, wires can be cut quickly, and the trained gas and electric workman are of great assistance to the fire department of the city in looking after live wires and gas pipes in burning buildings.



EMERGENCY FIRE AUTOMOBILE.

WIRELESS FROM THE WASHINGTON MONUMENT.

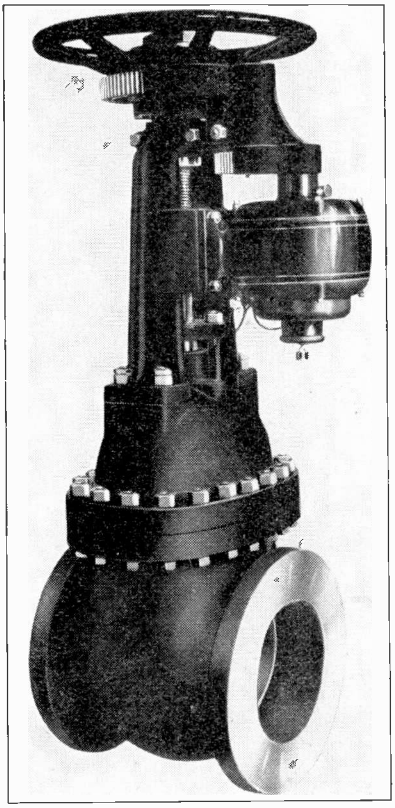
A plan is proposed to use the Washington monument temporarily for a wireless station and if the experiment proves successful to erect a permament tower of the necessary height, probably about the height of the monument, which is 555 feet. The plan, if carried out, will revolutionize the wireless telegraph and cable business of the government and will greatly facilitate communication to Europe and with the war vessels. The value of the plan in war time would be incalculable, if it can be worked, as the bureau of equipment believes it can.

MOTOR OPERATED VALVES.

In waterworks, power houses, gas houses, mines, refrigerating plants, etc., there are many valves located in places in the intricate pipe systems which are difficult of access. The valves are also in some cases so ponderous as to require a great deal of time and hard labor to open or close them by hand. Some bright mind, therefore conceived the idea of opening and closing them by an electric motor, which could be controlled from any point in the plant.

Electrically operated valves are, in consequence, a feature of nearly every up-to-date large plant. They are made in sizes ranging from a few inches up to five feet in diameter. The motors are controlled by special reversible controllers, and any number of controllers may be supplied to operate a valve from any number of places in the plant.

In an electric power plant, for instance, controllers for all the main valves may be located at the switchboard. The electrical engineer then has entire control of his plant from one point. He may turn the steam on in any section of the plant,



MOTOR OPERATED VALVE.

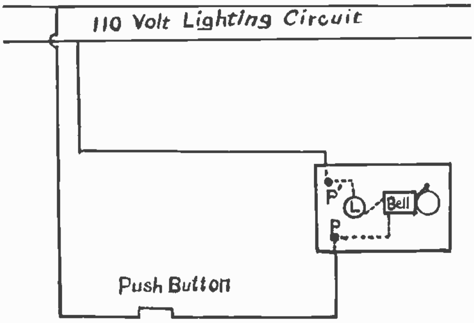
starting, stopping and reversing the motor of each valve at will. In case of accident he can control the emergency stop of any engine. If a steam pipe bursts, endangering the lives of the men, he can instantly cut out that section of pipe. Without the distant control system it might be half an hour before the steam would die down sufficiently to send a man up to close the valve by hand.

The illustration herewith shows a Crane motor-operated valve. The motor is mounted vertically and moves the valve gate up or down by means of gearing. The operation may be performed in from 10 to 60 seconds, depending on the size of the valve.

OPERATING DOOR BELL BY 110 VOLT CURRENT.

The most satisfactory way to operate a door bell is to employ the 110-volt current from the electric light circuit in the house. The objections to batteries are that the dry cell type will run down sooner or later and when the gravity cell type is used the solution will evaporate and require replenishing from time to time, and the salts in the solution will also crystallize and form a deposit all-over the jar and on the shelf. The following is a means by which the lighting current may be used.

Secure a good dry oak board about five



OPERATING DOOR BELL BY 110-VOLT CURRENT.

by eight inches and fasten the bell and a lamp socket (L) to it as shown in the diagram. Then connect up as indicated by the dotted lines, putting the wiring on the back of the board to make a neat job. From the binding posts (P) and (P^1) connect with the lighting circuit and insert a push button in the circuit at any point desired.

When the button is pushed, the current flows through the circuit and rings the bell. In doing this, however, it must pass through the lamp, the high resistance of which cuts down the voltage so that the bell magnet coils will not be burned out. A 16 candle power lamp should be used. Be sure also to tape all joints so that there will be no danger of fire.

ELECTRICAL MEN OF THE TIMES.

KEMPSTER B. MILLER.

No branch of electrical engineering requires a broader knowledge of the theories of electricity or more resourcefulness in their application than telephone engineering. The telephone engineer deals with comparatively small currents, it is true, but their very smallness and unruliness add to the difficulty of his problem. One of the men who understands telephone currents and telephone apparatus from beginning to end and who is one of the foremost authorities in this field is Kempster B. Miller of Chicago.

Mr. Miller was born in Boston, Mass., August 14, 1870, and received his preparatory education in the public schools and in the high schools of Washington, D. C. He entered Cornell University in 1889, from which he graduated with the degree of M. E. in 1893. From that time until 1904 his experience was of a varied nature. He was successively patent examiner in the United States Patent Office, practical engineer, text book writer, and superintendant and engineer in a large telephone manufacturing plant. In 1904 he began professional engineering and expert work in partnership with Mr. Samuel G. McMeen.

By far the most of Mr. Miller's adult activity has been in connection with telephone and similar intelligence transmission interests, and inventions resulting from his study of telephone problems have been a considerable portion of his contribution to that art. Most largely his inventions relate to telephone equipment, particularly central office switching mechanisms.

Although his contributions to technical literature have been numerous, he is best known among readers by his work "American Telephone Practice," which is now in its fourth edition. This book is considered a standard work on telephony and is largely used as a text book in colleges as well as by practical telephone men the world over. The revision resulting in the current edition brings the volume to about 900 pages, treating on the history and present status of both the science and the art.

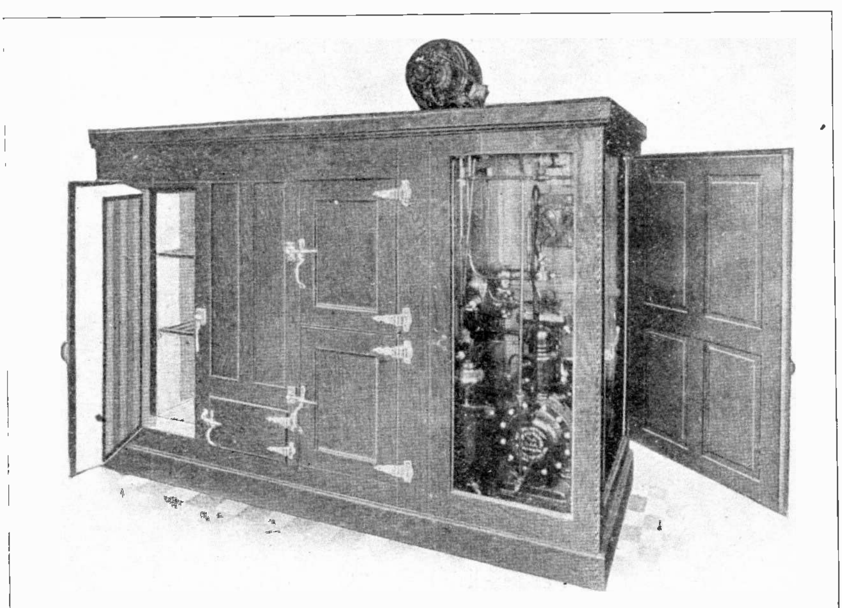
During several years past, Mr. Miller has been engaged in a broad study of the fire alarm telegraph system of the city of New York, which city undoubtedly presents the most enormous fire hazard of any city in the world. This work was undertaken by Mr. Miller at the request of the New York Board of Fire Underwriters, because of the desire of that body and of the National Board of Fire Underwriters to know whether the fire alarm telegraph system then existing was of a type and in a condition to afford an adequate protection against fire losses. The astounding conditions unearthed by Mr. Miller are more or less familiar to the public through the press. In consequence of his work upon the general fire alarm problem, Mr. Miller was retained by the city of New York to prepare for it a complete working plan for a new system to take the place of the present fire alarm telegraph system.

The firm of McMeen & Miller is now engaged in engineering and constructing a new telephone system for the city of San Francisco and the neighboring group of cities around San Francisco Bay. This is probably the largest piece of Independent telephone construction to date.

ELECTRICITY IN THE HOUSEHOLD

SANITARY REFRIGERATION FOR THE HOME.

Sanitary authorities and physicians agree that disease germs are not exterminated by freezing, and that ice may contain and convey dangerous disease germs found in reservoir, lake or other water. All natural ice is only as pure as the water from which it is frozen, and few harvesters of ice ever analyze the water from which they gather their winter's crop. It follows, therefore, that no refrigerator that depends upon the cold produced by melting ice for food preservation can be at all sanitary. First of all the air in such a refrigerator is certain to be damp. Moreover, no such refrigerator can be made to show a lower temperature than 50 degrees which is not cold enough to preserve any article of food. Beef requires from 36 to 40 degrees of cold for its perfect preservation while pork and lamb or mutton require from 29 to 36 degrees. Butter and eggs call for from 32 to 38 degrees—while poultry and fish need 25 to 30 degrees. Oysters require 33 to 45 degrees. Vegetables 34 to 40 degrees. Canned goods 38 to 40 degrees and fruits 32 to 36 degrees. Under the lowest temperature possible to obtain in an ordinary refrigerator (50 to 60 degrees)



HOUSEHOLD REFRIGERATING PLANT.

food naturally will not spoil as quickly or rapidly as it will when exposed to the kitchen heat, but it is steadily and surely undergoing decomposition.

Most of us are aware that nowadays ice may be manufactured on a large scale as well in the torrid heat of August as in the chill days of December. But comparatively few know that there are now obtainable small refrigerating plants of a size suitable for the home, which, in addition to keeping the refrigerator cabinet at any desired temperature, even below the freezing point, will also manufacture from 10 to 20 pounds of hygienic ice per day, for drinking purposes and for the sick room.

Such a machine, the Brunswick, is shown in the cut. It is operated by a half horsepower electric motor which drives the ammonia compressor, and all that is necessary is to close the switch in the morning and keep the plant running during the day time only. The motor is small and the cost of power insignificant when the elimination of ice bills and the sanitary results obtained are taken into consideration. The machine shown has a refrigerating capacity equal to the melting of 200 pounds of ice per day.

Like all artificial ice machines, this machine is based on the principle that the re-expansion of a gas which has been compressed and liquified produces cold. The best gas for this purpose is ammonia gas. This is compressed by the motor driven compressor to the liquid state, then pumped through the refrigerator pipes where it expands. In the process of expanding back into the gaseous state heat must be absorbed, as heat is absorbed in changing water to steam. This heat is taken from the inside of the cabinet, leaving the interior extremely cold. The cold is a dry cold, however, for no ice or liquid is necessary inside the cabinet.

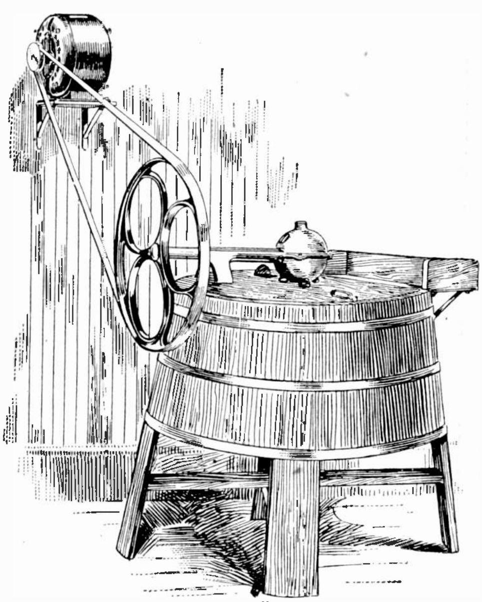
SANITATION BY ELECTRICITY.

Sanitation by electricity is the latest London idea. The process is simplicity itself, consisting of the passage of an electric current through sea water. As is well known, the fundamental constituents of sea water are the chlorides of sodium and magnesium. When an electric current of sufficient intensity is passed through this solution there is formed a hypochlorite possessing a high disinfecting value.

According to Dr. Klein, the eminent bacterioloigst, the hypochlorites are exceedingly powerful disinfecting agents, whether used in the presence of sewage or other organic matter.

MOTOR POWER FOR THE WASHING-MACHINE.

An easy and satisfactory method of attaching a motor to ordinary makes of washing machines is shown in the cut herewith, but it will doubtless often require some mechanical ingenuity on the part of the person making the installation, if entirely satisfactory results are procured. Wherever it is possible to do so, the motor should be placed on a level with or higher than the pulley of the



WASHING MACHINE AND MOTOR.

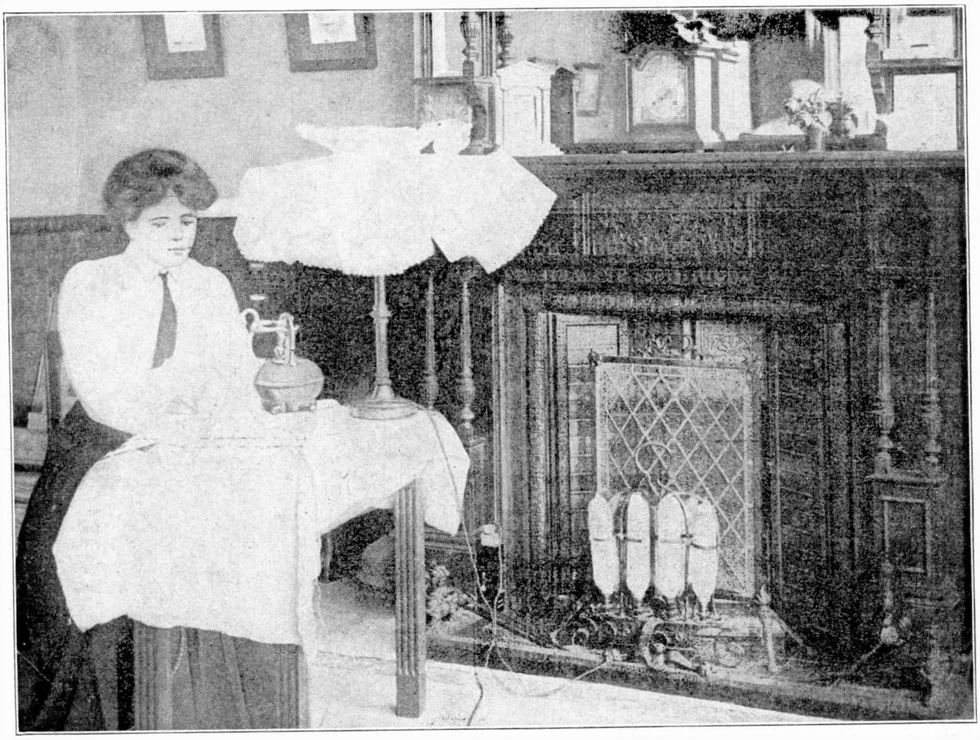
washing machine, where it will be out of the way of dirt and water.

For operating the common makes of rotary washing machines, which should revolve at a speed of about 75 revolutions a minute a special motor is not necessary. Any motor of the proper capacity (about 1-10 horsepower) will do the work. The motor should have a speed of about 1,200 revolutions a minute and should be provided with a small pulley so that the necessary reduction may be made by a belt to the driving wheel of the washing machine.

The cost of operating washing machines by motors is almost nominal. The amount of current actually consumed by these motors will, of course, vary with the work, and will also depend on the make of washing machine, the condition of its bearings, and the consequent load imposed on the motor. It is probably safe to say that the consumption of current by one of these motors operating the average washing machine will be approximately 150 watts per hour. On this basis the cost of operating the outfit with current charged for at the rate of 10 cents per kilowatt hour would be less than two cents per hour of steady operation.

A PORTABLE ELECTRIC RADIATOR.

The luminous electric radiator is now classed among the necessities of the modern home and is manufactured in a variety of forms, all of which are based on the principle of the electric glow lamp. The portable type here illustrated possesses the advantage that it may be placed anywhere in the room. As will be seen in the picture, the incandescent bulbs or tubes are mounted on an ornamental base, which is provided with a handle for carrying it from place to place. Current is carried into the base by a lamp cord and plug. The circuit is there branched out and not only supplies the lamps of the radiator but provides terminals for plugging in the cords from other electrical devices, such as the sewing machine motor, chafing dish, electric fan, etc., thereby serving a double purpose.

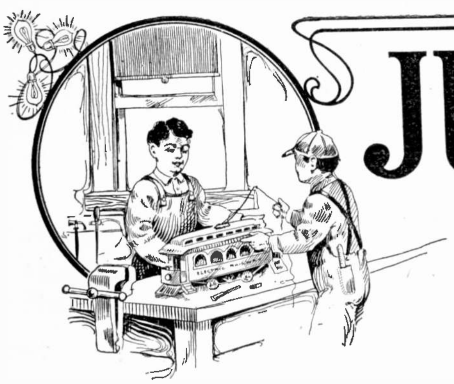


PORTABLE ELECTRIC RADIATOR.

LIGHTING CURRENT NOT DANGEROUS.

There is no reason to be afraid of the ordinary incandescent lighting circuit such as is used in houses illuminated with electricity. This circuit ranges in voltage or pressure from 110 to 118 volts. Incandescent lighting current is not at all dangerous. If a person should pick up the naked wires of such a circuit with his bare hands he would get but a trifling shock, if his hands were reasonably dry.

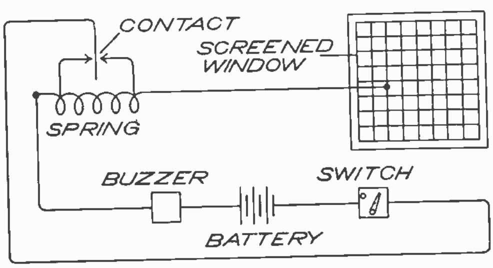
ELECTRICITY INCREASES OUR ENJOYMENT OF HOME LIFE AND AIDS US IN THE ENTERTAINMENT OF OUR FRIENDS.



JUNIOR SECTION

HOW TO CATCH A CHICKEN THIEF.

Here is a simple electric alarm which in two instances, at least, has frustrated the designs of chicken thieves. One of the faults of most burglar alarms is that the wires are readily perceived by the thief and cut, so as to break the circuit.



CHICKEN THIEF ALARM.

In this system, cutting of the wire closes the circuit.

In the window, as shown, is a wire netting, only, and simply cutting the wires seems to the thief to be the easiest method of gaining entrance. From the wire netting a single wire is stretched tightly to a coiled spring which carries two contact points. If the wire be loosened, or stretched tighter, one of these contact points will close the circuit around through the battery and buzzer, the latter being located in the house.

When Mr. Chicken Thief comes along and cuts the wire netting the tension on the spring is relieved and the circuit is closed, giving the alarm. Perhaps, however, he is a smart one and on the lookout for electric alarms. So when he sees the wire attached to the screen he thinks it is one wire of a circuit and by cutting it he will put the alarm out of service. This he does, with the result that he gets himself into the same trouble that he would if he had cut the screen without noticing the wire. Then it is the watchdog or the shotgun for him.

Walter Hadlock.

A SIMPLE TRANSFORMER.

The common use of alternating current for lighting purposes renders it an easy matter for the experimenter, provided with a small transformer of proper design, to "step down" the usual 100 to 110 volts of the supply current to a pressure more suitable for operating small lamps, experimental apparatus, or even the small direct current motors furnished with toy electric cars, etc. Such a transformer is readily made.

A core is first built up of soft iron wire of any convenient gauge, say be-

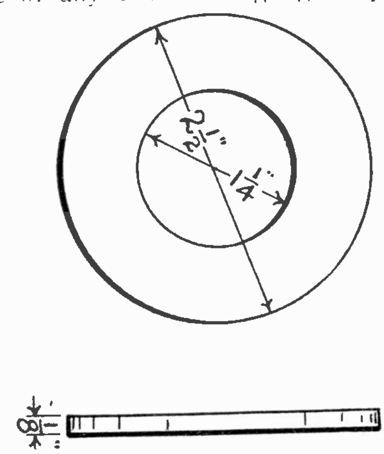


FIG. 1.

tween No. 16 and No. 24. The wire is cut into 10½-inch lengths, and formed into a bundle 1¼ inches in diameter, which is wrapped with thread to hold it in shape. Two washers, or spool heads, are then cut out of ⅛ inch fiber, 2½ inches in diameter, with a 1¼ inch hole, as shown in Fig. 1. These are placed on the core in the position shown by Fig. 2, and should be a very tight fit. The part of the iron core between these heads must be carefully insulated with three layers of tape, a few turns of the tape being taken around the core just outside of each head, as in Fig. 2. The heads and the tape are now treated to a coat of good shellac varnish, and baked until dry and hard. Care must be taken, however, to get no shellac between the wires of the core ends.

Winding the primary is the next step. Use No. 23 double cotton covered wire, and wind it tightly on the core between the heads until 1,000 turns have been put on. The two ends of the wire, left about 6 inches long, are then carefully taped. The whole primary winding is then protected with three layers of linen tape, covered with shellac and baked.

The secondary winding consists of 100 turns of No. 13 double cotton covered wire. This is wound directly over the primary, and is taped and covered with shellac in the same manner.

The next operation is forming up the core. The loose ends of the bundle of iron wires, which project 3⅝ inches at each end of the coil, are bent over the outside of the secondary winding, forming an iron wire shell surrounding the whole coil. If a neat job is made of this, the ends of the iron wires will scarcely be visible, and will appear continuous. Three strips of tape serve to bind the wires in place. This is illustrated in the views of the finished transformer shown in Fig. 3. The method of fastening the coil to a baseboard with a brass strap is also shown. The part of the transformer just under the strap should have an insulating strip of tape around it.

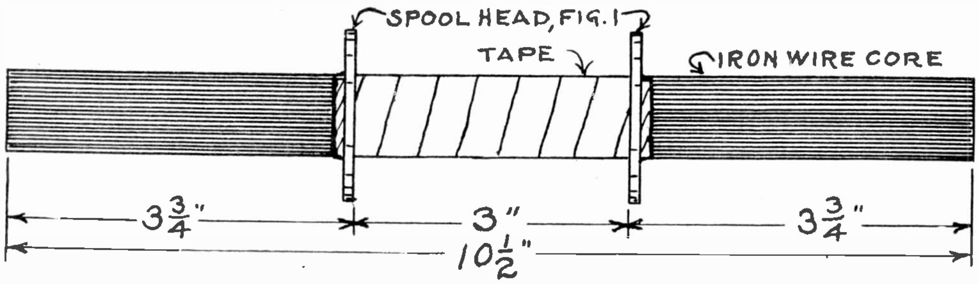


FIG. 2.

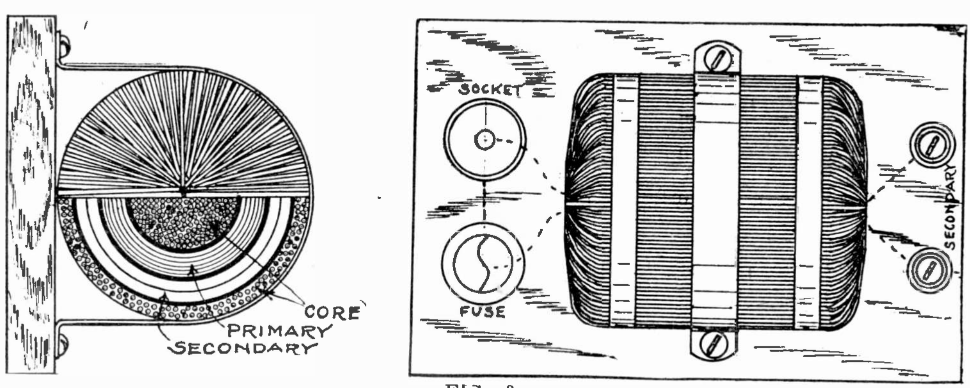


FIG. 3.

The simplest way to arrange for connection with the house supply is to obtain a plug to fit the regular lamp sockets, and solder the long "cords" of the plug directly to the ends of the primary winding, afterward thoroughly taping the soldered joints. However, it is advisable to include a one ampere fuse in the primary circuit, in which case two lamp sockets are mounted on the baseboard—one for a plug fuse, the other for connection with the supply. One end of the primary winding goes direct to the fuse; the other end goes to the socket; and the other side of the fuse connects to the other side of the socket. With this arrangement two plugs, connected by long cords, are necessary for connection with the supply.

The secondary winding, being of low voltage, connects directly to two binding posts on the baseboard. To these posts, of course, is connected any apparatus desired.

It will be noticed that the relative number of turns of wire in the primary and secondary coils is 10 to 1. Assuming the supply voltage to be approximately 100, the voltage at the secondary binding posts will be 10, which is convenient for experimental purposes. And conversely, as the allowable primary current is about ½ ampere, the secondary current on full load will be 5 amperes. The transformer will consume as much energy as one ordinary 16 candle power incandescent lamp.

The greatest care should be taken to thoroughly insulate all conductors in the 100 volt circuit, and no metal forming a part of that circuit should be exposed.

This transformer is designed for 60 cycles, because that frequency is commonly used. For 25 cycles, the core should be 1¾ inches in diameter. For 133 cycles, it should be one inch. The winding in each case would be the same.

PAUL H. WOODRUFF.

LEYDEN JAR MADE FROM A FRUIT JAR.

Leyden jars are necessary in many electrical experiments where a heavy spark or discharge is required, as in wireless telegraph work. Here is a way to construct one out of an ordinary glass fruit jar.

A thin glass fruit jar is first carefully washed and dried. Paint the inside with orange shellac and cover it with tinfoil at once, leaving a space of about two inches from the top, which is not covered with tinfoil. Now smooth the tinfoil down with a stick covered with cloth. Care must be taken not to scratch the tinfoil with the finger nails. The outside is covered in the same way and the space

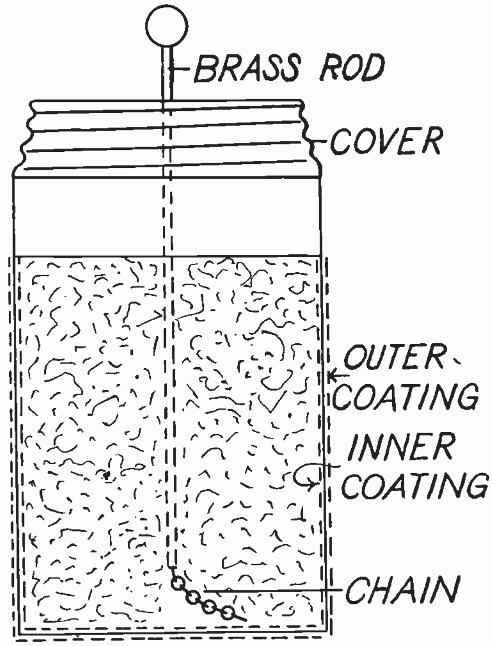


FIG. 1. LEYDEN JAR FROM FRUIT JAR.

left at the top is painted with shellac to insure perfect insulation.

A brass rod with a small ball at the end is soldered to the top. The lower

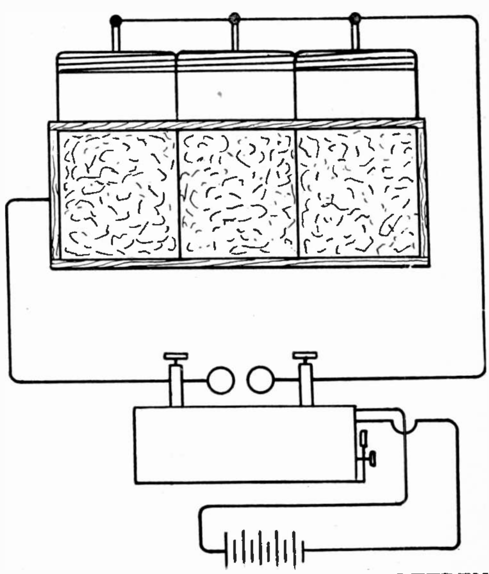


FIG. 2. METHOD OF CONNECTING LEYDEN JARS.

end terminates in a loose chain which just touches the tinfoil. Fig. 1 will make this clear.

When two or three such jars are connected to the secondary of a spark coil as shown in Fig. 2 an intense spark may be obtained.

TELEPHONE DOES DETECTIVE WORK.

About two o'clock one morning in a small town in Pennsylvania, the night operator at the telephone exchange closed the switch to her night bell, preparatory to taking her customary nap during the early hours in the morning when there were very seldom any calls.

She had scarcely composed herself when "whir" went the night bell, displaying at the same time the signal 202. This meant that someone at the flour mill was calling.

Now in a small town the operator is generally familiar with the goings and comings of most of the subscribers, and in this case she knew that no one was ever at the flour mill at this time of night.

But to make sure she "plugged in" with the customary "number please?" There was no answer, however; nothing could be heard but a faint buzzing and a faint "clink, clink," like a hammer ringing on a piece of steel.

Still the bell kept on ringing, and the quick-witted operator knew that something must be wrong at the mill. So she rang up the police station and also the owner of the mill. The latter was considerably agitated when the situation was explained to him, and said that anyone in the mill office at that time of night had no business there.

As he had placed a considerable sum of money in the safe the evening before, it did not take him long to get into his clothes and down to the office. He was just in time to see two seedy looking individuals with handcuff attachments emerging from the building, each escorted by a policeman.

The burglars, for such they turned out to be, had effected an entrance through a coal hole in the sidewalk, and had entered the office by removing a few loose boards in the floor, thus carefully avoiding the burglar alarms with which they knew all the doors and windows were provided.

One of them had been busily engaged in drilling a hole into the door of the safe when the other, in endeavoring to assist him, had inadvertently upset the desk telephone which stood on the desk at their side. Of course, as soon as the receiver fell off the hook, the signal was given to central and the developments which landed the culprits in the hands of the law followed in rapid succession as just described.

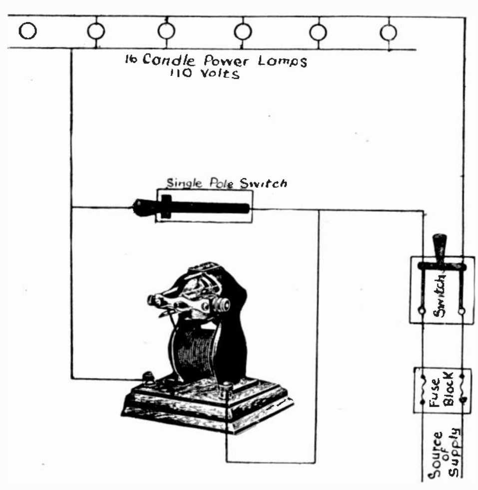
The burglars who stood high in the profession and had been uniformly successful in carrying out numerous robberies in that vicinity were very much chagrined that they should be captured in such a simple and unexpected manner.

OPERATING BATTERY MOTOR FROM 110 VOLT ALTERNATING CURRENT.

The amateur electrician who desires to run his battery motor of one to 20 volts direct current on a circuit of 104 to 110 volts alternating current, will find the following method available:

Connect up as in the diagram. When slow speed is required for the motor, turn on about two or three lamps; when a higher speed is required, turn on more lamps. If the voltage of the supply is between 90 and 130 volts the results will be astonishing.

When it is desired to stop the motor



for any reason, leave the lamps burning and close the single pole switch which is connected in parallel with the motor. Or if the whole outfit is to be controlled from one point, use the main switch.

QUESTIONS AND ANSWERS.

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

CHARGING LEYDEN JARS.

Questions.—(A) What is the best way to charge Leyden jars? (B) How may the strongest charge be obtained?—H. M. D., Kansas City, Mo.

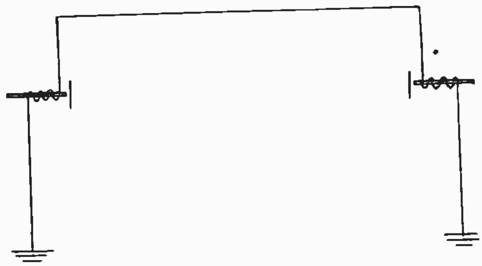
Answers.—(A)—Leyden jars can be charged by either the spark coil or static machine.

(B)—The strongest charge can be obtained with the static machine by connecting the outside coating of the jar to one pole of the static machine, the next pole terminating ¼ or ½ inch from the collecting ball which is connected to the inside coating. Run the static machine and allow the spark to play across the air gap for a few seconds and discharge with the discharging tongs. By charging and discharging you can soon determine when the best charge has been reached.

TELEPHONE LINE; SPARK COIL FOR WIRELESS.

Questions.—(A) I would like to know if two telephone receivers can be connected with battery, and conversation held up to 200 feet. If so show diagram. (B) What would be the best dimensions for a one-inch spark coil for wireless work?—A reader, Seattle, Wash.

Answers.— (A) — Two telephone receivers can be connected in series and conversation held up to possibly 200 feet, as shown in the diagram. This plan,



however, is not recommended as at the best very poor results are obtained. No battery is necessary as the ferrotype diaphragm which rests over the end of the permanent magnet and winding, vibrates when spoken against, inducing a current in the winding which flows over the line wire to the receiver at the other end.

(B)—No special dimensions can be followed to get an exact spark length in a coil so small, and the general rule is to "cut and try," the resultant usually being in the neighborhood of the desired length. The dimensions of a coil that will give an approximate spark of one inch are as follows: Core No. 22 soft iron wires formed into a bundle one inch in diameter and seven inches long; primary two layers No. 16 double cotton covered magnet wire wound to within one-half of each end of the core; insulating tube of hard rubber one-sixteenth inch thick; secondary one pound No. 36 double silk covered magnet wire wound in eight sections. Condensor 24, five by six inch sheets of foil.

SENDING DISTANCE OF SPARK COILS.

Questions.—(A) Will a 20 ohm instrument work on a wireless system 15 miles long? (B) How far will a five ohm instrument work? (C) Would a ¼-inch spark coil send 15 miles? If not what size would? (D) How far would a one-inch spark coil send? (E) Please give description of a coil winder?—C. R. B., Chicago, Ill.

Answers.—(A)—The meaning of your questions is not exactly clear. However, the 20-ohm instrument, relay or sounder will not work on the 15-mile wireless set. A very sensitive polarized relay used in conjunction with the coherer would be required to cover this distance.

(B)—A five-ohm relay, if this is the instrument you have in mind, would only work a few feet if at all. If it is a sounder, we refer you to an article in this issue on "Construction of a Two-Mile Wireless Outfit."

(C)—By using a very sensitive receiving end you could possibly send up to 100 feet with the one-fourth inch spark coil. To cover a distance of 15 miles, fully a six-inch spark coil would be necessary. It would be advisable to use a 250 watt transformer which is cheaper in first cost and more easily handled than the spark coil.

(D)—The one-inch spark coil will send up to a distance of one mile over water. One-half mile would be a good distance over land.

(E)—Coil winding machines are usually built up according to the special demands of the winder. The turning lathe is the most efficient winding device in the reach of the amateur. An old sewing machine answers well as the gear gives a good steady speed while the section former can be placed at the small wheel.

TUNING COIL; CONDENSER; CHOKE COIL.

Questions.—(A) Please explain how to make a condensor. (B) How to make a tuning coil. (C) What is choke coil and what is it used for?—L. R., Madison, Ill.

Answers.—(A)—In your question you do not state what type or for what purpose the condenser is to be used, consequently we are at loss to give you an intelligent answer. However, we refer you to an article in this issue on the "Construction of a Two-Mile Wireless Outfit," which explains the construction of a paper type condenser.

(B) — By referring to the article "Wireless Telegraphy Made Simple," in the July issue, you will find a description of the tuning coil and the method of adjusting for use.

(C)—The choke coil is simply a retardance or resistance coil and is introduced in the circuit between the relay and coherer. Its purpose is to prevent the incoming wave current from flowing through the low resistance relay in place of the high resistance coherer. By forcing the major part of the wave current through the coherer increased results are obtained.

WIRELESS SENDING END.

Questions.—(A) What size spark coil would be required to send up to a distance of 100 miles over land using the tuned receiving set and liquid coherer? (B) Can step-up transformers be used to any advantage?—J. S. H., Maud, Okla.

Answers—(A)—To cover a distance of 100 miles over land would require the use of a 15 or 20-inch spark coil, condensers, tuning coils, etc. The transformer is now used almost exclusively for long distance work, as it proves more efficient and is cheaper than the spark coil.

(B)—Step-up transformers are employed to an advantage in both the sending and receiving circuits. Quite a number of systems employ such transformers, among the most prominent is the Stone system.

WIRELESS TELEGRAPHY.

Questions.—(A) How is a wireless receiving outfit wired with a tuning coil? (B) How is a tuning coil made? (C) How many ohms resistance is necessary in a relay for wireless work? (D) How far would a four-inch spark coil send? (E) What kind of a coherer would you recommend for experimental work? (G) How would you make a condenser to use with a tuning coil? (H) How high should the aerial be to receive 100 miles? —L. W., Oakland, Calif.

Answers.—(A)— We refer you to "Wireless Telegraphy Made Simple," in the July issue, Fig. 18.

(B)—See above article, July issue.

(C)—This will depend on the distance you desire to cover. For ordinary experimental purposes a 150-ohm relay will answer. For considerable distances a polarized relay is recommended, as described in the July issue, page 188.

(D)—It is impossible to give the distance up to which a certain sized spark coil will send. However, as an estimate, a four-inch coil is capable of sending up to 10 or 15 miles.

(E)—Any of the present commercial types will answer for experimental work.

(F)—See "Wireless Telegraphy Made Simple," July issue, pages 160 and 161.

(G)—See answer to G. S. in this issue.

CONSTRUCTION OF WIRELESS APPARATUS.

Questions.—(A) What instruments are necessary to send up to 100 miles? (B) Please explain the parts of a four-inch spark coil? (C) How can I wind a watch case receiver of 2,000 ohms resistance for wireless use, and what size wire must be used? (D) What kind of aerial must be employed to receive up to 100 miles?—G. S., Muskogee, Okla.

Answers.—(A)—This will necessitate the use of a 750-watt transformer in connection with the tuned receiving set.

(B)—The dimensions of a four-inch spark coil are as follows: Core, 1¼ inches in diameter and seven inches long;

primary two layers No. 14 single cotton covered magnet wire wound to within one inch of each end of core; secondary 4½ pounds of No. 34 magnet wire wound in 24 sections; condenser 2,400 sheets of tinfoil. The above coil is designed for wireless use. By referring to the article, "Construction of a Two-Mile Wireless Outfit," in this issue, you will find the method of constructing a two-inch coil and the same rules will apply to both sizes.

(C)—Telephone receivers for wireless use are usually wound with No. 40 magnet wire. As this is a very delicate operation and requires special machinery, we would recommend that you apply to the concerns that make up such receivers.

(D)—By referring to the August issue, "Wireless Telegraphy Made Simple," you will find several types of aerials described that can be employed with a 100-mile wireless set.

TUNING COIL.

Question.—I am making a wireless set but am having some trouble in the tuning coil. I have wound an iron core with two layers of No. 14 insulated wire and would like to know if this will answer?—W. T. E., Chicago, Ill.

Answer.—We refer you to "Wireless Telegraphy Made Simple," July issue, which gives a general description of the tuning coil. The type you have suggested would not answer at all.

WIRELESS SET.

Question.—What instruments are necessary to work up to about 1½ miles? What will be a suitable antenna? What type of batteries are best to use?—W. M. H., Brooklyn, N. Y.

Answer.—You will find a complete set described in an article on "Construction of a Two-Mile Wireless Outfit" in this issue, which is capable of sending up to the distance you name. Storage or Edison cells are recommended for wireless use.

PRIMARY WINDING OF SPARK COIL.

Question.—In making a two-inch spark coil, is it best to wind only two layers, or more than two, for the primary? How can I get the best results—by winding two, three or four layers No. 12 or No. 13 B. S. gauge wire?—C. E., Chicago, Ill.

Answer.—In theory the primary and secondary windings of an induction coil should contain equal quantities of wire. In practice, however, two advantages are gained by reducing the number of turns of primary wire. The first is that inasmuch as the potential of the secondary depends on the relative turns of the two windings, reducing the primary turns is equivalent to adding secondary turns—and much easier and cheaper. Second, the fewer the primary turns, the lower the self-induction of the primary, hence the sharper the magnetic impulses. Two layers of wire, excited by a battery of considerable current capacity, will give the most satisfactory results.

ELECTROSTATIC MACHINES.

Question.—(A) In the electrostatic machine, what is the object of the stationary plates, and what are they connected to? (B) In the Toepler-Holtz machine are the stationary plates round, and of the same size as the revolving plates? (C) What is the tinsel of which the brushes are made? (D) What is the coating of lacquer with which the plates are covered—what is its object, and is it applied to all the plates? (E) What are the two prime conductors connected to? (F) Which is the simplest in construction—the Toepler-Holtz or the non-frictional machine? (G) Will a galvanometer act the same on a static machine as on a steady current? (H) Would a machine of eight to 12 plates be dangerous for an amateur to experiment with?—S. B., Kansas City, Mo.

Answer.—(A.) Some electrostatic machines have no stationary plates—notably the Wimshurst machine. The stationary plate of the Toepler-Holtz machine has coatings of foil, which act somewhat similar to condenser coatings, and are connected to two arms, which extend in front of the revolving plate, and are provided with tinsel brushes.

(B). Toepler-Holtz stationary plates are usually round, and about one-eighth larger than the revolving plates. This is not arbitrary, however, and the stationary plate may be square with the same results.

(C). The brushes may be made of strips of heavy foil, of fine wires, or of commercial metal tinsel.

(D). All insulating surfaces of any influence machine are ordinarily given a thin coat of the best shellac varnish. This prevents the accumulation of moisture which the unprotected glass would gather. In frictional machines, however, the plate is often left uncoated.

(E). The prime conductors of a

Toepler-Holtz machine are connected to collectors, which are simply metal arms provided with sharp points, which face the revolving plate and collect its electricity.

(F). The frictional machine is the simplest electrostatic machine employing a revolving plate.

(G). While the potential of an electrostatic discharge is very high, very little actual current passes, and the actual time of its passage is almost infinitesimal. A sensitive galvanometer will indicate the discharge by a jerk of the needle, but will show no permanent deflection.

(H). An influence machine with eight to 12 plates is capable of charging a large condenser or battery of Leyden jars, the discharge of which through the body would be painful, if not dangerous. The discharge of the machine itself would not be dangerous, and such machines are safe if the operator is familiar with their operation, and exercises ordinary caution.

QUESTION OF MOTOR OPERATION.

Question.—I have a motor of the "vintage" of the early nineties or later eighties, bipolar, ring armature, wound for from 15 to 25 volts. I would like to know the size of wire for field and armature to run on alternating current, single phase, 60 cycles. The dimensions of the magnet core are ½ by 1⅜ by 4⅛ inches, depth of winding, ⅜ inch. The armature core is ⅞ inch wide, 5/16 inch thick and 4⅜ inches diameter, depth of winding 5/16 inch. The motor runs fairly well with 20 lamps in parallel, in series with it, but I fear it is not very economical. I want to use it for fan and to run a sewing machine, and think a series motor would be better than a shunt.—T. M. G., Detroit, Mich.

Answer.—You do not give the voltage of your supply current; but assuming it to be 110 volts, and that the lamps you are using for resistance are 16 candlepower, you are taking 10 amperes from the line, or 1,100 watts—more than enough to drive a one-horsepower motor. Even figuring on the current actually consumed by the motor, 10 amperes at say 25 volts, you should obtain a quarter horsepower, although evidently you do not. It seems from your description that the form of field magnet of your motor is inefficient, especially on alternating current, the field core being rather too long and thin.: It is almost impossible to calculate the winding for so small a motor, for use with alternating current, with any degree of accuracy; and even with the best possible winding the machine will eat up enough extra current to pay for a new motor in a short time. However, if you wish to try the experiment, the simplest method, and one which avoids entering into calculations the result of which would be questionable, is to gauge the size of wire at present on the machine and rewind the armature and field with wire seven sizes smaller. You do not say whether the motor is shunt or series wound; but if shunt, it may be changed to series by winding the field with wire three sizes larger than that used on the armature. It would be well to try simply rewinding the armature, and use the present field winding, if shunt, as a series field for the rewound machine. We fear, however, that the motor will never operate quite satisfactorily on alternating current.

SHORT-CIRCUITING OF COHERERS—WIMSHURST MACHINE.

Question.—(A) Is there not a slight short circuit going on in a coherer in wireless telegraphy, that is, the battery circuit (Marconi system) as shown in the May issue? (B) Is there any way to overcome this slight short circuit if there be any? (C) Is there any device to make the spark from a Wimhurst static machine continuous?—W. R., New York City.

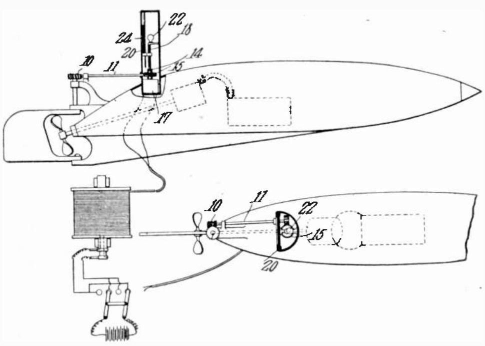
Answers.—(A and B). In the metal filings coherer described there is probably a slight current flowing in the intervals during which the filings are not cohered. But the resistance of the inert filings is so high that this current is negligible.

(C). The spark from a Wimhurst or any other static machine cannot be made continuous as the discharge represents successive ruptures of the dielectric and there must always be an interval of time between sparks for the charge to collect on the plates. By connecting Leyden jars to the terminals the sparks may be made to occur so close together that the sparks appear to the eye to be continuous and the discharge is almost deafening.

NEW ELECTRICAL INVENTIONS

TORPEDO BOAT ELECTRICALLY PROPELLED AND STEERED.

An ingenious method of propelling and steering a torpedo boat from a distant point has been invented by Edward J. Kelley of Washington, D. C. The invention applies to that form of boat which carries no one on board and is itself destroyed by the explosion. It is so designed as to be operated at night and be invisible to the enemy but at the same time to signal its position and direction of travel to the operator who is on land or ship in the rear.



The boat is propelled by an electric motor, current for which is derived from a cable which is unreeled as the boat proceeds. The direction of rotation of the motor and consequently of the propellor is determined by the direction of flow of the current through the cable.

The accompanying diagram shows the scheme, the lower right hand portion being a plan view.

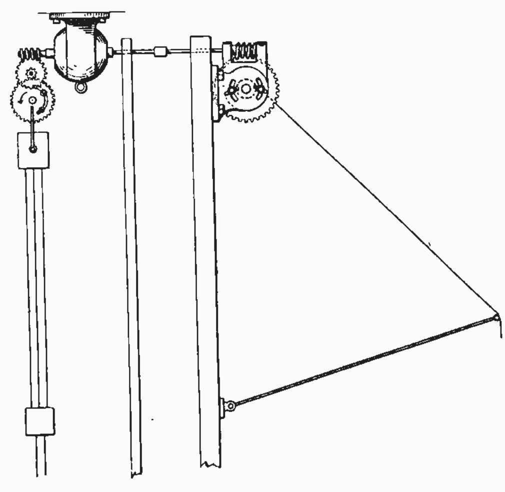
To control the direction a second motor (17) operates the rudder by the worm gear and shaft (14), (15), (10) and (11). This motor is also controllable from the land by an electromagnet device and turns the rudder either to the right or to the left.

Above the worm gear, and operated by it (by screw 18) is a glass slide (24), (20), made up of different colored sections. The light from the electric lamp (22) shines through this slide back toward the operator but is screened from the front of the boat and invisible to the enemy.

If the motor operating the rudder revolves in a certain direction, moving the rudder to starboard, for instance, the slide is moved to show a particular color of light. If the rudder is moved to port, the slide moves in conjunction and another color shows. In this way the operator can tell instantly the position of the rudder and the direction which the boat is taking.

ELECTRIC AWNING OPERATOR.

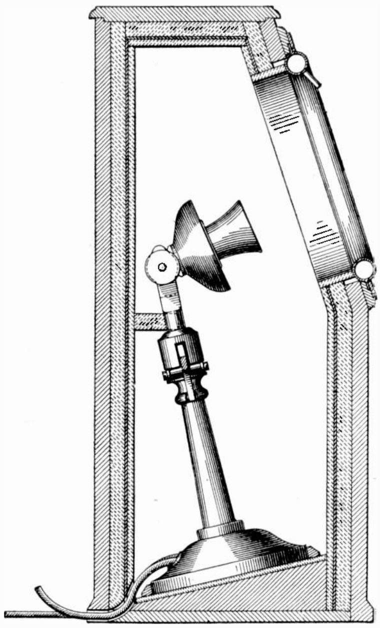
The accompanying diagram shows a device for raising an awning by electric power and is the invention of Egisto U. Giovannoni of New York City. As will be noted the motor shaft carries a worm gear, on the right, which operates a drum which in turn raises the awning. At the left is another worm gear which



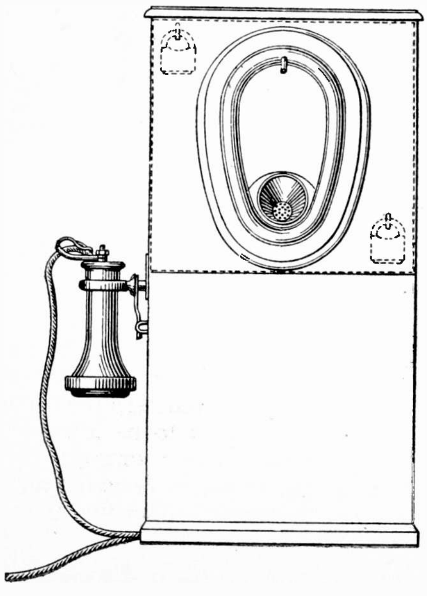
actuates a device to automatically switch the motor out of circuit when the awning has reached a predetermined height. When the awning is to be lowered the direction of the current through the armature of the motor is reversed and the motor revolves in the opposite direction.

A SECRET TELEPHONE.

Orrin H. Goodrich, of Castleton Corners, N. Y., has invented an appliance to be used with any telephone whereby the user of the instrument may carry on a

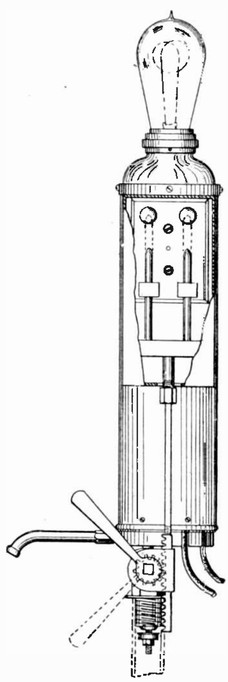


conversation without being overheard by nearby listeners. This device consists of a sound-tight case, enclosing the instrument as shown in the illustrations, all except an oval opening in front of the transmitter. In speaking into the transmitter, the mouth is placed in the opening and the face pressed against the sides so that the voice cannot be heard outside the box. The receiver hook extends through the side of the case and performs its usual function of opening and closing the circuit. A further advantage is that the instrument is protected from dust and dirt.



ELECTRIC WATER HEATER.

Herbert N. Roche of San Francisco, Cal., is the inventor of a new type of electric water heater which will heat water almost instantaneously as it is drawn from the pipe. It contains an electric heating coil inside of a cylindrical casing, the water flowing around the coil before passing out of the spigot.



The device is so arranged that cold water may be drawn without throwing the heating coil into circuit if desired. When the heating coil is in circuit the lamp at the top is also lighted showing that hot water is on.

THE THEORIZERS' CORNER.

No one knows what electricity really is. Neither has its relation to visible forms of matter, nor to other manifestations of energy, such as life, light, heat, etc., been fully explained. Nearly everyone, however, has a theory of his own on this subject, and these theories are interesting. Readers of Popular Electricity are invited to make free use of this department and give others the benefit of their views.

R. S. HEARD FROM AGAIN.

Answering F. W. S. in the October issue, which answer will also serve others, I will say that I account for the irregularities of the surface of the ether by the fact that different degrees of heat and cold expand and contract the atmosphere, thereby creating a different degree of density at the outer surface. Thunder and lightning are caused from the fact that when a giant arc is created it jumps across the vacuum, viz., the least resistance, which causes a noise (thunder) the same as when one breaks an incandescent lamp; the air rushes in and closes up the vacuum.

The earth passes through the ether the same as a fish passes through water. I did not say that the ether is a solid. Neither can it be known how far it is from the earth to the ether; no one can get that far up. I cannot see where it has anything to do with the question.

Clouds are suposed to be damp, therefore good conductors for lightning.

Answering E. H. J. in the October issue: He states that "If the contracting of the atmosphere caused a vacuum and the expanding caused thunder, there would be a continuous roar of thunder following the snow capped mountains around the world." This might be true if the mountains were high enough to puncture the ether; but even so, there is more thunder among the snow capped mountains in the world, than anywhere else. How does E. H. J. account for that?

Who knows that the ether is not as dense as the atmosphere, or is of a different substance? If it intermingles with our atmosphere, it must be of some substance. If it has no substance then all space above our atmosphere must be a vacuum, which would cause all of our atmosphere to be sucked into infinite space and the earth would disintegrate. Imagine all outer space a vacuum! What a puny resistance it would offer.

R. S.

BEYOND THE SPECTRUM.

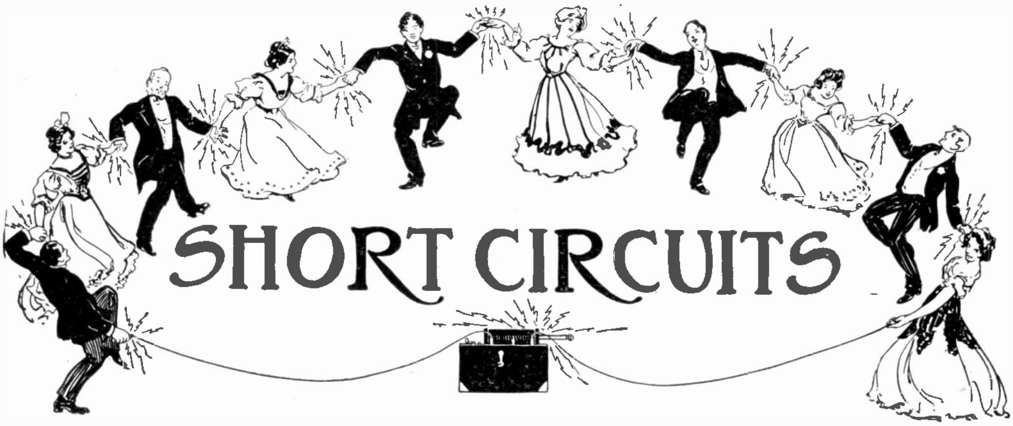
Every phenomenon which we are so far capable of recognizing is a form of vibration. The lowest form is sound—a few slow, heavy oscillations of the molecular structure. Above sound there is an undiscovered field, until the rate of vibration rises to that of heat. As the heat increases, there is light. At first the dark red glow of the comparatively slow movement, then rapidly augmenting through yellow, green, blue and violet. As vibrations increase still higher the light vanishes to darkness, silence, cold—we can sense nothing more, though the molecular vibrations mount into the countless trillions per second.

Yet throughout the whole range of vibratory phenomena, like a chain connecting all there is of science, runs the principle of electricity. Sound, heat, light—all are but manifestations of its power. Through the darkness, the silence and the cold of those upper vibrations which are beyond man's ken the electric principle works on unchanged.

The X ray and radio-activity, however exhibited, and all those other mysterious activities which have been discovered, all are but reflections of those higher vibrations beyond the spectrum. All are very evidently electrical, for electricity is the father of all physical manifestation, of matter, of the universe itself.

The discovery of electricity is comparatively modern, and that discovery marks the beginning of the end—of the attainment of that ultimate knowledge which embraces all creation. When we know electricity we shall sense the whole gamut of vibratory physics. Then there can be nothing new to learn.

B. C. W.



One of the college papers was struck the other day with the need of getting up a snappy appeal to subscribers. The result was the following:

Once upon a time a man who was too economical to take a college paper, sent his little boy to borrow the copy taken by his neighbor. In his haste the boy ran over a $4 stand of bees and in ten minutes looked like a watery summer squash.

His cries reached his father, who ran to his assistance, and failing to see a barbed wire fence, ran into it, breaking it down, cutting a handful of flesh from his anatomy and ruining a $4 pair of pants.

The old cow took advantage of the gap in the fence, got into the cornfield and killed herself eating green corn. Hearing the racket, his wife ran, upsetting a four-gallon churn full of rich cream into a basket of kittens, drowning the whole flock. In her hurry she dropped a $7 set of teeth.

The baby, left alone, crawled through the spilled cream, then into the parlor, and ruined a $20 carpet. During the excitement the oldest daughter ran away with the hired man, the calves got out and the dog broke up eleven setting hens.

Moral—Subscribe now.

* * *

"Well, where's that cook?" demanded his wife. "Don't tell me she wasn't on the train."

"She was on the train," timidily explained the commuter, "but I got to playing cards and a Lonelyville man won her at whist."—Philadelphia Bulletin.

* * *

"Halloa!" shouted one boy to another whom he saw running wildly down the street; "are you training for a race?"

"No!" yelled back the runner, "I am racing for a train."

* * *

"Joe," said a lady to the milk boy, "I guess from the looks of your milk that your mother put dirty water in it."

"No, she didn't, neither," said Joe. "I seen her draw it clean, out of the well."

* * *

Anderson was a man who would scarcely ever commit himself on any subject, especially politics. His closest friends could never find out whether he was a republican or democrat. One of his friends, however, determined to make a last effort to gather this information, so he approached Anderson, as he thought, very diplomatically and said: "Anderson, what do you think of Billy Taft for president?" "O, aye tank he bin good man," said Anderson, thoughtfully. "Well, then, what do you think of this man Bryan?" "He bin good man, too," said Anderson. "Well, honestly now, who do you think has the best show?" said his friend. Anderson scratched his head deliberately and answered: "Aye tank Ringling Brudders have best show."

A young man in want of $25 wrote to his uncle as follows:

"Dear Uncle: If you could see how I blush for shame as I write this, you would pity me. Why? Because I have to ask you for a few dollars, and do not know how to express myself. It is impossible for me to tell you. I prefer to die. I send this by messenger, who will wait for an answer. Believe, me, my dearest uncle, your most obedient and affectionate nephew.

"P. S. Overcome with remorse for what I have written, I have been running after the messenger in order to recover this letter, but I cannot catch him. Heaven grant that something may stop him or that this letter may get lost."

The uncle was naturally touched, but was equal to the emergency. He replied as follows:

"My Dear Jack: Console yourself and blush no more. Providence has heard your prayer. The messenger lost your letter. Your affectionate uncle."—Judge's Library.

* * *

A machinery salesman drove up to the farmer's gate and, no one else being in sight, he engaged the farmer's small boy in conversation. With grave incredulity he said:

"Are you sure you are only nine years old? I think there must be some mistake."

The boy was positive; but to make sure, he called:

"Ma, ain't I jist nine years old?"

"Yes, son," came from the kitchen.

After a time the boy ventured: "Say, mister, what made you think I was more'n nine years old?"

"Why," said the stranger. "I couldn't understand how you could get so dirty in nine years."

* * *

Pat—"What be yer charge for a funeral notice in yer paper?"

Editor—"Half a crown a inch."

Pat—"Good heavens! An' me poor brother was six feet high."

* * *

"What's your time?" asked the old farmer of the brisk salesman.

"Twenty minutes after five. What can I do for you?"

"I want them pants," said the old farmer, leading the way to the window and pointing at a ticket marked: "Given away at 5.10."

* * *

Maud—"I suppose you made a hit with that big red hat in the country."

Belle—"Hit! I should say so. It struck the bull's eye the very first time I wore it."

* * *

"Smithy, did you steal the ice cream off our back porch last night?"

"Wuz it your ice cream?"

"No, it was mamma's."

"Well, then send your mamma 'round to see me. I don't want to talk to no understudies."

ELECTRICAL DEFINITIONS.

Accumulator.—Storage 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.

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.

Branch Conductor.—A parallel or shunt conductor.

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 out-going 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.

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 for changing the direction of electric currents.

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.

Diamagnetic.—Having a magnetic permeability inferior to that of air.

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.

Electroscope.—Instrument for detecting the presence of an electric charge.

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 or system.

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

Galvanometer.—Instrument for measuring current strength.

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.

Multiple Circuits.—See parallel circuits.

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.—Space between the two electrodes of an electric 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.

Voltage.—Potential difference or electromotive force.

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.

POPULAR ELECTRICITY

CLASSIFIED ADVERTISING

Rates, 40 cents per agate line, cash with order, nothing less than 2 lines.

Advertisements should be in our office on or before the 3d preceding date of issue.

We will accept no objectionable advertising of any description.

HELP WANTED.

$6.00 PER 100 PAID FOR MAILING or distributing circulars. Steady work. Particulars, 4 cents. R. F. Kinyon Co., Newton, Iowa.

SCHOOLS.

UNCLE SAM will hold November Examinations everywhere for City Postoffice Clerks and Carriers; early examinations for Railway Mail, Customs and Departmental Clerks. $600.00 to $1,600.00 yearly. Annual vacation. Common education sufficient. Candidates prepared free. Franklin Institute, Dept. SR, Rochester, N. Y.

$200 TO $600 MONTHLY EASILY MADE fitting eye glasses. Short, easy mail course. Reduced tuition. Big demand for opticians. Write to-day for free "Booklet O." National Optical College, St. Louis.

FOR SALE.

ELECTRICAL EXPERIMENTERS can easily make a transformer to reduce 110 volts A. C. to 10, 20, 30 or 40 volts—1-5 K. W. Full detail drawings, price 50c. W. C. Getz, 645 N. Fulton Ave., Baltimore, Md.

BLACKSMITHS, you are interested. A bad weld makes an expensive break. With my methods and welding compounds every heat will be a solid weld. Also seventy-five modern easy ways to do hard jobs. Also two colored tool-tempering charts. Chart A explains annealing and hardening; Chart B explains tempering all tools to a standard. All for one dollar. Valuable samples free. Send to-day. W. M. Toy, Sidney, Ohio.

FOR SALE—Pressed steel frames, $15. Whitlock radiators, $35. Air-cooled motors, $75. Get our second-hand sheet. Auto Parts Co., 54 W. Jackson Blvd., Chicago.

HAND POWER bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

FOR 25C WE WILL MAIL YOU DESCRIPTION of 700 farms for sale or exchange with owner's address. Want farms. Farm Buyers' Guide, 507 Ridge Bldg., Kansas City, Mo.

TYPEWRITERS.

THE SUN TYPEWRITER marks an epoch in the writing machine business; high value, low price. If you do not know about it, write for information and trial offer. Sun Typewriter Co., 317 Broadway, New York City.

PATENTS.

MASON, FENWICK & LAWRENCE, Patent Lawyers, Washington, D. C., Box B. Est'd 47 years. Booklet free. Highest references. Best service. Terms moderate. Be careful in selecting an attorney. Write us.

FOR SALE—Outright—Ventilator Patent. U. S., No. 861,872; Canada, No. 109,184. For particulars address Roderick Macdonald, Glace Bay, Nova Scotia.

PROMPT ATTENTION—Popular Electricity Patent Bureau is reliable and we guarantee all patents granted through our Patent Bureau. Competent attorney in patent causes in charge to give you prompt and efficient service. Write for particulars. Popular Electricity Patent Bureau, 1252 Monadnock Block, Chicago, Ill.

AGENTS WANTED.

AGENTS, LOOK! Women and men. We have just added 4 new big sellers. Rockford, Ill., agent worked 3 days, then ordered 100 doz. Write for particulars and $2.00 FREE offer. Fair Mfg. Co., Box 74, Racine, Wis.

WANTED—One hustler in every concern employing any number of men to represent Popular Electricity. Here is your chance to double your income without interfering with your regular work. Others are making $2.00 to $5.00 a day and there is no reason you cannot do what others are doing. Give name of your company and number of employes, name of your superintendent or foreman and we will send free, samples and outfit. Address Circulation Mgr. Popular Electricity, 1116 Fisher Bldg., Chicago, Ill.

AUTOMOBILES.

FOR SALE—1 touring car, 1 auto delivery wagon, new double opposed auto engine, 15 h. p.; 1 Lambert stationary motor, 12 h. p. Everything cheap and in good condition. Roth, 783 Burling St., Chicago, Ill.

THE BELL ODOMETER counts revolutions and rings a bell each 100 revolutions, and attached to your vehicle, tells how far you drive. Bell Odometer Works, Oakmont, Pa.

LUBRICANTS.

LUBRICANTS, asbestos, graphite and mica candles for loose pulleys and shaftings; no drip; no dirt; economical. Swain Lubricator Co., 250 E Lake St., Chicago.

CLASSIFIED ADVERTISING.
(CONTINUED.)

MISCELLANEOUS.

WIRELESS—Construct your own wireless apparatus. Complete drawings as follows: Complete one-mile wireless set showing sending and receiving ends, all connections, aerial wires, etc., per sheet, 25 cts.; carborundum and silicon detector showing all constructional details, each 25 cts.; wireless telephone set showing all parts used, each 50 cts. List of high grade instruments and other drawings for stamp. Victor H. Laughter, Byhalia, Miss.

THOUSANDS OF PRACTICAL FORMULAS, 15c each. We can tell you how to make or mend anything. Consulting Chemists, Box 217, Redlands, Cal.

BROTHER—Accidentally have discovered root that will cure both tobacco habit and indigestion. Gladly send particulars. F. F. STOKES, Mohawk, Fla.

EXPERT AND SUCCESSFUL inventor will develop ideas and inventions, build models, make drawings and give general advice in perfecting and marketing inventions. Long experience. Circular free. L. Casper, 633 No. Park Ave., Chicago.

THIS BEATS NEW JERSEY. Charters for stock companies lower than other states. Information free. Philip Lawrence, Former Assistant Secretary of State, Huron, South Dakota, Suite 72.

WITH $5 started a mail order business bringing in over $60 a month; it's simple, easy and a sure winner; particulars free. G. E. Cousins, 25 Virginia Ave., Indianapolis, Ind.

ALL SAFETY RAZOR BLADES resharpened, sterilized, better than new. 2c each and return postage. Send your address for our convenient mailing wrapper. Keenedge Co., 87 Keenedge Bldg., Chicago.

TETTER CURE — Newly discovered liquid, made from roots and plants grown in Texas. Price $1, express prepaid. Imperial Medicine Co., Houston, Texas.

KEYLESS DOOR LOCKS can be placed on any door without tools; biggest seller out. Agents' nickel-plated sample by mail, 25 cents. Hoosier Novelty Co., Indianapolis, Ind.

EXPERIMENTERS can have receivers and small coils rewound. Write for information. E. C. Larson, 170 Larrabee street, Chicago, Ill.

ECZEMA LOTION — Pure white vegetable liquid; cures permanently. Sample free. Park Chemical Company, Houston, Texas.

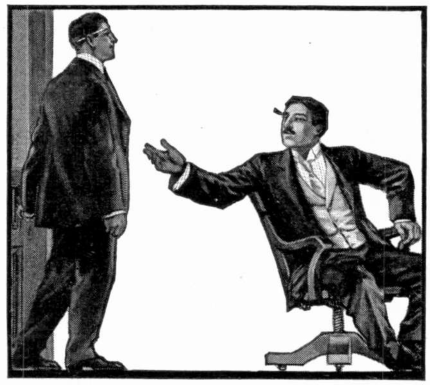
"OUR LITTLE BOOK FOR WOMEN" in plain cover, 10c. (Something different.) O. K. Pub. Co., Clerk 193, Decatur, Ill.

METAL SPINNING. John J. Pole, Geneva, N. Y.

FREE

This $13.85 DRAWING OUTFIT

See offer of **Successful Draftsmen** On Page 2.



We Will Raise Your Salary

"Yes, young man, we find that your training has been so beneficial to the Company that we are going to raise your salary."

Such scenes as this are actually taking place every day. The man who gets the raise is the **trained** man—the expert—while the untrained man plods along at the same old wages. If you are poorly paid and have ambition, there is a practical system by which you can obtain promotion—a system that last year brought over $20,000,000 in increased salaries to the men who adopted it. It will be of value to you to investigate this system and find out what it can do for your position and salary. You don't have to leave home—there is no interruption in your work—you won't have to buy books—lack of capital is no barrier. If you are ambitious, mark and mail this coupon now and find out the most practical way to raise your salary.

International Correspondence Schools

Box 1102, Scranton, Pa.

Please explain, without further obligation on my part, how I can qualify for a larger salary and advancement to the position before which I have marked **X**.

Bookkeeper	Electrician
Stenographer	Electrical Engineer
Advertisement Writer	Electric-Lighting Supt.
Show-Card Writer	Mechanical Engineer
Window Trimmer	Surveyor
Mechanical Draftsman	Stationary Engineer
Ornamental Designer	Civil Engineer
Illustrator	Building Contractor
Civil Service	Architectural Draftsman
Chemist	Architect
Textile-Mill Superintendent	Structural Engineer
French } With Edison	Foreman Plumber
Spanish } Phonograph	Mining Engineer

Name ____________________

Street and No. ____________________

City ____________________ *State* ____________________

The Peerless Kitchen Boiler

It heats the largest quantity of hot water in the least possible time at the least cost (maintains a temperature of 185° at a cost of ½ cent per hour) using

GAS OR GASOLINE FOR FUEL

as well as stove connections when desired. Sizes are 18 gallons up to 300 gallons, each tested and fully guaranteed.

Thousands in Use Giving Perfect Satisfaction

Is Economical, Simple, Safe, Clean and Efficient. No Soot, Dirt, Odor, Noise or Waste.

We are "headquarters for and sole distributors of the Peerless Kitchen Boiler." If your plumber can't supply you, address

After fifteen years of constant study, and after making many simplifying changes, is now

THE BEST and THE CHEAPEST HEATER

for supplying hot water, fit for cooking and drinking, in city and country homes, in apartment houses, hotels, clubs, restaurants, laundries, bath houses, barber shops, hospitals, schools, and all buildings where hot water is needed. Can't break or get out of order. A child can operate it.

HOT BATH COSTS 2 CENTS

HOT WATER IN TWO MINUTES

PEERLESS HEATER CO.

39 State St., Chicago, Ill.

HAVE IT PATENTED

THROUGH

Popular Electricity Patent Department

We have an able patent bureau which is conducted by well known **experts in patent cases,** and are in a position to handle your invention in a **thoroughly satisfactory manner.**

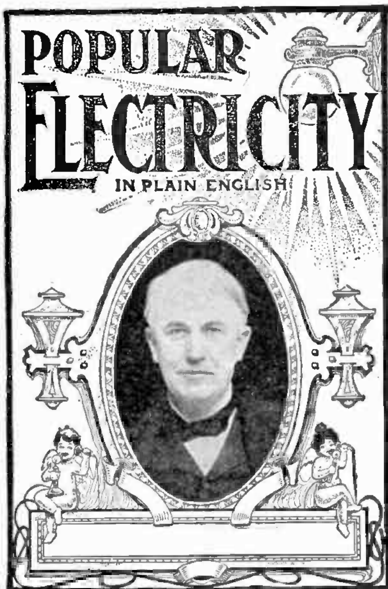
If you have any device or idea you wish protected, our department is at your service.

WRITE US FOR INFORMATION

All communications are held strictly confidential.

POPULAR ELECTRICITY PATENT BUREAU

Monadnock Block :: :: :: :: **CHICAGO, ILL.**



KNOW ELECTRICITY

You are interested in electricity —everyone is.

You are familiar with hundreds of its applications but there are thousands that you have never dreamed of, and new ones are coming up every day.

Electricity is fast becoming the ruling power in industrial and home life, and you owe it to yourself to become familiar with its principles and its possibilities. The best way to do this is to read

POPULAR ELECTRICITY

the new magazine that tells you all about this marvelous force in language you can understand.

There are no technical discussions, everything is presented in a simple, entertaining style.

Only $1 a year ($1.50 Canadian and foreign). Simply fill in the coupon and send to us with a dollar bill. Also enquire into our subscription proposition. You can make easy money and a lot of it.

Enclosed find $1.00 ($1.50 if Canadian or foreign) for which send POPULAR ELECTRICITY for one year to

Name..

City..

Street No..................................... **State**....................

by Wm. L. Weber, M. E.

Cloth, red edges, indexed, **25c**
Full leather, gold edges, indexed, **50c**

Contains upward of 4,800 words, terms and phrases employed in the electrical profession, with their definitions given in the most concise, lucid and comprehensive manner.

12mo, cloth, illustrated, **$1.00**

A Complete Manual of Instruction by Theodore A. Edison, M. A., Instructor at American School of Telegraphy.

---

by Henry C. Horstman and Victor H. Tousley

Price Net $1.50

Tables for direct and alternating current calculation, voltage, efficiency or power factor, etc., etc.

---

by Horstman & Tousley

16mo, 250 pages, 100 diagrams, full leather limp, **$1.50**

This book treats almost entirely on practical electrical work. It uses the "Rules and Requirements of the National Board of Fire Underwriters" as a text, and explains by numerous cuts and detailed explanations just how the best class of electrical work is installed.

---

by Horstman & Tousley

16mo, 250 pages, 200 illustrations, full leather binding, round corners, red edges; size, 4x6; pocket edition; new 1907 revised enlarged edition.

Price $1.50

It contains no elementary considerations; you are supposed to know what an ampere, volt or a "short circuit" is. And it contains no historical matter.

Popular Electricity Publishing Co., Chicago, Ill.

Book Department

EVERYTHING for Furnace Work

The HESS METHOD of warming and ventilating for Houses, Churches, Schools and Stores is far superior to steam, hot water or other systems and costs much less to install and maintain. We guarantee this in every case. You take no risk.

The responsibility for what we sell you and how it works is all on us. **We have to make good.** You pay us nothing unless everything you buy of us is satisfactory and does exactly what we claim. We can satisfy any owner, builder or contractor that the Hess Furnaces and Furnace Supplies are what they want. Just give us the opportunity to show what we can do and are doing.

Our No. 45 "Leader" Steel Furnace Heats 7 or 8 Rooms

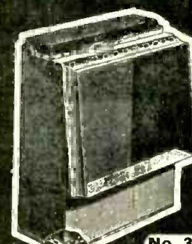
Price of this Furnace . . . $49.00 Delivered to any Station East of Omaha and North of the Ohio River

The Hess Steel Furnace and Everything for Furnace Work is sold direct from our factory to owners, builders or any one, at one small profit.

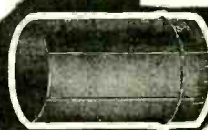
We Supply Everything—

Everything pertaining to Furnace Work is supplied direct by us. A full line of Furnace Pipes, Stacks, Fittings, Registers—everything in fact for furnace jobs—are carried at our warehouse, and each one is guaranteed to give best results where used with the Hess Furnace. Our supplementary catalog, just out, illustrating each article, giving net prices, free on request.

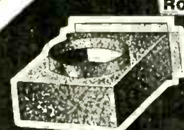
No Dealer Can Equal Our Prices On These Goods



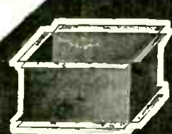
No. 3 Stack Head for First Floor with Collar for Extension to Second Floor



Round Tin Pipe

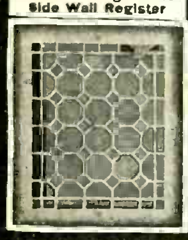


Air Supply Stub No. 2 for Metal Pipe



Box for Ceiling Register

Four-Piece 90° Elbow



Moorish Design Wafer Side Wall Register

FREE HEATING PLANS

In order to demonstrate that we know our business and are willing to make good, **WE WILL SEND FREE**, heating plans, prepared in detail, for any building. Our plans are prepared by our own furnace and heating experts. This we will do whether you buy of us or not. By making no charge for the heating plans or estimates, and giving the manufacturer's best price for the full equipment, we have met success beyond our expectations. It means money saved to anyone erecting new or repairing old buildings.

INFORMATION WANTED

Send us a rough sketch of the house, church, school or other building you want to heat. This sketch need not be drawn to scale, but must clearly indicate the location and size of rooms, measuring inside from wall to wall.

Show the partitions by single lines; the doors by spaces in the lines; the chimney by a square; stairs by parallel lines; mark folding or sliding doors, if any. Make a separate sketch for each floor and mark the size of each room in figures. Tell whether the upper story is a full story or half story. Give width of stairways—mark on plan. State thickness of floors. In the cellar plan indicate the piers, posts and beams, the location of chimneys, fuel supply, and the cellar stairs or entrance. Show the direction of the joists by an arrow, thus <———————>

Write Now, Today. Our Catalogs are Free

Hess Warming and Ventilating Co.

912 Tacoma Building, CHICAGO