POPULAR ELECTRICITY
IN PLAIN ENGLISH

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ELECTRICAL SPLENDERS OF RIVERVIEW.

This has been called the age of strenuous endeavor and people at the beginning of the Twentieth Century are said to be going the pace that kills in their efforts to keep up with the demands of industrial activity. Hard though they may work, however, the people of to-day play just as hard in proportion, and never was there a time when so much money and so much skill were expended on amusements as at present.

The numerous amusement parks in the larger cities offer perhaps the most marked example of the enormous scale upon which the efforts to furnish the public with fun are carried out, and it is only necessary for the observer to visit one of these amusement resorts at night, and watch the care-free crowds, to realize that they admirably fulfill their purpose.

But what would an amusement park be without electricity? It simply could not exist. An amusement resort at night must be light—light as the day—in order that people may congregate and make a business of forgetting their cares.

Beautiful Riverview Park in Chicago, one of the five great resorts of its kind in the city, has many features to distinguish it, and it is only by continued visits that one can begin to appreciate the wonderful ingenuity that has been expended in its conception and execution. This is one of the largest resorts of the kind in the world, containing within its enclosure 106 acres of land. There are miles of walks through beautiful groves softly lighted by festoons of incandescent lamps. There are crowded thoroughfares as brilliant as day. At every step new wonders present themselves, almost all made possible by some adaptation of electricity.

ENTRANCE TO RIVERVIEW PARK.

To plant new trees and keep the groves in condition ten arboriculturists are constantly employed. To devise new ways and means of improving the grounds 35 expert landscape gardeners are likewise employed. To keep the wheels of this great enterprise moving requires 1,165 employes, exclusive of those who work in the various concessions. It is a city in itself—a city for work as well as for fun.

To light this great resort over half a million electric incandescent lamps are required. These are principally of eight candlepower, and the current required to supply them reaches the enormous figure of over 16,000 horsepower. Then besides there are hundreds of electric motors scattered about the grounds aggregating many hundred horsepower.

The frontispiece in this issue shows one of the most brilliantly lighted portions of the grounds. The magnificent entrance to the grounds shown in one of the pictures is also a noticeable feature.

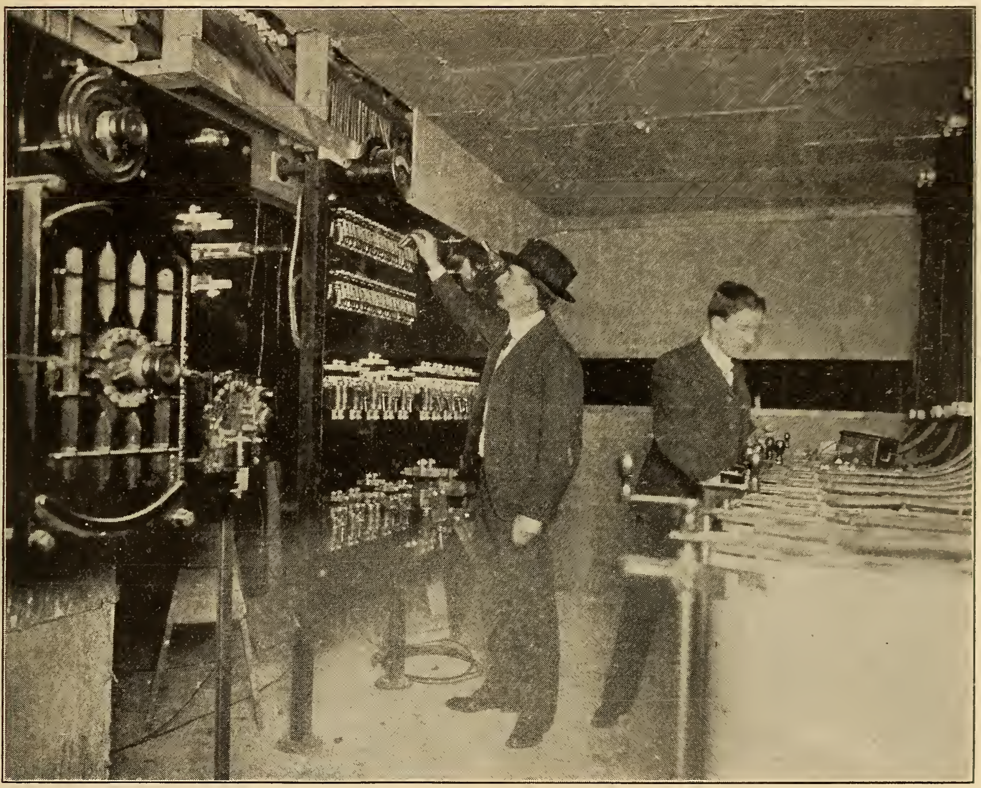
Among the various concessions one which perhaps attracts the most attention is the "Battle of the Monitor and the Merrimac," a highly realistic illusion. This spectacle is produced through the aid of electricity and merits a more detailed description, although many of its features are a secret known only to the inventor, Mr. Emmett W. McConnel, and the men who built and operate it.

From the auditorium, the scene of the battle of the Monitor and the Merrimac, Hampton Roads, appears as a mighty panorama. The river, the shore, even the clouds are as realistic as if the observer were actually gazing at the great historical spectacle. From behind the scenes, however, the appearance is altogether different, and what looked to be a comparatively flat landscape is in reality a series of semi-circular tiers of scenery, and in little pathways between the various sections of the scenery are operated the ships which take part in the action. These pathways are, however, not distinguishable by the audience. One of the views herewith shows how the scene actually appears from the auditorium.

From the main operating room above the auditorium is directed every move of the boats, and the electrical effects which beautify and add realism to the spectacle. Here sits the operator, like the officer in a submarine war vessel, seeing nothing actually of what transpires save through a peculiarly set brass mirror, which conveys a reflex of the whole action. In this operating room are 20 of the largest dimmers ever introduced in the articulation of electrical effects for shows of this nature. It is said that in this room are electrical appliances enough to operate three buildings, such as the Hippodrome, in New York City. The dimmers serve the purpose of lessening or increasing the strength of the burning or illuminating energy of some 5,000 lamps. The beautiful sunrise scene, the moon, its light and ripples on the water, and the terrific storm, with its rain and wind effects, the skies fretted with forked freaks of Jove's anger, and the tempest and tumult of the storm—all are controlled from this operating station.

"BATTLE OF THE MONITOR AND MERRIMAC."

The Monitor and Merrimac ironclads, the Cumberland, Congress, St. Lawrence, Minnesota, Roanoke, the Confederate gunboats, and the battleships, torpedo boats, destroyers, and submarines, used in the show's big climax, are operated by 30 differential electrical motors, with armatures and field resistances to



SWITCHBOARD FOR CONTROLLING "BATTLE OF THE MONITOR AND MERRIMAC."

increase or decrease speed. It is these that make the motion of the boats seem real. Even the guns on the vessels are fired by the controller in the operating room and its sparkers; all by electrical current. The moving of the waters, which many say makes them seasick, is created by a switch which controls an independent motor.

The main switchboard has 125 switches, running from 10 to 1,200 amperes. One gives current to the red and blue borders; another to the lighting of the cities around Hampton Roads; another to the sunrise; another to the sunset; another to the waters—all are electrical effects.

The great storm effects are created by ten cloud machines all operated by electricity. The clouds are photographed from nature and the films projected by an electric lantern.

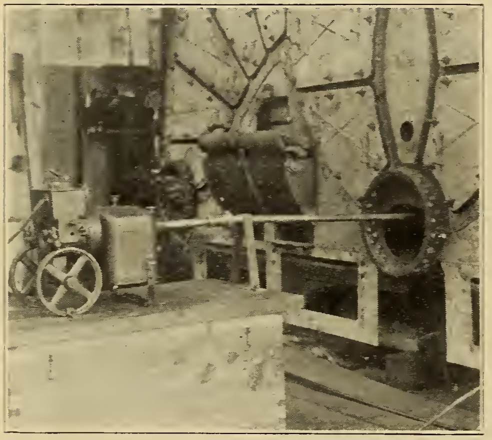
The number of skilled operators required to fight the mimic battle are: Electrical operators, 12; stage machinists, 35; stage clearers, 5; chief and assistant machinists, 3; stationary electrical calcium men, 6; a total of 61 men.

PHOTOGRAPHING THE STOMACH.

An improved apparatus has been made by Dr. Fritz Lang of Munich by which the inside of the stomach can be clearly photographed. The camera is actually swallowed by the patient, and when it reaches his stomach the walls thereof can be illuminated by a small electric lamp attached to the apparatus. At the bottom of the camera is wound a photographic film twenty inches long and a quarter of an inch wide.

PORTABLE ELECTRIC DRIVEN TOOLS.

In machine shop practice the customary method of operation in the past has been to bring the work to the tool. With the advent of electrically operated tools, however, the tools themselves are often made portable so that they may be moved from place to place about the shop. This is a great advantage as it is



PORTABLE ELECTRIC DRIVEN TOOLS.

obviously much easier and less expensive to move the tool than to move a heavy casting or boiler. Many drilling and boring operations are now performed in this manner. The accompanying cut shows a form of motor driven tool at work. The motor is mounted on wheels and is provided with an extendable shaft for the tool. The whole outfit may be moved to any part of the shop by one or two men.

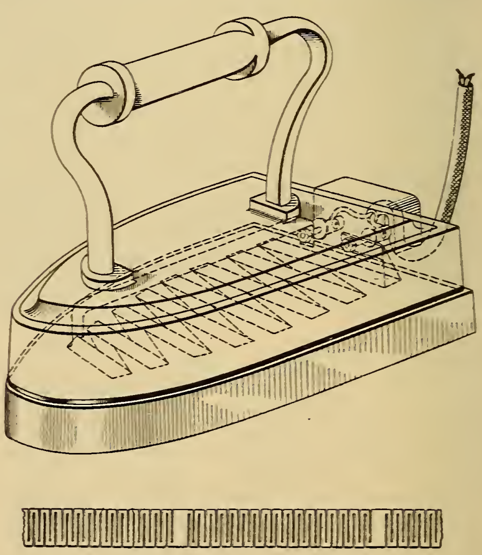
PLAYING CHESS BY WIRELESS.

Wireless telegraphy was made use of recently in a very interesting way. Two steamships started from the other side of the Atlantic on a little speed contest. Going in the same direction, but out of sight of each other, it was concluded to have a game of chess between parties on each boat. Tables were put in the "lounge" of the boats, near the wireless, and there the game was conducted, the moves being made by wireless instructions from the other boat. So the game went on to the thirty-fourth move, when one of the boats won, though it was the other that was the victor in the speed contest.

But the scene itself—a player at a chessboard, told how to move his pawns, his knights, his queens, by a silent voice that fluttered through the empty air, from a ship many miles away. If such a strange thing were told in the Bible there would be many people who wouldn't believe it. And yet the wireless has just begun its achievements. If there is anybody up in Mars and they know enough to catch step to an electric wave, there is coming a time when our daily papers will have the "latest from Mars" in startling headlines.—*Columbus (Ohio) Journal.*

ELECTRIC FLAT IRON.

A new form of heating unit for an electric flatiron is illustrated in the accompanying cut, which shows the unit itself and its arrangement in the iron. The resistence is composed of a flat strip or ribbon of metallic conductor stamped out in involute form to give the greatest length of conductor possible for a given length of strip. This conductor



ELECTRIC FLATIRON.

is then arranged in spiral form in the iron, as shown, and is assembled between the body of the iron and the plate forming the smoothing surface. The insulation between the ribbon and the two parts of the iron is built up of overlapping sheets of mica. This iron is the invention of William S. Hadaway of East Orange, N. J.

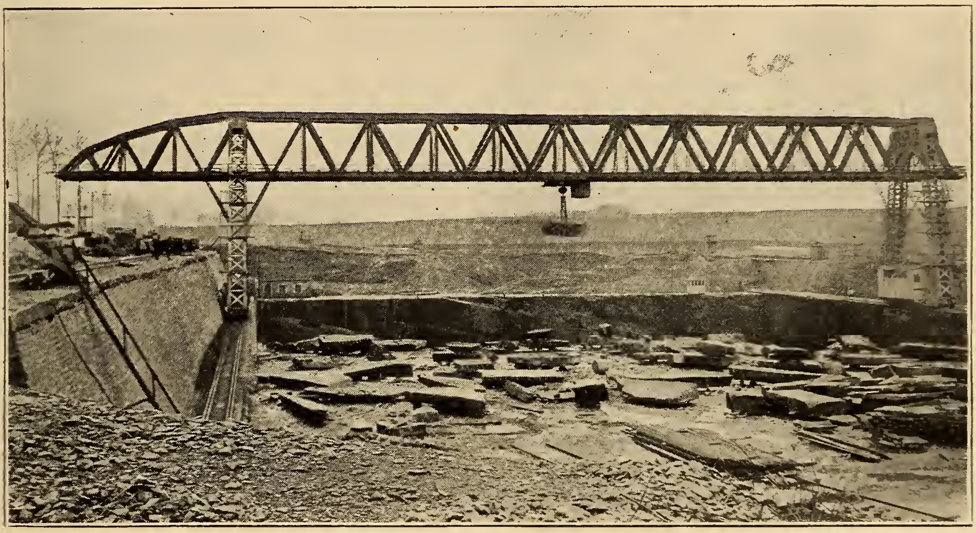
ELECTRIC CRANES FOR STONE QUARRIES

Electric power is now employed in up-to-date quarries, greatly facilitating the work and increasing the output very largely over earlier methods of operation. Not only is the electric driven traveling crane largely responsible for the increased capacity, but other electric labor saving devices are employed to advantage, and electric pumps, electric locomotives and electric drills are utilized extensively.

The electrically operated Belgian quarry shown in the picture has an output of 11,000 cubic meters a year, the blocks extracted ranging up to 15 and 20 cubic meters. A cubic meter equals 35.3 cubic feet.

The crane has a capacity for lifting a weight of 11,000 pounds and has a span of 246 feet. The total weight of this crane is 450 tons and it travels on a pair of tracks at each end of the span, each consisting of four rails, the total length of travel being 492 feet.

All the operations are performed electrically, the bridge movement along the track and two movements of the crane, both horizontal and vertical, being accomplished by electric motors.



ELECTRIC CRANES FOR STONE QUARRIES.

CABLE LAYING AN ENTICING PROFESSION

Associated with the development of the world's system of submarine cables, now aggregating about 250,000 nautical miles, is some admirable scientific, technical and administrative talent.

As observed in the Standard Weekly Supplement to "Empire" there are over 20,000 men and a big fleet of 45 ships at present engaged in the different branches of cable work—manufacturing, laying, repairing and operating. Directors, managers, superintendents, engineers, electricians and operators must all be smart men in their respective departments, for in this profession there is absolutely no room for a dolt. A resourceful mind, prompt action, personal courage, devotion to duty, and a contempt for danger are all required in the performance of their delicate duties. Wonderful zeal and energy are displayed by cable men, in peace and in war.

It would be difficult to imagine a more attractive career for an adventurous young man than that which is offered by service in any of the big cable companies. There is no exaggeration in saying that he could by judicious changes of companies travel right round the world in the practice of his profession in the course of ten years.

ELEMEMTARY ELECTRICITY.

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

CHAPTER V.—MAGNETIC EFFECTS OF ELECTRIC DISCHARGES.

The passage of an electric discharge through any circuit, no matter what may be the character either of the circuit or the discharge, is invariably attended by the production of magnetism. So far from being difficult to produce magnetism from electricity, it is impossible for an electric discharge to occur without being accompanied by magnetic effects.

It might, therefore, naturally be supposed, since magnetism can so readily be produced by electricity, that one of the earliest discoveries in electricity would have been that magnetism is necessarily the accompaniment of an electric discharge. In point of fact, however, the world remained in ignorance of this important fact until it was discovered in 1819 by Hans Christian Oersted, Professor of Physics in the University of Copenhagen.

What renders all the more curious the failure to discover at an earlier date the relations existing between magnetism and electricity, was the fact that it had been suspected long before 1819 that some relation existed between these two great natural forces. Franklin, by his famous kite experiment in the city of Philadelphia, when he drew electricity from the clouds, had demonstrated, as early as 1752, the identity between lightning and electric discharges. It had been noticed that lightning flashes frequently change the polarity of the magnetic needles employed in the mariner's compass. It therefore seems almost certain that an electric discharge possesses in some way the power of producing magnetic effects. Nevertheless, the world remained in ignorance of just how these effects were produced until 1819, when the problem was successfully solved by Oersted.

Like many other great discoveries, that which demonstrated the relation existing between electricity and magnetism, although apparently difficult to make, yet, when once made, proved to be so simple that it seemed astonishing it had not been made long before. As is often the case, what seemed to be extremely simple after it is once done, was accomplished only after long and persistent efforts. What could be simpler, when Columbus once showed the way to reach the new world of America from Europe, by simply turning the vessel's prow towards the west across the Atlantic? Yet, it was not until the year 1492 that this venturesome voyage which resulted in the grand discovery of a new world was made. When once made any navigator could visit the new world by merely following in the path pointed out by the great navigator.

And so it was in the voyage or investigation that it was necessary to make in order to show how magnetism can be produced by electric discharges. Like the sailing of Columbus towards the west, this voyage also resulted in the discovery of a new world, the world of electromagnetism, or magnetism produced by means of electricity.

Like other scientific men who lived before him, Oested firmly believed that some simple relation actually existed between electricity and magnetism. All others failed except Oersted, who succeeded only because, unlike his predecessors, he experimented with an electric discharge and not simply with an electric source that is only capable of producing an electric discharge when its poles or terminals are closed or placed in a complete circuit.

Take, for example, the experiments that were made with a voltaic battery in 1805, by Hatchett and Desormes. Convinced that an electric battery was capable of producing magnetism, these investigators carefully insulating, and so suspending a battery as to render it capable of free motion, looked to see it assume a position like a magnetic needle, and point approximately to the earth's geographical poles. Unfortunately for the success of their experiment, they failed to close the circuit of the battery, and, no electricity flowing, of course no magnetic effects were produced.

All Oersted did was to close the circuit of a voltaic battery. It may seem that this was not much, and yet it constituted the entire difference between failure and success. Nor are we forgetting that in a delicately suspended magnetic needle Oersted employed a far more sensitive means for detecting any magnetic effect than had been offered by the clumsy device of a suspended voltaic battery. Nevertheless, Oersted's success was not due to the greater sensitiveness of the magnetic needle than a battery, but to the fact that he had experimented with an actual electric discharge and not simply with a device capable of producing an electric discharge. Indeed, there is but little doubt that if the battery employed by Hatchett and Desormes had been powerful enough and the suspension delicate enough, they would have made the expected discovery had they only closed the circuit of the battery.

Let us now see just how Oersted made this discovery. Closing the circuit of a voltaic battery so that electricity could be discharged through a copper wire connecting its poles, he held the wire over and parallel to a small compass needle in the manner represented in Fig. 34, ("Electricity in Everyday Life," Houston). The compass needle had come to rest under the influence of the earth's magnetism, and was pointing, approximately, to the earth's geographical north and south poles. As the discharge passed through the wire the needle was deflected from its position of rest in the directions indicated by the circular arrows, provided that the discharge passed through the wire in the direction indicated by the straight arrows; that is, from the left to the right. There was thus made a great discovery; a discovery that may properly be regarded as one of the greatest in physical science.

It did not take Oersted long to discover that the direction in which the compass needle is deflected depended on the direction in which the electric discharge is passing through the conductor. If, instead of passing from left to right, or from + to —, as indicated in Fig. 34, the discharge passed from the right to the left, then the direction of the deflection of the needle was opposite to that indicated by the curved arrows.

Evidently the passage of an electric current through a conductor imparted to the conductor the properties of a magnet. Nor did the character of the conductor make any difference in the effect. No matter what substances formed the circuit, magnetic effects invariably attended the passage of the electric discharge.

As was natural, Oersted's discovery produced great excitement throughout

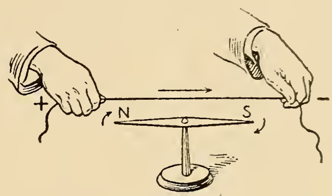


FIG. 34.

the scientific world. His experiment, simple in its details, but great in its results, was repeated by many eminent physicians, among which may be mentioned Arago, Davy and Ampere.

In a communication to the Royal Academy of Sciences, made September 25, 1820, Arago, a French physicist, states that when repeating Oersted's discovery, he found that a short conductor consisting of any metallic substance, such as copper, acquired, when a powerful electric discharge passed through it, the property of attracting iron filings towards it just as a magnet does. He also found that when such a conductor was bent in the form of a hollow spiral or coil, needles of steel, placed inside such coils, were instantly magnetized by the passage of an electric discharge.

Shortly afterwards, Sir Humphrey Davy, the celebrated English chemist, in a communication to the Royal Society of London, on November 16, 1820, describes the results he obtained and among others the following:

"I found, in repeating the experiments of M. Oersted with a voltaic apparatus of one hundred pairs of plates of four inches, that the south pole of a common magnetic needle (suspended in the usual way) placed under the communicating wire of platinum (the positive end of the apparatus being on the right hand) was strongly attracted by the wire, and remained in contact with it, so as entirely to alter the direction of the needle, and to overcome the magnetism of the earth. This I could only explain by supposing that the wire itself became magnetic during the passage of the electricity through it, and direct experiments which I immediately made proved that this was the case. I threw some iron fillings on a paper, and brought them near the communicating wire, when immediately they were attracted by the wire, and adhered to it in considerable quantities, forming a mass round it ten or twelve times the thickness of the wire. On breaking the communication, they instantly fell off, proving that the magnetic effect depended entirely on the passage of the electricity through the wire. I tried the same experiment on different parts of the wire, which was seven or eight feet in length, and about the twentieth of an inch in diameter, and I found that the iron filings were everywhere attracted by it; and making the communication with wires between different parts of the battery, I found that iron filings were attracted, and the magnetic needle affected in every part of the circuit."

It appears that the ability of a conducting wire, while carrying a discharge, to attract iron filings, thus observed by both Arago and Davy, was made by each independently of the other.

But before either of these investigators, though almost at the same time, another celebrated French physicist, Ampere, began a series of experiments on Oersted's discovery that resulted in a number of important generalizations that led to the invention of the electromagnet. Ampere showed, in a variety of ways, that not only did the short piece of wire through which the discharge was passing acquire the properties of a magnet, but that all parts of the circuit including the battery itself became magnetic. For example, by closing the circuit of the voltaic battery, represented in Fig. 35, (Ibid), he demonstrated that magnetic needles, placed as shown, were deflected by means of the discharge, whether through the circuit outside the battery or through the internal circuit of the battery itself.

The relation existing between electricity and magnetism affords simple means not only for detecting the passage of an electric discharge, not only for determining its direction, but also for measuring the amount of its discharge, for it was soon discovered that the amount of the deflection of the needle varies with the amount of electricity passing; that is, with the current strength. As the amount of electricity increases the amount of the deflection increases, the

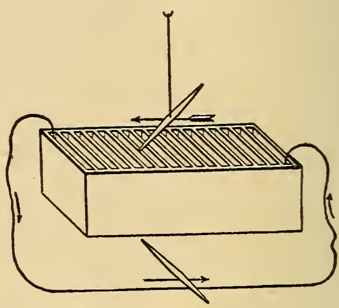


FIG. 35.

needle tending to place itself more nearly at right angles to the length of the conductor as the current increases.

In order intelligently to discuss the production of magnetism by electric discharges, we will briefly consider a few of the effects produced by magnetism. In the case of all magnets, there exists outside of the magnet, a region or space called the magnetic field. This space is filled with peculiar streamings or whirlings in the universal ether that constitute what is known as magnetism. Among other peculiar properties possessed by these streamings is that any body that is capable of being magnetized, instantly becomes magnetic when brought into them. It is only necessary that the streamings pass through the body for it to become magnetic. Although all bodies permit some magnetic streamings to pass through them, and thus become magnetic, yet some, such as iron, passess this power to a much greater extent than others. As we have seen, both Arago and Davy had observed that when iron filings were brought into the neighborhood of a conductor through which an electric discharge is passing, the conductor becoming magnetic attracted the iron filings to it.

A magnet can, therefore, be defined as

any body that is capable of producing magnetic streamings; or, as these streamings are sometimes called magnetic flux. Magnetic flux is invisible, but both its presence and the paths it takes, can be

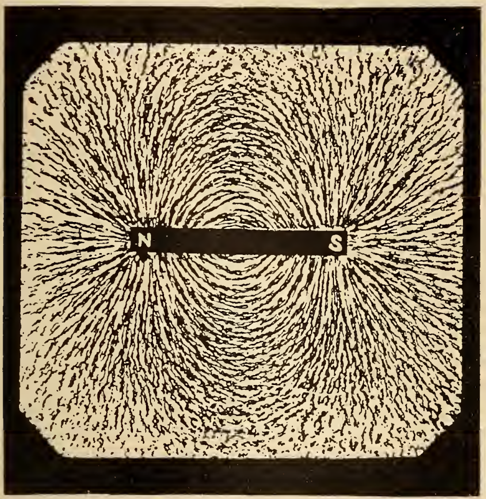


FIG. 36.

readily seen by the use of iron filings. For example, suppose the bar magnet, (NS) Fig. 36 (S. P. Thompson's "Dynamo-Electric Machinery,") be supported in a horizontal position as on a table, and a plate of glass is placed over it in a horizontal position. If now, finely divided iron filings be sprinkled evenly over the upper surface of the glass plate, and the plate be slightly tapped by a lead pencil or penholder, the iron filings will at once assume the peculiar groupings shown in the figure. The magnetic streamings pass freely through the glass plate and especially through the iron filings. These particles becoming magnetic assume positions like beads strung on the stream lines of magnetic flux.

The preceding figure only shows the directions of the flux streams lying in a single plane; that of the glass plate. If the same bar magnet be supported in a vertical position, as shown in Fig. 37 (Ibid), and a collection or grouping of iron filings be obtained in a manner similar to that already described, the peculiar groupings shown will be obtained. Here the paths of the magnetic streamings appear to radiate or pass in all directions in straight lines from the magnet. In reality, however, as could be shown, these paths extend outwards in curved lines from the ends of the magnet.

If the conductor through which an electric discharge is passing instead of being held in a horizontal position above and parallel to a magnetic needle that has come to rest under the influence of the earth's magnetism, as already shown in the first figure of this article, is supported in a vertical position, a magnetic needle when brought into its neighborhood will be deflected in different directions according to the side of the conductor near which it is brought. If, for example, the north pole of the needle is deflected in a certain direction on any side of the conductor, it will be deflected in the opposite direction on the opposite side of the conductor; and the same is true of any other position. If, for example, four different magnetic needles are placed as shown in Fig. 38 (Houston & Kennelly's "Magnetism"), 90° apart, or diametrically opposite one another, they would, under the influence of electric discharge, assume positions as represented; the north pole would

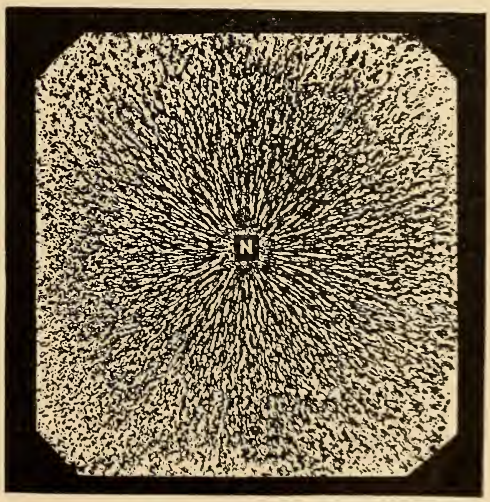


FIG. 37.

point to the right hand at (D) and to the left hand at (B) diametrically opposite (D). So, too, the directions of the deflections will be opposite to each other at (A) and (C).

If, instead of using four magnets

only, as represented in Fig. 38, a greater number of magnets are employed, as by using finely divided iron filings, the flux passing through the particles of iron filings will magnetize them and cause them to come to rest in the directions in

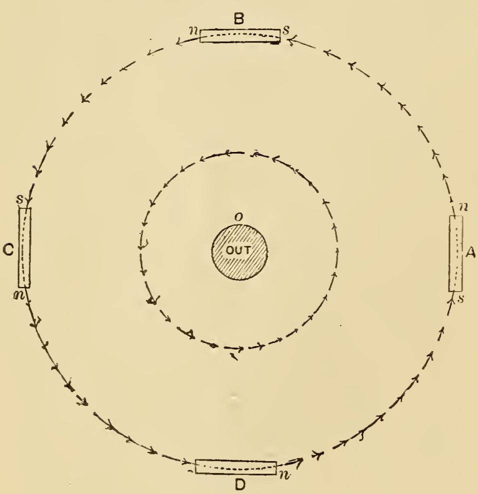


FIG. 38.

which the flux is passing. This can be shown by placing a plate of glass, or a piece of stiff cardboard in a horizontal position, sprinkling iron filings over its surface and tapping as before, when there will be obtained the groupings shown in Fig. 39 (S. P. Thompson's dynamo-electric machinery). An examination of this figure will show that the discharge of electricity through a conductor produces in the space around the conductor concentric streamings or whirlings that move in circular paths around the wire as a common center. As the amount of electricity passing through the wire increases, the space occupied by the circular flux increases, so that the flux appears to move outwards from the wire. On the other hand, when the amount of the electric discharge decreases, the flux lines apparently move towards the axis of the conductor.

A simple bar magnet when carefully examined will be found to possess two places, at nearly opposite sides or ends where the strength of its magnetism is greatest. This can be shown by rolling a bar magnet in iron filings and then removing it from the filings and giving it a number of taps; the filings will collect not evenly on the surface of the bar but in greater quantities near the ends. These ends constitute what are called magnetic poles. Their position can be best determined by supporting the bar magnet midway between its extremities as shown in Fig. 40. Under these circumstances, the magnet will be able to move in a horizontal position, and will, as is well known, point approximately to the earth's north and south poles, so that the ends of the magnet are called the north and south poles of the magnet.

A careful examination of the groupings of iron filings obtained on the glass plate, as shown in Fig. 37, magnetic flux appears to pass out from all portions of the bar magnet, so that there are in reality a number of separate magnets. It can be shown, however, that the amount of this flux is greatest near the ends or poles of the magnet. It will also be seen from an examination of this figure that the flux apparently comes from both poles of the magnet. This, however, is only apparent. It is believed that the flux passes out of the magnet at its north pole, and after having passed

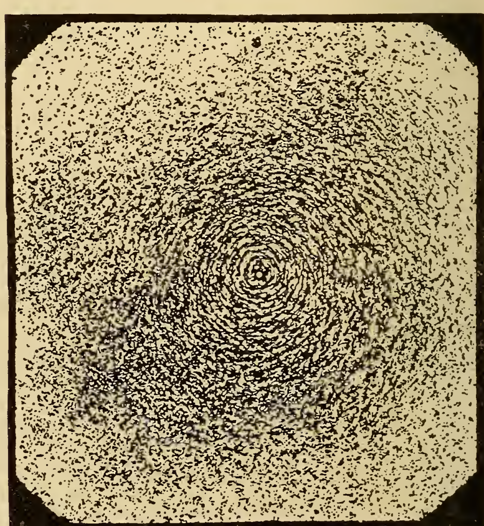


FIG. 39.

through the space around the magnet re-enters it at its south pole.

Since magnetic flux is invisible it is not definitely known whether the flux comes out of a magnet at its north or at its south pole. For convenience, however, it has been generally agreed to regard the flux as coming out of a magnet at its north pole and re-entering at its south pole, after passing through that portion of its path that lies outside the magnet.

But our knowledge of the magnetic flux, produced by a magnet or by an electric discharge, is not limited to the shape of its path, but extends, by agreement, to the direction in which the flux moves through that path. It is from the north pole of the magnet that the flux passes out of the magnet into the space surrounding it, and it is at the south pole of the magnet that the flux re-enters it.

The magnetic flux that moves in circular paths around the axis of the conductor through which an electric discharge is passing also possesses direction; or, in other words, polarity. This, indeed, would naturally follow from the fact that an active conductor causes the magnetic needle to point to it in certain direction. Without going any further into this subject at present, it may be said that if, as in Fig. 41 (Houston's "Electricity in Everyday Life") (D D) represents a conductor through which

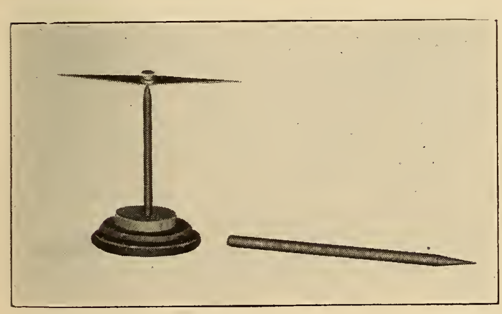


FIG. 40.

a current is flowing from below upward and (B B) represents a sheet of cardboard with the conductor passing through its center, then the passage of the discharge will be attended by the production of the circular lines of magnetic force, and the direction of the flux in these circular paths will be that indicated by the curved arrows. As will be seen, this direction is opposite to that of the hands of a watch or clock, or is what is known as a counter clockwise motion. The grouping of iron filings around an active conductor, when the current is passing from below upward, the direction of the circular lines of force, on which are strung as beads the separate particles of iron filings, will also be counter-clockwise.

When a magnetic needle is brought into the field of another magnet, attrac-

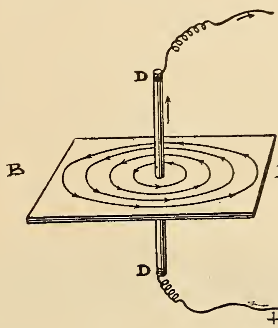


FIG. 41.

tion or repulsion will occur, and the needle will only come to rest when the flux produced by the field passes through the magnet in the same direction as that in which its own flux passes. In other words, the flux of the field must enter the magnet at its south pole and pass out of it at its north pole. If, therefore, in Fig. 38 (B) represents the direction of the flux produced by a discharge passing vertically upwards through the conductor (O), the four magnets (A), (B), (C) and (D), placed on different sides of the conductor, must come to rest in the positions shown, since in these positions only will the flux of the conductor be able to pass in at their south poles and out at their north poles.

(To be continued.)

CENTRAL STATION ON WRECKED SHIP.

A member of the New York Maritime Exchange is authority for the statement that a town on the coast of Guatemala is being supplied with electrical service from the abandoned wreck of a German steamer. The steamer was wrecked some time ago off the shore of Ocos, a small town on the west coast, and while the hull has settled deeply in the sand, the dynamo and a boiler (presumably the "donkey" boiler) are not submerged and are in good condition. A Gautemalan engineer rigged up a line to the shore, put the electrical generating machinery in operating condition, and is now stated to be supplying the town with electric light.

BERLIN LONG DISTANCE TELEPHONE EXCHANGE.

From the Berlin long distance telephone exchange a vast amount of interurban business is handled as well as long distance service between Breslau, Leipzig, Nurnberg, Wiesbaden and other important German cities. It is stated that the Berlin long distance connections alone amount to over 6,000 per day, while those from Charlottenburg and the surrounding towns increase the number to over 1,200 per day.

The new long distance office shown herewith is designed for 500 long distance lines, of which 252 lines have been installed. For handling these circuits there are 42 long distance boards for day service and four night long distance boards, as well as distributing boards and testing boards. The operating room is very artistically arranged and decorated as shown in the cut, incandescent lamps being mounted above the boards, with gas used for auxiliary illumination.

As will be noted in the illustration, each long distance board is provided with two operators' seats, each taking three long distance lines. The distributing boards are connected with the various city offices provided with the usual lamps and connections. The room looks very much like the operating room of an American exchange with the exception of the operators' chairs, which are used instead of the high stools common in this country.

From nine o'clock in the evening until seven in the morning long distance service is handled from four boards, each arranged for two operators, in this case 30 long-distance lines are cared for by each operator.

BERLIN LONG DISTANCE TELEPHONE EXCHANGE.

ELECTRICITY FOR CURING MEATS.

An invention which, it is said, will revolutionize the curing of meats has been perfected by Cleveland men. Electricity will be used to cause the salt to penetrate the meats and thus prepare them for market in one quarter the time the present method requires.

STEPS NECESSARY IN PATENTING INVENTIONS.

BY MAX W. ZABEL.

The profitable nature of inventions is well understood, but information is not always at hand to enable the individual to clearly comprehend the necessary steps to be followed in obtaining patents on inventions himself, or to guide him in seeing that his patent application is being conscientiously prosecuted by the attorney.

To bring the invention properly before the patent office it is necessary to file papers and drawings together with claims of the alleged invention, all of which must be in a certain specified form.

A complete patent application comprises a petition, specification and claims, an oath, a drawing or drawings together with a model when needed, and the first government fee of $15.00.

All of the above papers excepting the drawings must either be legibly written, typewritten or printed. A model is required only in the most exceptional cases.

When all the above papers are received by the patent office, the application is given a serial number and is then taken up for examination in its regular order.

The first part of the application comprises the petition and it should be in the following language:

"To the Commissioner of Patents:

Your petitioner ————, a citizen of the United States, residing at ————, in the County of ————, and state of ————, postoffice address ————, prays that Letters Patent may be granted to him for the improvement in ———————— set forth in the annexed specification.

————."

Following this comes the preamble:

"To all whom it may concern:

Be it known that I, ————, a citizen of the United States, residing at ————, in the county of ————, and state of ————, have invented a certain new and useful improvement in ————, of which the following is a full, clear, concise and exact description, reference being had to the accompanying drawing forming a part of this specification."

Now follows a general description of the invention, using the reference numbers which are placed upon the drawing to identify the parts. Care should be taken that in the description it is pointed out that the form of the invention described, is only one form in which the invention can be carried out, and that the invention is capable of many modifications. It is not necessary and is generally unwise to show more than one form of carrying out the invention in the drawing, because the patent office will permit claims in any application only on one form of the invention, although of course claims, broad enough to cover a great variety of forms of carrying out the invention are permitted.

These drawings must be made according to patent office specifications which require that they be made upon pure white paper of a thickness corresponding to three-ply Bristol board, and must be executed with India ink, so that all lines are perfectly black. The size of the sheet must be 10 inches by 15 inches with a margin line drawn along all four edges, one inch from each edge.

A space of not less than 1¼ inches must be left at the top of the sheet for printing which is supplied by the patent office.

Each sheet of drawing must be signed in the right hand lower corner by the inventor under a heading "Inventor"; and two witnesses must sign in the left hand lower corner under a heading "Witnesses."

After the specifications come the claims which are very important. There are many patents issued where inventors without the necessary knowledge have prosecuted their own cases only to get limited and generally worthless claims.

The claim is the most vulnerable point. For instance, one which goes into details, very often using some of the reference numerals of the drawing, is narrow and any slight modification from the specific wording of the claim will not be an infringement.

You frequently hear it said that all you have to do is to change a little screw and then you don't infringe. Well, that is the inventor's own fault for not having either the necessary knowledge of drawing claims himself or for not having consulted a good and competitent attorney.

The less elements there are in a claim the broader it is and the more details that are added to a claim the narrower it becomes.

After the claims it is necessary to supply the following ending:

"In witness whereof I hereunto subscribe my name, this —— day of ———, A. D. 190--," with the names of the patentee and two witnesses appended.

Following this comes the oath which should have the following form:

"State of ————, County of ——— , ——————————————, the above named petitioner, being duly sworn, deposes and says that he is a citizen of the United States and resident of ——— in the county of ————————— and state of ——————————, and that he verily believes himself to be the original, first and sole inventor of the improvement in ——————————— described and claimed in the annexed specification; that he does not know and does not believe the same was ever known or used before his invention or discovery thereof; or patented or described in any printed publication in the United States of America or any foreign country before his invention or discovery thereof or more than two years prior to this application; or in public use or on sale in the United States for more than two years prior to this application and that no application for foreign patent has been filed by him or his legal representatives or assigns in any foreign country except——————————.

——————————

Sworn to and subscribed before me this ———— day of —————, 190--.

——————————

Notary Public."

This then completes all the papers necessary to be filed. After the case has been taken up and examined by the pattent office, which sometimes takes six months, then a letter is sent by the pattent office outlining their objections and citing prior patents.

In answering this letter is where the skill of the attorney can be shown, so to redraw the claims that they do not cover what the patent office shows to be old, and yet cover everything else besides to safeguard all modifications of the invention.

Thus correspondence is carried on to and fro with the patent office until the case is finally allowed.

Upon payment of the final government fee of $20.00 the patent will then be issued.

A COMPLICATED COMPLAINT.

The telephone manager is fortunate when a letter of complaint is capable of being turned into a source of amusement. This sometimes happens, as is shown by the following letter, received by the telephone company at San Francisco:

Gentlemen: I now take the steps to inform you that I have no prosperity at present time with the restaurant which I keep, so I must take cheaper rate phone. My nearly by neighbor has got a phone also which is a nickel kind I like to get the phone as him but another one. I make two requesteds of the recent dates for to have sent up a man to do as above required but nobody show up to do it for me and further, I wait all last weeks expect for him to come but not.

Please kind sirs make a hurry as soon as you possible in order to help out my business troubles which I worry every day since hard times can come by. As a matters of importance I request to you a new book for my place one with outside city names which I understand is in the uses of subscribers for telephones.

Here I also complain against operator on my fone is very bad, she say hello what number you want and I say the number and she say questions after questions again for the same number and call skidoo skidoo every time I make a requests for numbers. I wish you for to please kindly make a stops to prevent some more as this.

Please sent up a man as before requests and do much to get service as better what is possible and I am obliged, Very truly, Y. Sugihara.—*Journal of Electric Power and Gas.*

ELECTRICITY AND SUB-MARINE MINES.

The fact that the United States government is about to expend a quarter of a million dollars for the conversion of one of its vessels—the U. S. S. Baltimore—into a "mine-planting ship" serves to call attention to one of the least known and yet one of the most interesting and important modern uses of electricity. Reference is made to the use of the current in the discharge or explosion of sub-marine mines. Sub-marine mines, it may be explained, afford one of the best means of protecting a harbor, river or other waterway against invasion by an enemy's ships.

The subaqueous mine which at the outset was nothing more nor less than an anchored torpedo first came into use during the Civil War and during that memorable conflict no less than 22 vessels were destroyed and numerous others were seriously damaged by this means. During the two score years that have intervened since that time many notable improvements have been made in submarine mines not the least important of which has been the substitution of gun cotton for powder as an explosive. The ingenuity of electrical engineers has been largely responsible for the marked improvements which have been made in mines.

Present day submarines are divided into several general classes, including "observation mines," "electrocontact mines" and electromechanical or electrochemical mines. The observation mine, as may be inferred from the name, is exploded upon observation and is completely under the control of an observer stationed at some convenient point on shore. The electrocontact mine is free to explode on contact with the bottom of a vessel, provided the shore ends of an electric circuit have been closed. The electromechanical or electrochemical mine is sufficient unto itself and once planted will explode of its own accord, so to speak. The electrocontact mine is the most favored of all the varieties and is the surest and most effective in its operation where current and tidal considerations permit its employment.

The approved type of electrocontact mine is made either of iron or steel and may be either spherical or cylindrical in shape. It carries, as a rule, a charge of 75 pounds of gun cotton, which charge is stowed in copper cases around the primer, one case having a hole in the center for the reception of this attachment. In the center of the mine and over the charge is a shelf or platform, supporting a pedestal upon which, in turn, is placed the circuit closer.

In an up-to-date mine of this type the

EXPLODING SUBMARINE MINE BY ELECTRICITY.

circuit closer consists of an upright steel cylinder containing a fine iron spindle, which, insulated at the top, points down to the cylinder. A wire connects with the upper end of the spindle and passes down outside to the primer. Fine redistilled mercury fills the lower part of the circuit-closer cylinder but does not reach high enough to touch the lower end of the iron spindle. Another wire is immersed in the mercury and that wire also passes down and around to the primer. To close the circuit it is necessary to heel the mine over to an angle of 70 degrees and then the end of the second wire and the lower end of the spindle are both bathed in the metal contact of the mercury and the circuit is complete, provided the shore ends of the wire have been joined.

ELECTRICITY IN MEDICINE.

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

Part V.

The Roentgen, or X-rays, are not, strictly speaking, electrical manifestations. They are, however phenomena that depend on the action of certain electrical modalities under certain conditions and for this reason it seems eminently proper to discuss them in connection with the uses of electricity in medicine. Nothing has contributed more to the popularization of electrotherapy than the discovery of the X-rays by Prof. Roentgen.

Roentgen was experimenting with high tension currents. He studied the effects which these currents produce when passing through a glass tube out of which more or less of the air has been exhausted. Crooke, an English scientist, constructed glass tubes which were provided with two terminals for the reception of positive and negative electricity. These tubes were called Crooke's tubes. Roentgen was studying the action of high tension currents when passing through these tubes, and the peculiar fluorescent effects that they produced on certain chemical substances. He found a peculiar form of fluorescence that was different from anything that was known at that time. He had found an unknown variety of rays and, not being able to account for them or to explain their conduct, he called these rays X-rays, the symbol "X" meaning "unknown quantity."

Two things are necessary for the production of Roentgen rays: A machine that will generate a rapidly interrupted current of high tension, and a properly constructed Crooke's tube.

The machine to generate the current is either a static machine or an induction coil. For X-ray work static machines have nowadays become almost obsolete. A well constructed induction coil is the proper kind of a generator. The construction of an induction coil we have discussed in a previous chapter.

In order to interrupt the current with suitable frequency, a special instrument called an interrupter is used. It is put in the circuit of the current and may be either an electrolytic (chemical) interrupter or a turbine by which the current is interrupted mechanically. In the latter case a motor furnishes the power by which the turbine is rotated.

The rapidly interrupted current of high tension which is generated by the coil is carried by two wires to the tube. The tube has a special terminal (anode)

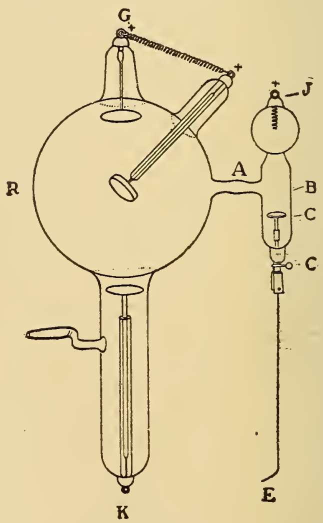


FIG. 18. MODERN X-RAY TUBE.

for the positive current and another (cathode) for the negative current. Fig. 18 shows the type of X-ray tube which is used at present.

The disk in the center of the tube is the anode or the positive terminal. The wire carrying the positive current is attached at (G). The current reaches the anode through the spiral wire which begins at (G) and connects with the straight stout wire upon which the anode is mounted. At (K) the negative wire is attached. The current travels along the stout straight wire which begins at (K) and carries on its other end the cathode or negative terminal. The crank shaped attachment on the outside of the tube, almost below the cathode, is the place where the tube maker or glass blower attaches his instrument when he exhausts the tube. (R) is the part of the tube which is turned toward the object to be treated or examined. The Roentgen rays are given off from the outside of the tube, or to be explicit, from the hemisphere of the tube which is in front of the anode. There are no rays back of the anode. When the tube is properly excited, the hemisphere in front of the anode is aglow with a characteristic greenish light while hardly any light appears in the half which is situated back of the anode.

A tube which has been exhausted, represents a relative vacuum. The vacuum is not perfect because the glass bulb could not stand the pressure. It would collapse. The vacuum, therefore, is a relative one. The tube still contains a certain amount of gas or air. This amount is variable. There may be a great deal of gas or air in the tube or there may be but little. There may be any number of degrees of exhaustion. If the exhaustion is comparatively high and but little air remains in the tube, the latter is called a "hard" or a high tube. If the exhaustion is imperfect and quite a good deal of air remains in the tube, the latter is known as a "soft" or a low tube. We can readily understand that between extreme hardness and extreme softness of a tube there are innumerable degrees of exhaustion. The point to remember is that a tube varies constantly in its vacuum. The vacuum is not constant. A tube may to-day be soft, to-morrow less so, in a week quite hard.

From a practical point of view the hardness or softness of the tube is of the greatest importance. The softer the tube is, the greater is the amount of X-ray energy produced, but the smaller is the degree of their penetrating power. The harder the tube, the smaller the amount of the X-ray energy but the greater the penetrating power of the rays. Considering that the results of X-ray work depend on the physical characteristics of the tube, we can readily see that it is desirable and in fact imperatively necessary to be able to control the degree of vacuum in the tube. This is the object of the attachment which in our illustration is seen above the tube proper. It is also made of glass and communicates with the tube by means of a pipe (A). This attachment also has a positive terminal (J) and a negative terminal (C). The positive is seen to end in a small spiral wire. The straight wire (E) represents the negative side and is movable. It can be brought near (K). Since the object of the smaller tube above the X-ray tube proper is to regulate the vacuum in the larger tube, it is called the "regulating attachment."

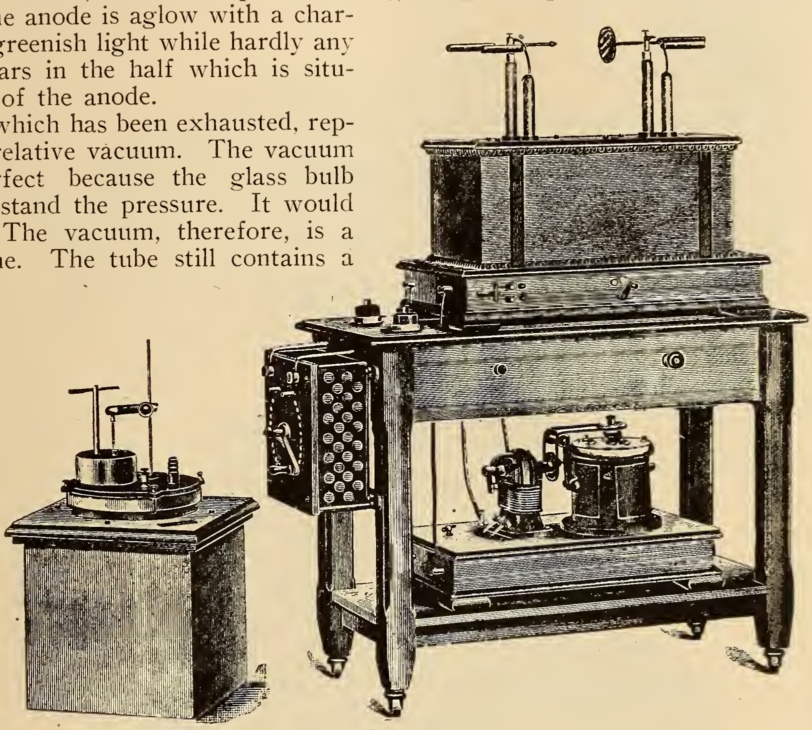


FIG. 19.

By allowing the negative current to run through the negative terminal in the regulating attachment instead of the negative terminal of the X-ray tube proper, the vacuum of the X-ray tube is lowered. The negative terminal in the regulating attachment is made not of metal but of a chemical mixture which sets nitrogen gas free the moment the negative current passes through it. The nitrogen gas passes through (A) into the interior of the X-ray tube proper and in this way decreases the degree of intra-tubular pressure. The tube becomes softer. If we wish to increase the pressure and make the tube harder, we allow the positive current to pass through the platinum spiral (J). The latter heats up and absorbs gas which is present in the interior of the tube. Thus the pressure rises and the tube becomes harder.

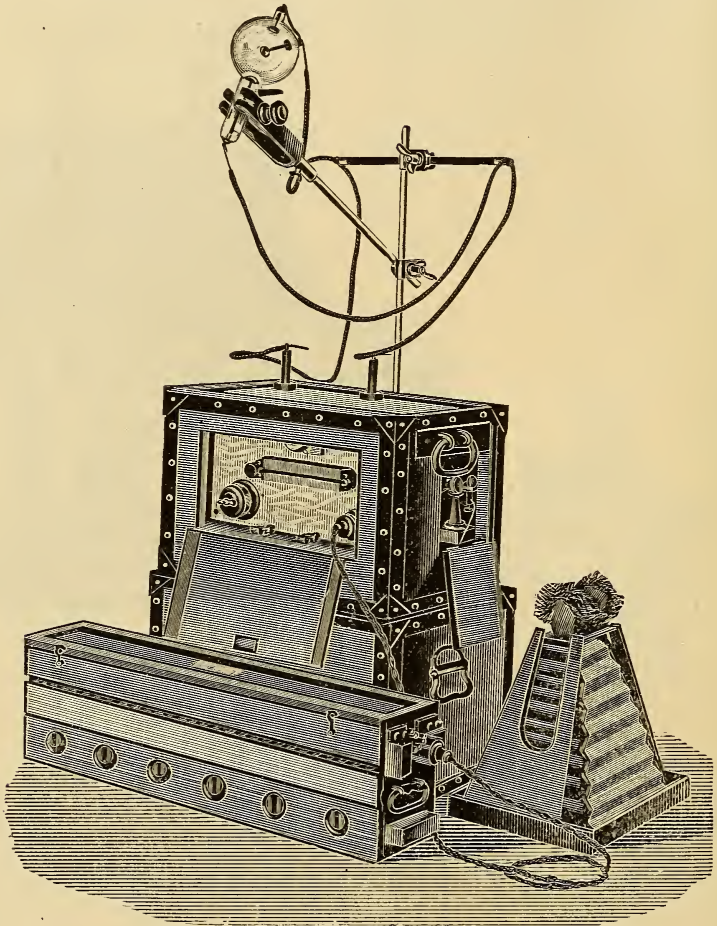


FIG. 20.

Figs. 19 and 20 show two different types of X-ray coils which are used nowadays. Fig. 19 shows also the two kinds of interrupters (electrolytic or chemical and mechanical) used.

The Roentgen or X-rays are principally used to render a part of the body translucent. Different substances offer different degrees of resistance. The soft parts offer hardly any, while the bones offer quite a good deal, depending on their thickness and density. Metallic substances are impermeable, especially lead. Thus, if we examine a hand by means of X-rays, we would see the bones distinctly while the soft tissues are hardly visible. The softer the tube, the darker the bones would appear. If there is a metallic substance in the hand, for instance, a pin or a bullet, it would plainly show. Breaks in bones or bony tumors can be distinctly seen, likewise dislocations. Solid concretions in the kidneys or in the bladder (stones or calculi) can be located by X-rays. The so-called gallstones, however, cast hardly any shadow because they are porous and the rays pass through them.

FIG. 21. EXAMPLE OF X-RAY BURN.

There are two kinds of X-ray examination. If we place the part to be examined, for instance a hand, in front of the excited X-ray tube and wish to actually see through it, we must use a chemical substance which, if placed in the field of X-ray energy, will become fluorescent. There are many chemicals of this kind. The chemical mixture is spread on a piece of pasteboard and the latter enclosed in a box with an opening for the eyes of the operator. By looking at a hand held between tube and screen, the hand becomes translucent. The box containing the fluorescent screen is called a "fluoroscope." This kind of examination is of doubtful value because of the liability of the human eye to be mistaken and thus misinterpret.

A far better and more reliable method of X-ray examination is by "radiography" or "skiagraphy." The former word means "taking a picture by means of rays," in this case emanating from an X-ray tube. Skiagraphy is the opposite of photography. The latter means "recording lights," the former "shadows." A photograph is a light picture, a skiagraph is a shadow picture. If we take a photographic sensitive plate and, before taking it out of the dark room, wrap it up in black paper in order to prevent the daylight from affecting the plate, and, after putting the plate on a solid

FIG. 22. EXAMPLE OF X-RAY BURN.

surface like a table, place the object to be examined directly on the plate, we can get a record of it by letting the X-rays penetrate the object. The photographic plate will receive a density record of the object at every point. The dense parts of the object will leave a faint record or shadow because they offer some resistance to the rays and only a part of them reach the plate. Where there is no resistance, the rays leave a marked record or a deep shadow. After the exposure the plate is developed in the ordinary manner. The result is a negative from which prints can be made. The art of skiagraphy is principally in the interpretation of the picture.

treatment. We know that the effects of the X-rays are spent on the surface of the body. Therefore diseases of the skin are particularly adapted to X-ray treatment. Wonderful results can be achieved by the proper use of the Roentgen rays in many diseases of the skin, especially skin-cancer, so frequently seen in the face, especially the lip. The prejudice against the use of the Roentgen rays in the treatment of diseases has been produced by the abuse of the rays rather than their use. The X-ray operator should not only be an experienced physician but a skilled specialist in the line of X-ray work. Most of the work is done by physicians who are in no way qualified and by their ignorance, lack of skill and by their total unfitness, have brought a legitimate kind of medical work into undeserved disrepute.

FIG. 23. A SKIAGRAPH OR X-RAY PICTURE.

In addition to the uses of the Roentgen rays as means of examination, they are serviceable as curative agents in the treatment of a variety of conditions. This is what is known as the therapeutic use of the X-rays. A good deal of confusion exists in the mind of the laity and of many physicians in regard to the possibilities and limitations of X-ray treatments. The X-rays have a triple action. They are stimulating, germicidal and destructive, depending on the quantity of X-ray energy use, on the length of exposure and on its frequency. Since the curative effect depends on the quantity of the rays, it is plain that the so-called "soft" tube is the most available tube for treatment.

The so-called X-ray burn is an example of the destructive action of the X-rays. Proper protection by means of sheet-lead would prevent the occurrence of these obstinate and painful conditions. The accompanying illustrations, Figs. 21 and 22, show hands that have been injured by the Roentgen rays.

To illustrate the possibilities of X-ray work in rendering the body translucent the accompanying pictures, Figs. 23 and 24, will prove of interest.

(To be concluded.)

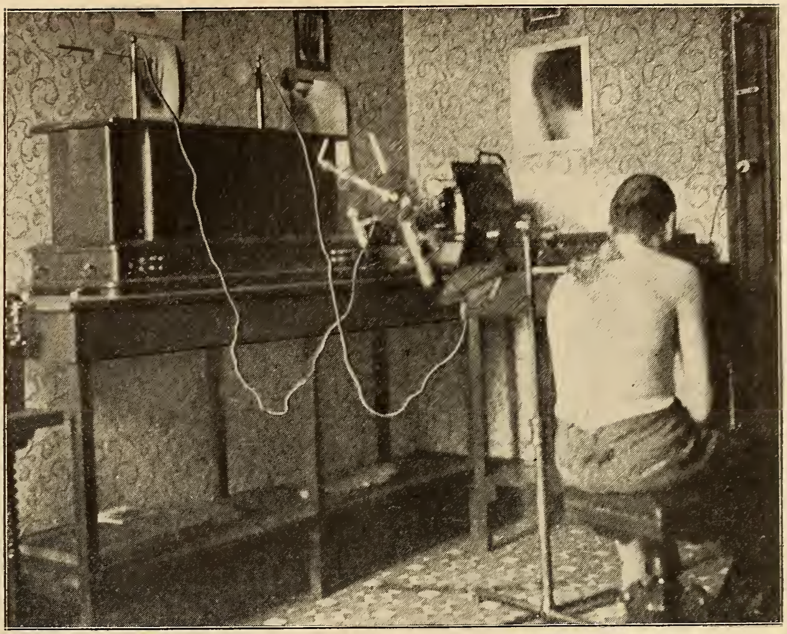


FIG. 24. OPERATING WITH X-RAYS.

NIAGARA'S ELECTRIC FURNACES.

BY ORRIN E. DUNLAP.

Niagara Falls didn't know what an electric furnace was until about 1894, when a man about 38 years old, weighing less than 150 pounds in flesh, but with a brain which, if judged by accomplishment, would balance the Egyptian pyramids, came to the town eager to learn about the possibilities of the wonderful power development of the Falls, then under way.

It is not known that this man had ever been to Niagara Falls before, but this visit in 1894 was destined to be of truly remarkable benefit, not only to the Niagara locality, but to the world at large. This visit was just a "happenstance" in the man's life. He had an idea. He had had many of them before that day, and he has had many since, and, still, the world hasn't yet come to realize the full value of what he has given it as a result of his jaunt to Niagara 14 years ago.

The man was Edward Goodrich Acheson. He was leading the march of electricity. He thought he was following it, but the fact is the mighty turbines and generators of Niagara had not at that time taken up their work. So Edward Goodrich Acheson was in the lead and those who knew his life's work—those who knew the full story of his deeds—will tell you he still leads.

Men had conceived a remarkable electrical power development for Niagara. Eminent engineers had met in London, England, as members of the International Niagara Commission, and there they had planned things before unheard of for the electrical development of Niagara. Impressed, as they were, by the tremendous power available through hydroelectric possibilities, the lamented Lord Kelvin and his colleagues on the commission were inspired to deeds of greatness, and they outlined a power plant of magnitude and creation that astonished the electrical engineers and scientific men of the world.

In March, 1891, Mr. Acheson recalled experiments he had previously made, and having at his command the electric generating plant he thought to try the impregnating of clay with carbon under the influence of the high heat obtainable with the electric current. He had in mind the making of an abrasive material. He mixed together a quantity of clay and powdered coke, placed the mixture in an iron bowl such as plumbers use for holding their melted solder. Into this mixture he inserted one end of an electric lamp carbon, the other end being connected to one lead from a dynamo, the other lead being attached to the iron bowl. A good strong current was sent through the mixture until the central portion of the clay was thoroughly melted and raised to a very high temperature. When cold, the mass was removed and examined carefully. Adhering to the end of the carbon rod Mr. Acheson noticed a few small bright specks. He placed one on the end of a lead pencil and drew it across a pane of glass, and he found that it scratched the glass. The value of the product he at once appreciated.

After other experiments extending over two months he had enough of the crystals to fill a small vial, and placing this vial in his vest pocket, after he had himself cut the polished face off of his diamond, he hurried off to New York, en route naming the product "carborundum," under the belief that it contained carbon and corundum. It was after this that he learned it was the silica in the clay, and not the alumina, that was associating itself with the carbon. In New York diamond cutters bought the contents of the little vial at thirty cents per carat, or at the rate of $560 per pound.

It was in 1894 that Mr. Acheson formed the Carborundum Company in Monongahela City, where a plant using 134 horsepower was operated. There the cost of production was so high that the trade was restricted, only about half of the production of the plant being sold. However, Mr. Acheson was convinced that carborundum had a great future.

These were the conditions that prevailed when Mr. Acheson was led to visit Niagara to investigate the power possibilities there. He was enthused by the outlook, and returning to Monongahela City he convened a meeting of the company's directors and placed before them his scheme of moving to Niagara and there locating a plant that would consume 1,000 electrical horsepower. This was far too visionary for the sedate directors, who couldn't see what they would do with the production of a plant of this size when the market didn't eat up the output of the 134 horsepower plant. Every director resigned. Mr. Acheson organized a new board, and moved the business to Niagara Falls, where 10 years later the company had a 5,000 horsepower plant and that year produced over 7,000,000 pounds of those specks he had picked off the lamp carbon in 1891. The product he discovered has revolutionized the abraisive world.

Early in the history of the manufacture of carborundum, Mr. Acheson discovered that when this product was heated to a very high temperature decomposition occurred, the contained silicon being dissipated in vapor and a beautiful graphite left as a pseudomorph. Right there he started on a new line of thought. He learned how to make graphite and organized a company for its manufacture. This product is not "artificial," but in the language of the day, it is the real thing. Its superiority develops from the fact that the raw material that enters into its manufacture, as well as the operation of the giant electric furnaces in which it is made, are handled and governed at every stage by scientific cruelty, if I may make the statement, so that the hit-and-miss process, in reality the accident, of nature's work has been surpassed by the wonderful purity of the product. Astonishing as it may seem, there are grades of this graphite guaranteed at least 99 per cent pure, a fact that makes an astonishing demonstration of what the electric furnaces of Niagara are doing for the world.

But this success did not satisfy Edward Goodrich Acheson. Having worked out the details of the manufacture of graphite, he began the study of its application. In making experiments in connection with the application of his graphite to crucible work, he learned that clay treated with a dilute solution of tannic acid, was increased in plasticity, made stronger—in some cases as much as 300 per cent—in the sun dried condition required but 60 per cent as much water to produce a given degree of fluidity, was caused to remain suspended in water, and made so fine that it would pass through the finest filter paper. The effect was remarkable. He studied ancient literature to see what was known on the subject. In the Bible he noted we are told that the Children of Israel, under the instructions of the Egyptians, used straw in the making of brick, also that they successfully substituted stubble for the straw. The fiber of straw is very weak, not nearly so valuable as a mechanical bond as many other vegetable fibers, and so he concluded the Egyptians must have used it for another purpose. He treated clay with extract of straw and found it had the same effect as tannin, and he realized the Egyptians must have been aware of the effect. For this reason Mr. Acheson called clay so treated "Egyptianized Clay."

The importance of this discovery came in 1906, after Mr. Acheson had discovered a process for making a soft, unctuous graphite with a purity of over 99 per cent carbon. The world, previous to that time, did not possess a graphite of this character, and he was quick to determine that it was an ideal lubricant. Practically the same furnace that had turned out the hardest known abrasive had given him this lubricant. The next problem was to make it available for lubrication purposes. As he wished it to enter the field occupied by oil, he knew it was essential that it remain suspended in a liquid. He encountered many troubles, but in the latter part of 1906 the thought occurred to him that tannin might have the same effect on graphite that it had on clay. He tried it, with satisfactory results. He learned how to "deflocculate" graphite, in which condition it is so fine that when suspended in water it readily and freely passes through the finest filter paper made. One result was to add a new word to the dictionary, for up to that time we did not have the word "deflocculate." No dictionary has it yet, but will in time give proper recognition to what among men of science is known as the "Acheson Effect." When graphite is deflocculated, it is reduced to the molecular condition, there being no known law in chemistry or physics to explain the effect. Mr. Acheson further learned how to remove the water from deflocculated graphite and substitute oil for it. Deflocculated graphite in water is now known as "Aquadag," which when in oil it is called "oildag."

The pure, soft, disintegrated, unctuous graphite of those electric furnaces of Niagara gives great promise of revolutionizing the lubricating features of the universe. Time was when animal fats and grease served as lubricants. Then petroleum oils entered, and for forty years have held sway. Now, it is intimated, the world's supply of oil will hardly last another 50 years, and it is to be made the subject of protection, as are the forests, in order that the world's supply may be conserved. This inclines to the belief, particularly so among these who feel that the plan of the universe is all right and that the needs of mankind will be supplied, that the era of graphite has been opened, for in these latest and newest products of the great electric furnaces of Niagara, we have lubricants for every purpose, for there is the dry, soft, pure unctuous powdered graphite; the deflocculated graphite in water, and the deflocculated graphite in oil.

But how strange it is that the process which applied in one way develops an abrasive, will and does give us a lubricant when the temperature is carried to unknown heights. It is known that carborundum is produced in a temperature approximately 7,000° F., while it requires a still higher temperature to produce graphite. This temperature is the highest used on earth, except possibly the center of an electric arc. It is a temperature that vaporizes every other element except carbon, and which makes Acheson graphite of a purity over 99 per cent carbon.

In an address before the American Academy of Arts and Sciences in Boston, Mr. Acheson said: "Some months ago while crossing the Mississippi at St Louis, I looked down from the car window and saw the great muddy stream sweeping by to the Gulf, and having fresh in my mind the deflocculation of non-metallic amorphous bodies, it occurred to me that possibly the matter suspended in the water was in a deflocculated condition. I remembered that I had been told that nearly, if not quite all of this muddy water, came out of the Missouri river from the great plains of the middle west, and further, that the water did not clear during its entire course of some hundreds of miles, also that none of the muddy water was found at any great distance from its entry into the salt waters of the Gulf, the suspended material being deposited at the mouth of the river, there forming the great bars of the Mississippi. I also recalled the formation of the Great Delta of the Nile, and I felt quite convinced, without an experiment that the material was deflocculated and in a colloidal condition, and became flocculated and settled on coming into contact with the electrolyte—salt water. I have not had an opportunity to make any investigations of the waters of the Mississippi, but I have to the best of my ability artificially produced which seems to me to be similar conditions."

One day I asked him:

"Why don't you try to make diamonds?"

"Why should I devote my time to that?" asked he. "If I succeeded, I would only effect a destruction of the present world values on these gems. I don't think that would be to my credit. No, I want the work of my life to be helpful to humanity, and then, perhaps, when I am dead and gone, some place, somewhere, in some distant part, maybe, there will be a lingering memory and esteem for what I at least aimed to accomplish in my allotted time. We should build to help others; not with a selfish purpose."

TELEGRAPHING AND TELEPHONING OVER ONE LINE.

While a practical solution of the problem of simultaneous transmission of telephone and telegraph messages over the same line has long been known, the adaptations of it to railway work have opened so large a field that great attention is now being paid to the subject.

The experimental age of the composite system has passed and we now have hundreds of miles of wire serving the double purpose of a telephone and telegraph line. This has been brought about by the demand on the part of the public for a more rapid and frequent train service, and the near approach of the date for the enforcement of the federal eight-hour law, coupled with the scarcity of operators. To meet these conditions, three ways were open: The present telegraph system could be enlarged, a separate telephone system could be installed, or the present telegraph line equipped with telephonic apparatus; in other words, the installation of a composite telephone and telegraph system. Of these three methods for increasing the communicating facilities, the composite system possesses marked advantages in first cost, operating cost and maintenance.

These installations are principally used in the middle and far west, where stations are far apart and the cost of constructing telephone lines would be high. The uses are as varied as could be imagined. Sleeping car berths are secured by telephone, and many roads use the telephone as a means of communication between block signal stations. This allows more detailed information than that possible by the use of the telegraph instrument. The most important use of the telephone, however, is for train dispatching.

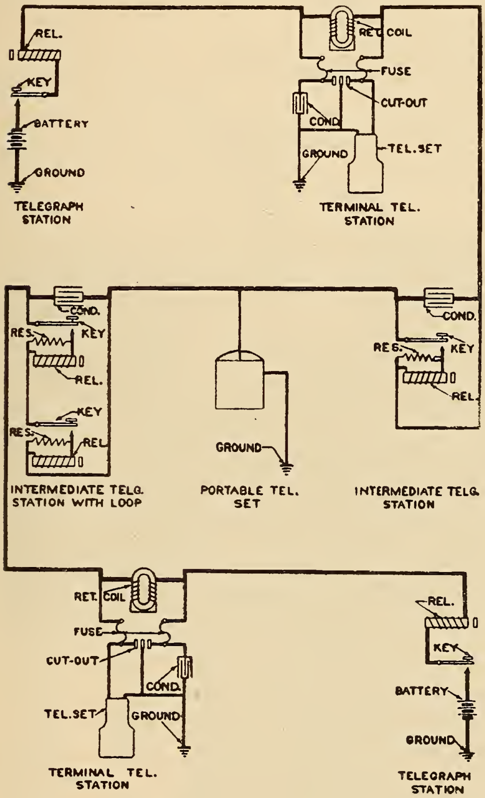
The various systems in use vary but little in general principle, a grounded telegraph line being used for telephonic purposes. The sketch shows schematically the arrangement of the composite system used by the Western Electric Company, which will be readily understood by those familiar with circuit drawings.

Composite telephone and telegraph systems it may be further explained, are adapted to simple Morse circuits where the interruptions in the telegraphic current are of comparatively low frequency and when the change in potential or voltage of the current due to the operation of telegraphic apparatus is not excessive.

To adapt a telegraph system to telephone operation requires no change in the telegraphic apparatus or its operation. At each telegraph station the apparatus is bridged with a condenser and a resistance, and at the telephone stations the apparatus is connected between the line and ground. The condenser in the telephone set prevents the telegraphic current from passing through the apparatus to ground.

On the composited portion of the system there may be three kinds of telephone stations, viz., terminal stations located at each end of that part of the telegraph line used for telephonic purposes; intermediate stations located between terminal stations, and portable stations to be carried on a train for emergency use and used when the train is at a standstill.

For emergency purposes the portable telephone set has come into almost gen-



ELECTRICAL CONNECTIONS FOR TELEGRAPHING AND TELEPHONING OVER ONE LINE.

eral use on the western railroads, some of which carry one on every train. This set consists of a transmitter, receiver and a signalling device, known as a "howler." These instruments are all of special design, being compact and enclosed in a carrying case. In case of a wreck or a washout, this set can be quickly connected to the composited portion of the telegraph line by means of a pole and line provided for the purpose. Any member of the train crew can instantly communicate with the nearest station and give a detailed account of the wreck. The train despatcher can be informed and change his train orders to prevent further disaster, while the division superintendent, because of the detailed information given him by some one right on the spot, can issue clear and explicit orders for clearing up the wreck.

The wrecking trains also are provided with these sets, enabling them to keep in touch with the chief wrecker. The advantages of such a system over the old practice of sending a train man back over many miles of track to some way telegraph station, are apparent. A few minutes gained at such a crisis may mean life to the unfortunate victims of such a catastrophe.

Telephonic signalling is accomplished by pressing a button, which operates what is known as a "howler." This "howler" is really a high resistance telephone receiver equipped with a resonating horn. The incoming current will operate this "howler," causing it to make sufficient noise to attract the attention of any one in or near the station. A regular local battery talking circuit is used.

At each terminal telephone station is located a telephone set, a protector, and a condenser which contains a retardation coil and a condenser. This retardation coil is joined in series with the line to prevent the telephonic current from passing to ground over the telegraph line beyond the telephone station, but does not impede the telegraph currents, because they are of a much lower frequency than those generated by the telephone.

At each telegraphic station, protective apparatus is installed which not only protects the telephonic apparatus from lightning and abnormal currents, but owing to fuses, prevents a permanent ground at the cut-outs from interferring with the telegraphic service.

The length of telegraph line and the number of stations with which this composite system can be successfully employed, depend largely upon the character of the telegraph line. The length, gauge, material of the line and the amount of wire in the cable are the most important features which govern the perfect operation of the system. Iron wire is much inferior to copper wire of the same size when used for telephonic transmission, and conductors in cable are much less efficient than open wires. Furthermore, paper insulated wires in cables are much more efficient than wires of the same size in rubber insulated cable, on account of the high electrostatic capacity of the latter.

Owing to the many different conditions governing the use of a railway composite system, and the variations of these conditions for each particular line, it is impossible to give inflexible rules applicable to every case regarding the length of line over which service can be successfully obtained, or regarding the number of stations which can be successfully operated on a single line. In general, lines up to 200 miles in length can be satisfactorily operated by using No. 12 copper wire, and lines up to 100 miles in length by using No. 8 iron wire.

ELECTRICITY ON SHIPBOARD.

A field in which the utilization of electricity has undergone notable extension during the past few years is found in the highly important one of signalling on shipboard. As modern battleships and the great passenger carrying steamers of the Atlantic and Pacific have grown in size until they exceed in length the dimensions of a city block and have decks so numerous as to make them the counterparts of seven or eight-story buildings it has become imperative that all parts of the floating monsters shall be linked by lines of electrical communication.

WIRELESS STATION ON U. S. S. CHICAGO.
(Copyright, 1908, by Waldon Fawcett.)

Moreover, by means of wireless telegraphy which has been generally adopted in the navy and merchant marine of every leading nation these sensitive electrical nerves are enabled to reach beyond the confines of the vessel itself and keep its floating population of perhaps 2,000 souls in close touch with the world in general.

Probably the place of first importance among the utilities for electrical signalling on shipboard must be accorded to wireless telegraphy and its sister invention wireless telephony which has recently been introduced on all the principal battleships of the United States navy. So general is the use of the wireless systems that a vessel sailing the high seas is almost never out of communication with land and may also exchange messages with other vessels preceding in the same or opposite directions. The possibilities of this employment of electrical energy are well illustrated by the fact that on many of the large trans-Atlantic liners daily newspapers are now published, the contents of which are made up almost solely from aerograms received from shore stations.

APPARATUS FOR NIGHT SIGNALING ON SHIPBOARD.

All the large naval and merchant vessels are now lighted throughout by electricity, the installation on an up-to-date vessel comprising not only thousands of incandescent lights but the powerful illuminants needed for the searchlights which play so conspicuous a part in the cruises of war and peace. Electricity is employed to operate the elevators that connect the various decks of the twentieth century passenger steamer and the magic current is depended upon to provide energy for the ammunition hoists on the warships—a class of miniature freight elevators the function of which is to convey powder and projectiles from the magazines in the hold of a ship to the turrets and gun stations.

It is on the modern warship of large size that electrical signalling on shipboard has reached its highest development. The entire interior of one of these floating fortresses is a network of electrical communicative lines of various kinds. They center in the conning tower where the terminals surround the commanding officer and place within reach of his hand the means of instant communication with every officer and enlisted man in his command. By means of the telegraphs and other signals the officer in command may flash the signals "Begin Firing," "Cease Firing" or other commands, simultaneously to every gun station on the entire ship and similarly equally pertinent commands may be transmitted to the engine room or the magazines and set before those in charge in illuminated letters that cannot fail to arrest their attention.

The system of electric bells on the modern ship is equally efficient and affords the means of instantaneous communication between the bridge and the engine room. At night signaling between ships is done by means of the manipulation of arms studded with electric lights on the same principle as the block signals employed by railroads.

THE ELECTRIC EEL AND HIS BATTERY.

The electric eel, which is common in the streams of Brazil, is possessed of a natural electric battery—but a tremendous one. Beneath the skin are two pairs of peculiar little bodies passing longitudinally along the muscles and near the tail. One pair is next to the back and the other near the lower fin. These bodies are made up of great number of little cells, two or three hundred of them, and plentifully supplied with nerves.

Examination of one of these electrical organs has shown that in action it is very much like a galvanic battery, with the anterior extremely positive, the posterior negative, and the current only discharged at the point of contact with an object. This has been proved to be so powerful when complete that chemical compounds are decomposed by it and steel needles magnetized.

CAUSE AND EFFECT OF LIGHTNING DISCHARGES.

Vagaries of lightning are so many that it is impossible to foretell, with any degree of accuracy, what it will do next. This is due to the enormous voltage which is developed, which is doubtless up in the millions of volts, far beyond any electrical pressure that man has thus far been able to control. Nevertheless, it is a form of static electricity the origin of which is well known to science, and theories concerning its cause and effect have been worked out which will account in a general way for its actions.

All things in a natural state contain equal portions of electricity. The natural state of a body may become disturbed, however, by friction or chemical action, so that the electricity is separated into two divisions called positive and negative.

One kind of electricity, positive, may be developed in a cloud by the friction of its passage through the air, causing an equal amount of the opposite, negative, form to be accumulated in the earth. This difference in potential between the cloud and the earth causes a stress in the medium between, the air, and finally the resistance is overcome and the air is punctured by the discharge which we know as lighting. The difference in potential is then for a time neutralized until another charge is collected. Fig. 1 is a theoretical sketch showing a positively charged cloud passing over a building the + signs indicating the positive charge in the cloud. If the cloud passes close enough to the building the pressure is relieved by the lightning stroke as shown in Fig. 2.

An object on the earth occupying a prominent position is naturally the delivery point of the earth's electricity and receiving point of the cloud's electricity. This object may be a building, barn, tower, or other elevation which is a slightly better conductor than common air. Buildings are said to be struck by lightning, whereas the buildings have only acted as an easier path than common air for the passage of this current of electricity. On account of the resistance the friction is often so great as to cause fire or disruption.

A cloud in its passage through the air is continually being electrified. As soon as one charge is dissipated another collects, sometimes in a very short interval of time. An idea of the frequency with which this occurs may be obtained from Fig. 3. This illustration was reproduced from a photograph, the time of exposure being about one minute and a half. It

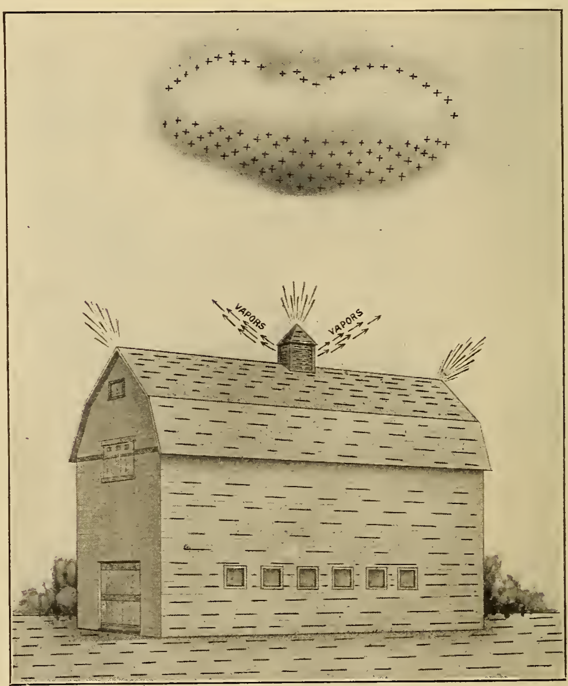


FIG. 1. THEORETICAL SKETCH SHOWING POSITIVELY CHARGED CLOUD OVER BUILDING.

will be noted that during this comparitively short space of time there were a large number of distinct flashes.

There are three classes of structures which are particularly susceptible to lightning strokes, namely, isolated farm buildings, churches and tall chimneys.

Farm buildings are susceptible because they stand alone and are generally the only high points in a locality of considerable extent. There is also another rea-

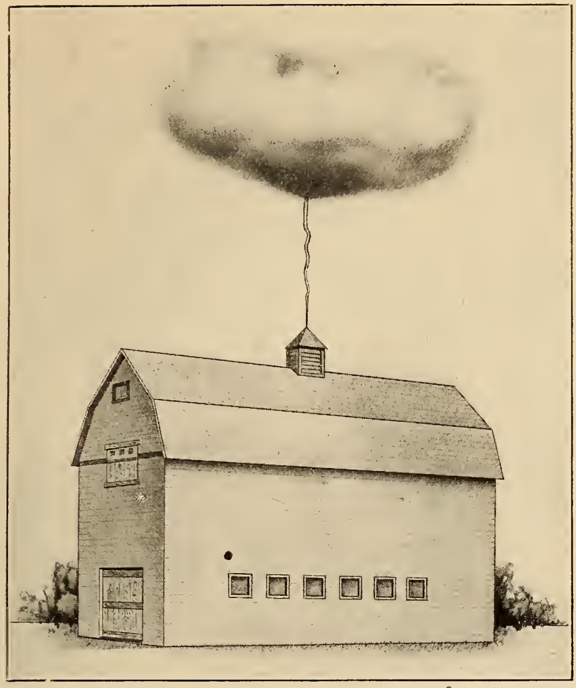


FIG. 2. DISCHARGE FROM CLOUD.

son. Barns for instance usually contain live stock, and at the season of the year when lightning is prevalent there is very likely to be a large amount of fresh hay in the mows. The vapors which arise from the animals and the hay have been found to conduct the discharge more readily than the structure itself. Fig. 4, although from a theoretical drawing, shows the effects of a lightning stroke under these conditions. The chances are all against the farm owner under conditions as illustrated. A barn stocked with new hay or grain sends off a vapor that in freezing weather appears like steam from a locomotive. These vapors, the wet roof and all the influences condensed within the space of the barn serve to make the building a point of contact for the earth and cloud electricity.

In churches the point of susceptibility of course lies principally in the spire. Fig. 5 is an interesting view showing the complete destruction of a church roof, the point of attack being the corner spire. Similarly with tall chimneys the height increases the danger, although another factor enters in this connection, which is the warm air and gases which rise from the

FIG. 3. FROM PHOTOGRAPH OF LIGHTNING DISCHARGES. TIME OF EXPOSURE, 1½ MINUTES

top. Fig. 7 represents a 310-foot chimney which was struck by lightning. The arrow points indicate the length of damage, about 110 feet. As is general with chimney damage the effect shows usually from the top to about half of the length, and from there on no perceptible effect is shown. The occa-

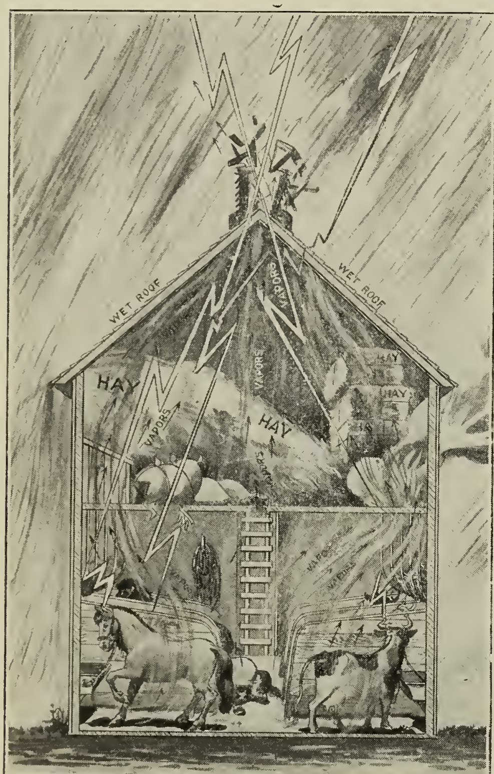


FIG. 4. THEORETICAL SKETCH OF LIGHTNING STROKE.

sion for this is, that during the storm the chimney becomes rain soaked and towards the bottom moisture is more dense and able to carry the discharge, acting as a natural conductor for the electricity. Hot air emitted from top of chimney serves in directing the discharge. In the picture the chimney is shown in the process of repair and the comparative size of the man in the sling gives a good idea of its great height.

Whether or not lightning rods or conductors are a protection against lightning is a question that has been much disputed, but the preponderance of opinion appears to be in their favor. It is true,

FIG. 5. DESTRUCTION OF CHURCH BY LIGHTNING.

as stated in the beginning, that the vagaries of lightning are not to be accounted for and it is entirely possible that a building protected by rods may be damaged. But in the majority of cases they are a protection. Thomas A. Edi-

FIG. 6. PROTECTION OF POWDER DRY HOUSE.

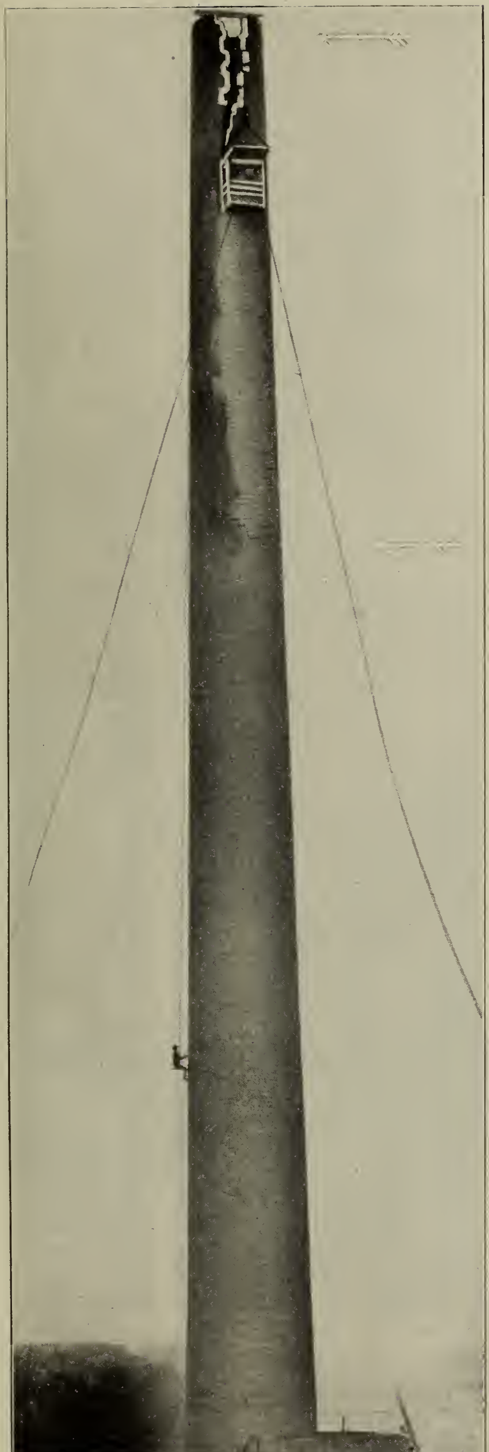


FIG. 7. 310 FOOT CHIMNEY DAMAGED BY LIGHTNING.

son is quoted as saying: "There is no doubt whatever that lightning conductors are a source of great protection when buildings are properly equipped with them. In doing this it is necessary to have metal of good conductivity, and a perfect connection with the earth at the bottom of the rod."

The lightning rod not only acts as a conductor to carry to the earth the heavy discharges which are visible to the eye but it also acts to dissipate the charge slowly and continuously—a form of discharge which is not visible but which may be heard as a hissing sound if the observer is near the rod when a thunder storm is in dangerous proximity. This form of discharge is what is sometimes called a brush discharge and seen at night appears as a sort of a halo of light around the discharging object.

Most lightning rods terminate in a high point but they may also be used effectively in the form of a grounded conductor encircling the object to be protected as shown in Fig. 6. This is a view of one of the smokeless powder dry houses of the United States Government. These buildings contain smokeless powder in the drying process, and a large amount of ether vapor, which is heavy in air, surrounds the buildings. The buildings are usually metal covered, which metal work is grounded and acts under what is known as the prime system. Outside of the envelope of ether vapor are set tall poles with cables running from one to another and a grounding at each pole. This serves in protecting the envelope of ether vapor. The same form of equipment could be used to advantage in the protection of oil tanks.

ELECTRICITY COOKS FOR THE KING.

Electricity in the household is creating a sort of domestic revolution in England and other European countries just now. In the newest hotels in London, old-fashioned cooking ranges have been completely done away with. Even in King Edward's household—a conservative institution—electricity has been introduced into the kitchen, while his new yacht and the royal train have been equipped with electric cooking and heating arrangements.

WIRELESS TELEGRAPHY MADE SIMPLE.

BY V. H. LAUGHTER.

PART V.

GENERAL REVIEW AND RESULTS.

In this series of articles the writer has treated of the construction and operation of wireless telegraph sets from the more simple kind to the standard forms in use by the Navy and all leading wireless concerns. It will no doubt be of interest to the reader to follow out the changes that have been made and are now being made to get better and more satisfactory results.

The dawn of wireless telegraphy came on the date of Marconi's original experiments when he found that by addition of an aeiral and ground wire signals could be sent to a distance almost unbelievable at that time. It was then realized that the range of communication was unlimited, depending only on the height of the aerial and the current strength of the sending end. Other well known scientists have contributed to the devolpment of wireless telegraphy, but to Marconi, as before stated, is given the credit for eliminating a number of weak points and applying it to practical use.

Hertz, a well known German investigator, discovered in 1888 that the discharge of a leyden jar would set up a wave motion in the surrounding space, and this wave motion could be detected by use of a "feeler" which was a loop of wire terminating in a small spark gap. When the loop was brought within the wave range a tiny spark would break across the gap, proving to Hertz that such waves were sent out and could be detected. Whether or not Hertz would have followed up his experiments with a perfected system of wireless telegraphy is not known, for he died just after giving the world the benefit of his long years of research. Such waves take on the name of their discoverer, "Hertzian Waves," and are the basic principle of wireless telegraphy at the present time.

Branly discovered that a loose mass of metal filings would cling together or "cohere" under the action of ether waves, which brought out the common metal filing coherer as described in the first of this series. The introduction of the coherer opened up to the scientist of that day the possibilities of such signalling, from which wireless telegraphy has gradually developed up to the present.

Since the introduction of wireless telegraphy in 1898 steps have been constantly turned to the perfection of selective signalling sets, as it was at once realized that no successful application could be made of wireless telegraphy unless two stations, say A and B, could be made to work with one another without interference from station C. The sending end used by Marconi was deficient for such purposes, for reasons set forth in Part II.

To repeat the analogy as in Part II, we strike a tuning fork and hold near it a second fork of the same size. The vibration of the tuning fork sets up sound waves in the air which sets up a like vibration in the second fork provided the two are of the same size, the vibration gradually dying away to zero. If the vibration of the first fork could be maintained at a constant rate the second one would take up the vibration much better, as the decreasing properties of the wave would not come in consideration.

When the key is pressed at the sending end of a wireless station the vibrator or "current breaker" starts in action and at each swing a periodic wave is sent out which takes on the theoretical plan as shown in Fig. 29. This wave constantly decreases from the maximum to the minimum as did the tuning fork. We learn from the tuning fork that a decreasing wave, or one that quickly dies down, is not capable of producing as good results on a receiving body as a wave or more continuous character. The same conditions apply to the Hertzian waves in ether as to sound waves in air. Hence we have the numerous plans for making a wave more continuous, or better known as a sustained oscillation. These sustained oscillations also allow of more accurate tuning, and are produced by using a closed circuit set as described fully in Part II. The closed circuit set comprises leyden jars and a tuning helix connected across the secondary of the transformer. When the set is in action the leyden jars will alternately charge and discharge several hundred times a second, depending on the speed of the vibrator in the primary circuit, the tuning helix etc. The wave in this way is sustained to a greater length than the wave of the open circuit set.

Valdemar Poulsen, the Danish inventor has recently perfected a system of wireless telegraphy that is remarkable in a number of ways as it employs an arrangement that gives a continuous wave and is being used for daily communication up to 300 miles, although it is claimed that a distance of 1,560 miles has been covered. It has been long realized that with the perfection of a constant wave generator wireless telephony would also be made practicable as it would only remain to impress on this wave the modulations of the human voice which would be picked up at the receiving end in the form of talk. DeForest is now utilizing a plan of this kind in his wireless telephone system which was described in the July issue of this magazine.

The Poulsen generator which was first discovered by Dudell consists of an arc lamp burnt on a direct current circuit in the flame of an alcohol lamp, with high tension coil bridged directly across the arc through a set of leyden jar condensors. The complete arrangement of sending and receiving end is shown in Fig. 30. The arc burning in the flame of the alcohol lamp sets up a series of high frequency alternations which surge through the condensor and the primary of the high frequency coil. The theory advanced on this action by Dr. DeForest is that the shunt circuit around the arc draws a certain amount of current to charge the condensors, thus drawing current away from the arc increasing the resistance across the electrodes and thereby charging the condensors to their highest capacity. The condensors now discharge across the arc, lowering the resistance across the electrodes causing an increase in the current flowing to it. The reversals of current, charging and discharging, occur several thousand times per second in some cases as high as 100,000 per second. This rapid flow of current through the high tension coil sets up a like action in the secondary which has the aerial and ground wire connected to it. The number of alternations per second is governed by the kinds of electrodes used for the arc. It has been found that one electrode of carbon for the positive and one of copper for the negative give the best results, or better than two of carbon. The arc in some cases is burnt under the influence of a magnetic field which to a certain extent stresses the arc and increases the number of alternations. In Poulsen's long distance experiments several arcs are burnt in series on a high voltage circuit, this plan, however, is not necessary for ordinary use.

In connection with his wireless telephone system Dr. DeForest employs a device known as a "chopper," which is interposed in the aerial wire. The "chopper" very much resembles the ordinary

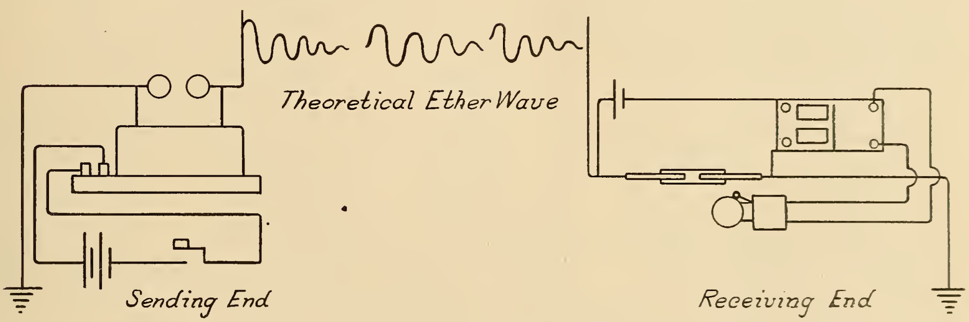


FIG. 29. THEORETICAL WIRELESS WAVE.

buzzer and is operated by a separate battery and Morse key. On pressing the Morse key the "chopper" will start in operation chopping up the wave in the form of periods the same as emitted from the ordinary wireless telegraph set; allowing the wireless telephone to be used equally as well for telegraphy.

In the kinds of communications we have reached the limit; the telegraph, telephone, the wireless telephone and the wireless telegraph, and changes can only be made in the developing of these types.

Possibilities of wireless communication can be at once realized when we take in consideration the amounts expended for the maintenance of the telephone and telegraph lines. While the writer does not think that wireless will ever replace the ordinary wired circuits in cities, etc., yet for long distance work it is far superior and more desirable owing to the low cost. That wireless telephony is better than wire telephony was proven by Prof. Fessenden in his experiments from Brant Rock, Mass., to Brooklyn, N. Y. The conversation was held simultaneously over the wireless and wire line and the wireless telephone was found to be much more distinct, and the fine inflections of the voice were brought out more clearly. Prof. Fessenden believes this is due to the electrostatic capacity of telephone lines, which tends to destroy speech. Instead of employing the arc lamp generator Fessenden has a special generator of his own design which is given the name of the "wave mill." The transmitter connection is the same as used with the DeForest set.

From the results that are being daily accomplished we can see that wireless telegraphy is still in its infancy, and greater things are yet to come.

(THE END.)

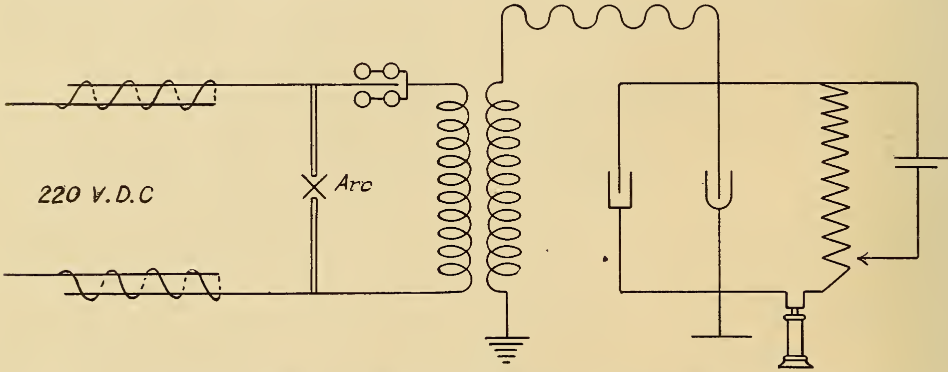


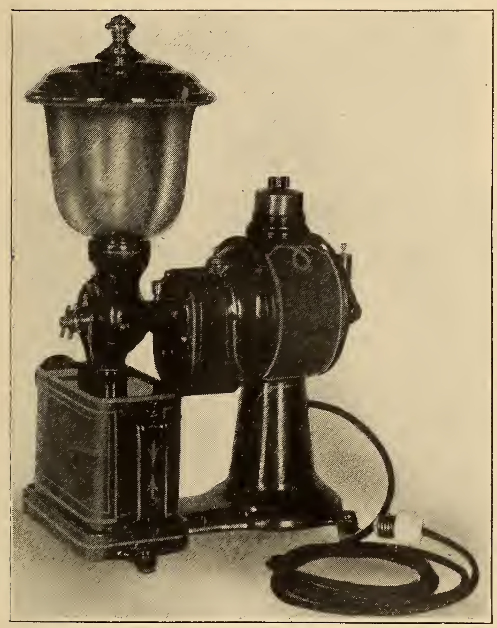
FIG. 30. COMPLETE SENDING AND RECEIVING STATIONS WITH DUDELL ARC.

A LITTLE STRATAGEM.

In a large laundry works in London recently the attempt to introduce electric ironing met with strenuous resistance on the part of nearly all the laundresses. They were prejudiced against the "newfangled irons, with bits of string tied to 'em," and almost went on strike when the manager tried to make them give up the old methods. However, being an astute judge of human nature, he quietly fitted up a room with nothing but electric irons in it. Several of the more courageous and enterprising women were sent in to work on what is called "piece work" plan, being paid so much per piece, provided they worked solely with electric irons. The main advantage of the irons is that they remain hot all the time, and as there is no changing from warm irons to hot ones, the women were therefore able to do twice as much ironing as was done in a given time by old methods. Consequently, being paid by the piece, they made twice as much money. When the women had had a week at piece work with the "electric" the manager put them back at the ordinary irons, and they almost went on strike once more, this time clamoring to be allowed to work by the new method. And the electric iron—and the manager—triumphed.

ELECTRIC COFFEE MILL.

In groceries, boarding houses, hotels, etc., a small coffee mill, operated by power, is a great saving over hand labor. Before electricity came into common use a small mill could not be economically operated by power. The electric motor, however, solved the problem and electric coffee mills are now on the market, among them being the one shown in the illustration.



ELECTRIC COFFEE MILL.

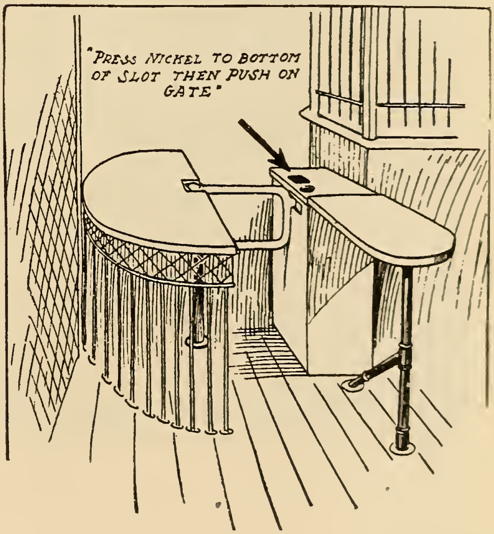
In the Diehl mill the grinder case, gear case and back cover of the motor are combined in one unit. The hopper is of spun brass and provided with a spun cover, and both are heavily plated with nickel highly polished. The motor base is extended to hold the receiver, making the whole combination entirely self contained. The mill may be readily adjusted to give any degree of fineness, from granulated to pulverized, by means of the thumb screw that regulates the distance between the grinders.

The motor is provided with a switch for starting and stopping and has 10 feet of flexible cable attached, and when the mill is to be put in service all that is necessary is to connect the plug to a convenient light socket and turn the switch.

Capacity of the mill is about one pound in two minutes and the current consumption is less than that required for three 16-candlepower incandescent lamps.

NICKEL-IN-SLOT DEVICE FOR STREET CARS.

The Boston Elevated Railway is experimenting with an automatic nickel operated turnstile for use in subway and elevated stations. The device has been installed at the Scollay Square subway station. As described in the Electric Traction Weekly it consists of a box about three feet high and one foot square attached to the turnstile. The upper end of the box is covered with a brass plate. In this is a slight depression, in the bottom of which is a slot just large enough to receive a nickel. Near the slot are the following directions: "Press nickel to bottom of slot. Then push on gate."



The arm of the turnstile is prevented from turning at will by a knob on the end of a horizontal lever, which is just visible at the edge of the box. When the coin is inserted and pressed downward this knob is released and swings away, returning to its position as soon as the person has passed through the gate and another quadrant of the gate has swung into place.

It is possible this device offers a suggestion for adapting some form of turnstile to pay-as-you-enter surface cars.

DENVER, THE CITY OF LIGHTS.

Some years ago, someone in Denver, Colorado, suggested that the city be named "The City of Lights." The citizens unanimously indorsed the sentiment and straightway prepared to "make good" on the declaration.

The Denver Gas and Electric Company established a newspaper bureau to help in the cause. It had its own motive perhaps in boosting the name, but then, while boosting for itself, the work was necessarily of much good to the general public. It, the company, sent out newspaper stories broadcast describing the virtues of the Colorado climate and extolling life in Denver. The general public read and believed and when the time for the National Democratic convention rolled around they came, at least more of them than had ever before been in Denver at a convention, and were convinced that the "City of Lights" was no myth.

Prominent among the visitors were the newspaper men, not the least important of whom was Col. B. M. Harvey, editor of Harper's Weekly. The Colonel was so impressed with conditions in Denver and particularly the lights that he went back home to old New York and wrote a poem all about it.

> "The streets were sparkling every night,
> Red, white and blue with light—
> They spent a mint of money
> Just to make things gay and bright."

The New York delegation was particularly fond of Seventeenth street and upon leaving they sang "Good-bye Dear Old Broadway" and explained it by saying that so far as light was concerned they had no choice between the two.

THE CITY OF LIGHTS.
One of the cross streets showing the display of one of the large dry goods companies on the front of its building.

And those visitors who happened along from Chicago compared it to State street on Saturday night.

From the Brown Palace Hotel on Seventeenth Street to the depot is 12 blocks and these two points represented the extremes between the incoming visitors and headquarters. The Auditorium is beyond Fifteenth Street and so just to make a good job of it the decorations were extended the 12 blocks on Seventeenth, Sixteenth and Fifteenth and also on all of the connecting streets between the extremes mentioned above.

Red, white and blue lamps alternating were used on the stringers which on the main streets were placed at an average of three to the block and two to the block on cross streets. At intersections the stringers were crossed.

DENVER'S "WELCOME ARCH" AT NIGHT.
The lights shown are the regular equipment and are burned every night until the cars stop running. The arch is located at the foot of Seventeenth Street, immediately in front of the entrance to the Union depot.

WELCOME SIGN.
A near view of the sign erected by the Denver Gas and Electric Company on the roof of their building. It was 40 by 60 feet and weighed 5,000 pounds. The figure of Bryan which can be distinguished on the donkey with the head immediately beneath the halo was put on after he was declared the nominee of the convention.

Eighteen thousand 16 candlepower incandescent lamps were in nightly use during the convention week, in addition to the many thousands used for private displays and for the regular lighting of the city.

Among the private displays that of the Denver Gas and Electric was foremost in prominence. Two thousand 16 candlepower lamps were arranged on a hugh frame as a sign showing Miss Denver handing the key of the city to Democracy. The sign was placed on the roof of their building. It was built up of two inch gas pipe with an iron wire netting. The sign was 40 x 60 feet and weighed 5,000 pounds.—E. C. S.

THE CITY OF LIGHTS.
View on Sixteenth Street from Curtis Street, showing the Capitol dome in the distance, 18 blocks away.

A NOVELTY WINDOW DISPLAY.
Denver Gas and Electric Company's display, supposed to be typical of the gathering of the clans for the Democratic convention. The buildings were all small models of the structures in the bigger cities of the country. The largest in the foreground was supposed to represent the Denver Auditorium where the sessions of the convention were held.

ELECTRIC AIR FILTERS.

Electric air filtration is the idea of an English engineer, and is based on the discovery that a body positively electrified by 100 volts or more will become covered with soot in a single day in a smoky atmosphere, while a negatively charged body remains clean. Inserting a sheet of wire gauze in the intake flue of a ventilating system and electrifying it by connecting to a 250-volt supply main, the gauze extracts a large quantity of soot from the air.

SPLICING LEAD-COVERED TELEPHONE CABLES.

Underground cables are usually left by the pulling-in gang without much reference to their final arrangement. It is the jointer's first duty to inspect the cable thoroughly from the edge of the duct to the sealed end, in order to find any injury done to the cable while being pulled in. Where there are several cables to be jointed in the same manhole care must be taken to join the proper ends together. Next put the protectors in the mouths of the ducts.

On large cables heat should be applied to the outside of the cable to aid in bending, so as to stow the cable around the manhole in a neat manner. This heat

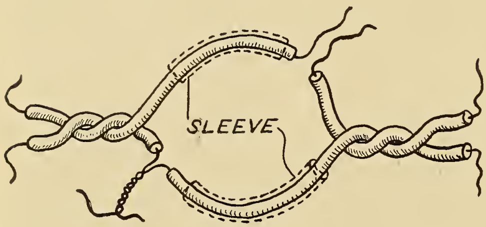


FIG. 1.

is applied to the cable to warm the insulation, as well as the lead sheath so that when the cable is bent the insulation will not break or crack.

In bending the cables the ends are brought into position for splicing and should always be in such a position that when the joint is finished it will be between hangers or whatever supports the

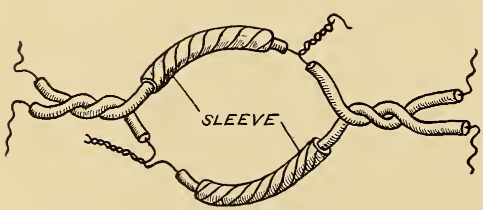


FIG. 2.

cable, so that no strain will be on the joint. After making a careful examination of the soldered end to see that moisture has not been admitted from the end, cut off the end with a hack-saw and dip the end into a pan of hot paraffine. Should there be any moisture in the end of the cable bubbles will rise. Should bubbles show in the paraffine, cut off a little more of the cable and again dip in the paraffine; should bubbles still appear and it is not possible to cut away any more of the cable, although the

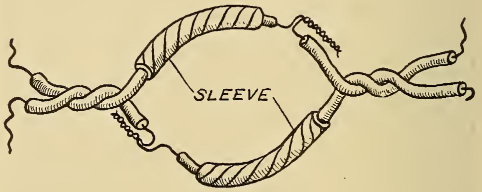


FIG. 3.

moisture is still present, heat must be applied to the outside of the cable.

There are several ways in which this may be done. When there is gas in the manhole use hot paraffine, place a pan under the cable and pour hot paraffine in the lead sheathing starting at the duct and working very slowly toward the open end of the cable. In doing this the moisture is driven out at the open end. Should there be no gas in the manhole a blow-torch may be used, but

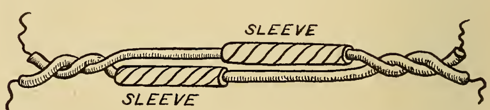


FIG. 4.

care must be taken not to burn holes in the sheathing. When the cable is covered with saturated fiber and a blow-torch is used a steel screen must be placed between the cable and the torch so that the fiber covering will not catch fire.

Never cut off both ends of cable until sure that there is no moisture in either end, as it often happens that the location of the splice is moved one way or other on account of moisture.

When satisfied that there is no moisture in the cable ends, allow them to lap eight to 20 inches according to size of cable. Then score the cable back far enough to allow for the splice. This scoring is first done around the cable and then two cuts are made lengthwise of the cable about three-fourths inch apart. Care must be taken not to cut through into the insulation with any of these cuts, except in one place, that being at the end of cable. Cut the lead through into the insulation at this point,

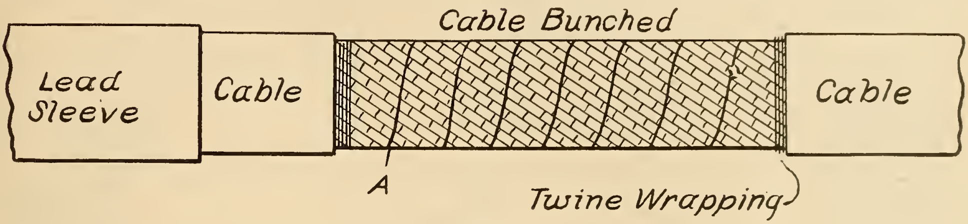


FIG. 5.

then, using a narrow tool, push under this narrow strip and pry upon it until a pair of pliers can be used to take hold of the narrow strip. Remove this narrow strip by lifting upon it until the circular score is reached. Then bend this narrow strip back on the cable and pound it down flat, next bend the strip back to its former position and it will break off. Then with both hands remove the balance of the sheathing by prying it

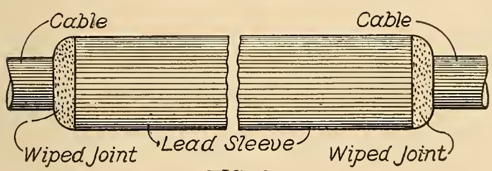


FIG. 6.

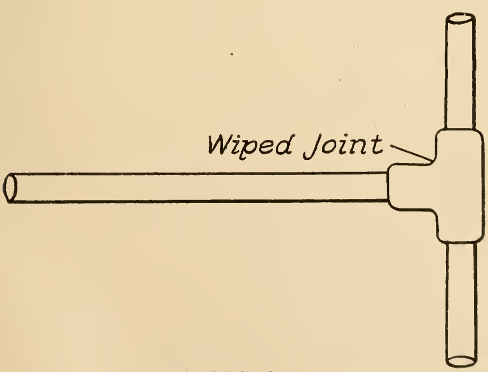


FIG. 8.

apart or open and bend it back and forth and it will break off. Now trim up the end of the lead with a wooden hammer so as not to have any sharp edges, and wrap the wires up close to the lead sheath with twine so as to hold them firm.

Prepare the lead sleeve as follows: Scrape the inside of the sleeve at both ends back about 1½ inches and also scrape the outside of the sleeve back about 2½ inches and smear with mutton tallow; this tallow is put on to stop the bright spots from tarnishing by contact with the air and hands. Now slip the lead

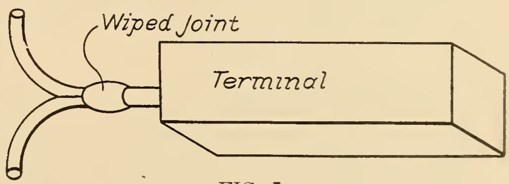


FIG. 7.

sleeve over one cable and push it out of the way. Have hot paraffine ready and pour over the cable (as soon as you remove the sheathing), this is to stop the paper from untwisting, and also to stop any moisture going into the cable. Next open out the cable by bending the wires

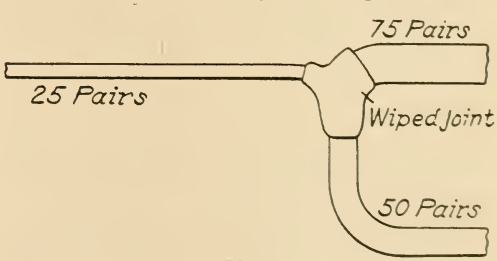


FIG. 9.

back, layer by layer, until the center is reached (it being understood that this is being done at both ends of the cable where the splice is being made). Choose the center part from one end and its mate from the other end and bring them together as shown in Fig. 1. Now slip on the paper sleeve as shown by dotted lines Fig. 1. Next twist the ends together as shown in Fig. 2. Then lay them back as shown in Fig. 3. Draw the paper sleeve over the bare joint as shown in Fig. 4 and close them together as shown. When the joints are made in this way there is no danger of the paper sleeve wasting away from the splice, as one sleeve will hold the other in position.

Treat all the other conductors in this way and break joints as much as possible, being careful not to cross any pairs and splice red to red and blue to blue.

The "mate" of a pair is any pair in that same layer. The object of breaking joints is that is that when all the splicing is done the joint may be drawn up as small as possible.

When all the joints have been made, "bunch" them together and boil them out with hot paraffine, have at hand narrow strips of manganese tin about two inches wide and wrap as shown in Fig. 5 at (A), and boil out the joint with hot paraffine. Now wrap a full layer of tape over the joint and boil out, being careful to pull the tape tight. There should be three such layers put on and boil out each layer as you put it on. Fig. 5 shows how the cable should look after all the joints have been made and with the joint pulled in.

After the joint has been made as above, slide the lead into position as shown in Fig. 6, the ends being beat down to fit on the lead sheathing, a plumbers joint being wiped at each end as shown. This wiped joint must never be made by an inexperienced person, for it must be put on hot and carefully wiped so that moisture cannot enter. When the joint is properly put on and after it has cooled off, bright spots will be seen in the wiped joint. A good wiping solder is made from 60 per cent lead and 40 per cent tin.

Fig. 7 shows how cables are brought into terminals, while Figs. 8 and 9 are branch joints. Fig. 8 shows how a cable may be "split" while Fig. 9 shows a method of looping into a terminal, often used, as it affords a method of testing all the conductors in the cable when necessary.

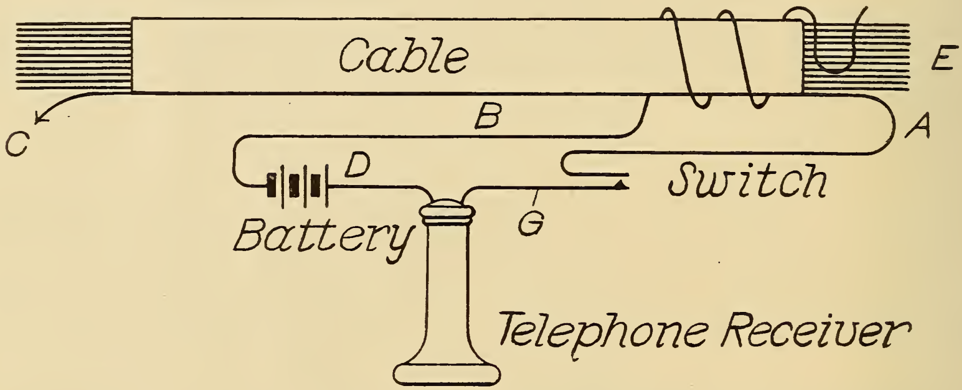


FIG. 10.

Fig. 10 shows a method of cable testing with a telephone receiver. (A) and (C) are both ends of the wire under test (B) and (D) are wires connected to the battery. In arranging the cable ends for the test, at the (E) end of cable remove the insulation from all the wires. Wire (B) is wound around the lead sheathing. At the (C) end of the cable the wires are carefully parted from one another and from the lead sheathing. After making the connections as shown in Fig. 10 the test is made by making rapid taps with the wire (A) on the contact (G). The first tap will produce in the receiver a distant click. If the cable is very long a second faint click may possibly be detected, but if the wire under test is well insulated no more sound will be heard in the receiver after taping. But if the wire under test is crossed with any other wire in the cable or with the sheathing every tap will be followed by a clear clicking sound and if there is moisture in the insulation which makes a partial connection clicking sounds will occur;

the loudness of this clicking will depend upon the amount of moisture in the cable. In turn test all the wires in the cable and if any trouble is found it is best to carefully inspect the exposed ends to be sure that they are cleared from one another and from the sheathing. The above may be called a moisture test and affords a method of testing a cable on the reel.

Fig. 11 shows a method of testing for broken wires. Make the connection as shown by removing all the insulations from the (I) end of the cable and wrap a wire around them all as shown by wire (H) and connect the other end of (H) to the battery, from the other side of the battery run wire (K) to one side of bell or buzzer and to the other side of the bell connect wire (M). At the (J) end of the cable the wires are carefully separated from one another and from the sheath. To make the test touch in turn each wire at the (J) end of the cable. Should one or any of them not ring the wire is broken.

The splicing of aerial cables is the same as the above method, only a platform must be erected at the splice and a blanket spread over the joint to keep out the wind and moisture.

Sub-aqueous cables are spliced in the same manner, the difference being that the armor wires are to be looped on after the splice is made. In arranging the cable for the splice, bend the armor wires back on the cable and tie them in this position until the joint is completed. Then after laying a wrapping of jute over the joint lay the wires down on the jute over and around the joint in such a way that when the armor wires forming the other end are brought down the wires will interlace like the interlocked fingers of the hands. Then with a spool of steel wire bind those wires down by laying close layers of wire around the joint so as to bind them together the entire length of the cable splice. Then wash off the joints with acid and solder these joints or wrappings, being careful to get all around the joint with the soldering. This is best done by aid of wiping cloths.

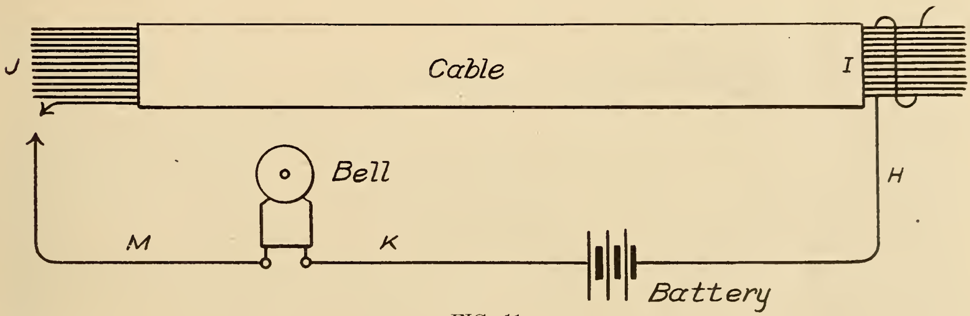


FIG. 11.

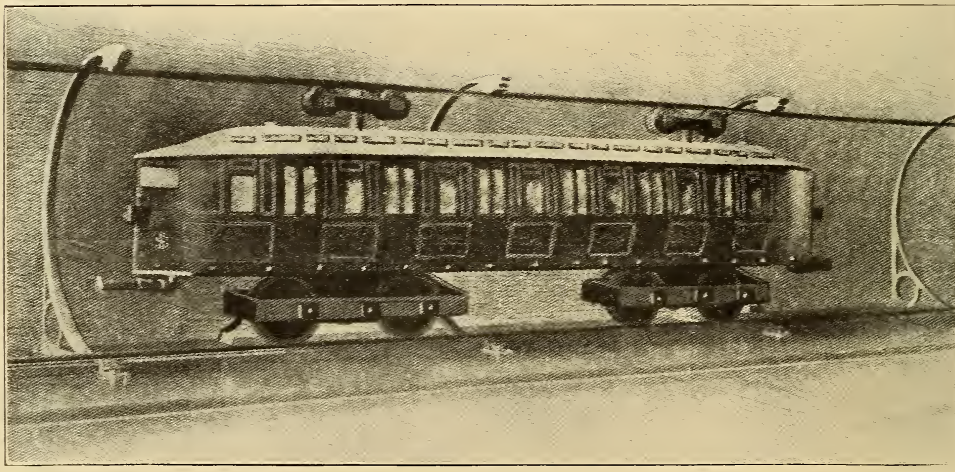
Heating of paraffine deserves a few words. In heating paraffine care must be taken not to heat it too much, as it will ignite. When handling paraffine that is heated, always remove the cover on the ground before sending it into a manhole, for should too hot paraffine be poured on a cable that has moisture in it it will fly all around and may burn the workman. The best way to test the heat of paraffine is by rolling a piece of newspaper and pushing it into the paraffine. If the paper chars as soon as it is pushed into the paraffine it is hot enough. Should it be put into a cable any hotter it would burn the cable.

OHIO LEADS IN INTERURBAN ROADS.

Ohio leads the country in the mileage of interurban roads with 2,300 miles, and then Indiana, Michigan and Illinois. There are 36,000 miles of electric railways in the United States, 10,000 miles of which are interurban, as against 1,000 miles in Canada. The word interurban, in description of independent electric lines connecting villages or cities, came into use about ten or twelve years ago. Before then city lines extended to nearby towns and were called suburban roads.

THE KEARNEY HIGH-SPEED MONORAIL CAR.

A demonstration was given on June 15 in London by means of an electrically driven model, of Mr. E. W. C. Kearney's proposed monorail system of working railways by means of high-speed trains or cars. This system is the result of some six years' experiment following upon an exhaustive research into the system. Two motors are fitted—one to drive each set of wheels. Each set of guide and track wheels is carried by a rectangular frame, so that the vertical distance between the centers of these wheels is rigidly maintained. Thus the frame carrying the guide-wheels at the top and track wheels at the bottom fits in the rails and cannot fall out sideways, being retained in position by the flanges



MODEL OF KEARNEY HIGH-SPEED MONORAIL CAR.

numerous railway systems which have been introduced for the purpose of reducing the cost or increasing the speed, as compared with the ordinary twin-rail road.

There are two rails, between which the cars run. The bottom one is the running rail and supports the car. The top rail is merely a guide. According to the inventor, it is only on curves that any appreciable stress is put upon the top rail, and the safety and economy of the system depend on the correct design of the guide-wheels. Presumably, any convenient kind of motive power might be used. If the cars are propelled by electricity generated at a central power station, the rails are insulated. Current is then collected from the top rail and flows through the motors to the bottom rail by which it returns to the power station.

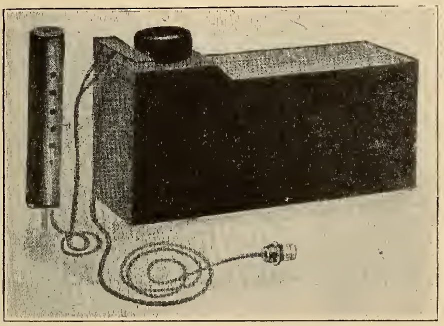
The model used at the demonstration is shown in the accompanying illustration. It is constructed entirely for the purpose of showing the working of the of the wheels. The frame carrying the guide-wheels and that carrying the track wheels are each made to swivel, so that the wheels can follow curves in the track. The armature of the motor is vertical, and drives a bevel pinion by a squared socket fitting so that the end-thrust does not come upon the pinion. The field-magnet is bolted to the car body, which is free to rise and fall independently of the frame, and is supported by a coil spring concentric with the pivot upon which the wheel truck swivels. By this construction the car is carried by two frames, each provided with top and bottom wheels fitting between the rails, and is free to move vertically by the action of the suspension springs.

A spring shoe collector is fitted to each of the top trucks. They are insulated from the framework and rub against the top rail. They are connected electrically, so that each conveys current to both motors.—*Model Engineer and Electrician.*

AN ELECTRIC CIGAR MOISTENER.

One of the latest electrical products is the Hygro Electric Moistener, invented by W. P. Cook, and used for moistening the air in cigar cases. It consists of an incandescent lamp submerged in water in a small enameled zinc tank. The heat of the lamp raises the temperature of the water a trifle above the surrounding air. It is not hot enough to make steam, or to make any noticeable increase in the temperature of the cigar case, but causes rapid evaporation when the lamp is burning.

The moisture thus thrown off, being of a higher temperature than the surrounding air, circulates perfectly to all corners of the case, and the same degree of moisture will be found in every cubic inch of contents of an entire cigar case, no matter what its size. To regulate the moisture thus provided, a hygrostat is connected in series with the lamp. This hygrostat is composed of a hygrometer in the shape of a vane, which bends in one direction in response to moisture, and in the other direction as the moisture falls. This is connected directly into the circuit of the lamp, and is adjusted to a relative humidity of 70 per cent. As soon as the lamp has generated sufficient moisture to raise the humidity of the case to 70 per cent, the hygrometer turns the lamp off, and the evaporation ceases. The moment the moisture falls below 70 per cent the hygrometer turns the lamp on, and more moisture is evaporated into the atmosphere, until 70 per cent is reached again.



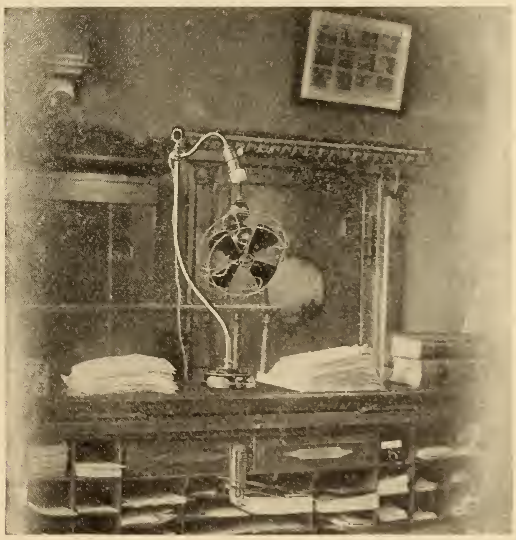
ELECTRIC CIGAR MOISTENER.

In operation, the lamp in the moistener is turned on and off many times during the day, and accurate records kept in a 20-foot case in Milwaukee have shown it to burn all told about one hour in twenty-four. This has proven sufficient to keep the moisture at 70 per cent, and not allow a variation to exceed five per cent either way.

The result, in the condition of cigars, has been very pleasing to practical cigar men, as the flavor is thus retained absolutely, no matter how long cigars remain in the case. It eliminates all broken wrappers, and requires no attention whatever, except to pour water into the tank about once a week.

AN INDIVIDUAL DESK FAN.

An ever-present breeze just where it is needed makes work seem easier during the hot summer months. A novel way of mounting an electric fan over the office desk is shown in the accompanying cut. The fan, a comparatively small one, is designed to be suspended by a cord and plug to the regular desk lamp fixture, the light being seldom used during the long days in summer. The fan, therefore, when it is in position, swings just above the worker's head and sends a cooling breeze just where it is needed, being so directed as not to disturb papers on the desk.

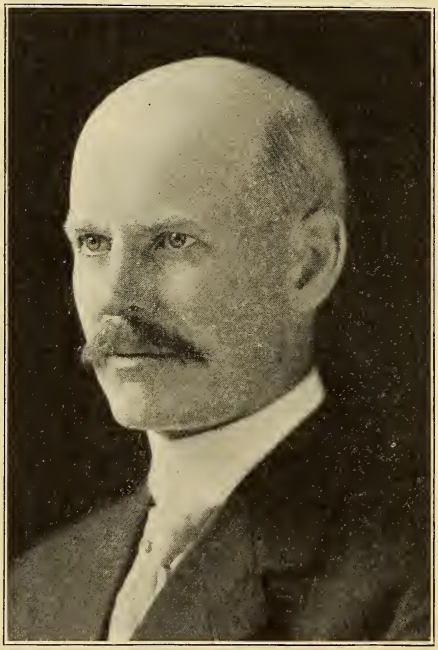


AN INDIVIDUAL DESK FAN.

ELECTRICAL MEN OF THE TIMES.

EDWARD GOODRICH ACHESON.

No longer ago than 1894 very little was known of the possibilities of the electric furnace. At that time, when the first power plant was in course of construction at Niagara Falls, there came to this great resort a casual visitor whose eyes were open, however, to far more than that which is seen by the ordinary observer. What he saw on that visit gave him an idea which later resulted in the development of an entirely new industry. This man was Edward Goodrich Acheson, inventor of the process of making an artificial abrasive—carborundum—by means of an electric furnace and of another process, very similar, strange as it may seem, for making an exactly opposite substance used for lubricating purposes, namely, artificial graphite. Elsewhere in this issue will be found a more detailed description of his work under the title "Niagara's Electric Furnaces."



Edward G. Acheson was born in Washington, Pa., March 9, 1856, and was educated at Bellefonte (Pa.) Academy. He was taken from school in 1872 to work about his father's blast furnace until his father died. He then engaged in various occupations, finally becoming attached to a surveying party. His chief interest, however, was in electricity and chemistry. His first practical experience with electricity was about 1873, when, after buying a number of cheap yellow-metal watch cases, he fitted up a galvanic battery, and, using his mother's silver forks as anodes, silver plated the watch cases, selling them at an advanced price. There was the start.

Up to the fall of 1880 Mr. Acheson filled various positions in western Pennsylvania, but his desire to become interested in the electrical industry, then quite young, would not down. With $100 in his pocket he started for New York. A few days found him at Edison's laboratory at Menlo Park, N. J. He was given a position, and the 12th day of September, 1880, when he was in his 25th year, he entered Edison's employ.

Edison, himself, was then only 33 years old. In time a closer personal acquaintance developed between Mr. Edison and Mr. Acheson, and the latter found himself in the original experimental department, where he had full opportunity to develop and use his inventive faculties. He was moved from the experimental department to the lamp department because he was "a thinker," Mr. Edison feeling he would do better work there. He learned the lamp business in all its details. In July, 1881, he went to Europe as assistant in connection with the Edison exhibit at the Paris Exposition.

After he left Mr. Edison's employ he became superintendent of the lamp department of another company. He made still another business change, and then, continuing his progress, he organized the Monongahela Electric Light Company.

In 1894 Mr. Acheson formed the Carborundum Company and a little later the International Acheson Graphite Company. He is one of the recognized leaders in the electrochemical industry and is now president of the American Electrochemical Society and vice-president of the Chemical Society.

SPONGE FISHING BY SUBMARINE BOAT.

Along the banks surrounding the Kerkenah on the coast of Tunis are extensive sponge fisheries. Most of the sponge fishing has been done until recently by naked natives who descend to great depths by means of a stone which they leave at the bottom when bringing up the sponges. This is very dangerous to the health and extremely hard work and recently divers have used modern equipment for this work. The very latest development in the art, however, is the submarine boat which is provided with electric searchlights for illuminating the bottom of the sea.

SPONGE FISHING BY SUBMARINE BOAT.

The submarine sponge fishing boat shown in the accompanying illustration has a buoyancy of 600 kilograms and is capable of carrying two men in sponge fishing service, the above buoyancy with the water tanks empty causes the boat to remain on the surface and rise from the bottom of the sea when desired. By opening the proper valves the ballast tanks are filled with water and the submarine vessel sinks, the manhole at the top, surmounted by a turret, having first been closed by a cover and hermetically sealed. When it becomes necessary to rise to the surface compressed air is admitted to the ballast tanks.

A movable arm is provided at one end of the boat for use in sponge fishing. This arm is worked through a watertight ball and socket joint on the curved bow, projecting from the lower part and having at the end of the arm claws or pinchers for cutting the sponges or detaching them and placing them in a basket or iron framework.

There are four electric lamps provided each of 10 candlepower on the interior of the boat, and other electric lamps are attached to a fixed arm, with a reflector so arranged that the sea bottom is lighted brilliantly and the work of gathering the sponges may be noted through a glass window on the bow of the vessel. A number of storage battery cells are used for supplying current to the electric plant and telephones are provided on the sub-marine boat, so that conversation may be carried on with a floating boat which carries the sponges which are gathered by the sub-marine vessel.

Vice-President Wilgus of the New York Central railroad gave the results of his investigation of the comparative cost of electric power and steam for the suburban service of that line in an address before the American Society of Civil Engineers, stating that the daily cost of running a steam locomotive, including interest, depreciation and repairs, was $13; the cost of the same service by electric motor was $10.50. Although the

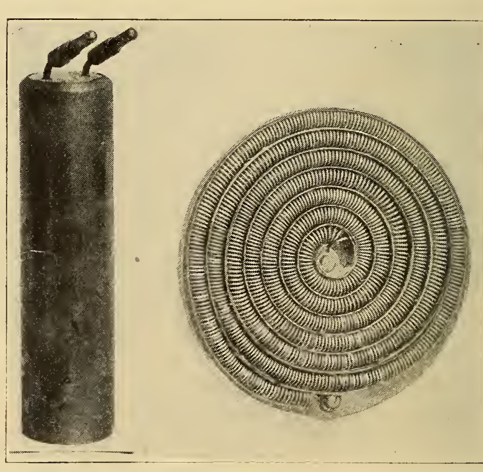
ELECTRICITY IN THE HOUSEHOLD

EQUIPMENT OF AN ELECTRIC KITCHEN.

SINCE times remote, when our aboriginal ancestors first secured the blessing of fire by rubbing together two sticks, the idea has been bred into the human race that fire is a domestic necessity for heating and cooking. It was, indeed, a necessity until a few years ago, when the discovery was made that fireless, smokeless heating and cooking by electric current was practicable. It is not to be wondered at, therefore, that many people are not as yet familiar with the wonderful possibilities of electricity as an adjunct to household economy, or that those who are aware, in a general way, of its applications are prone to think that the old way, which has been handed down from ages past is still good enough. It is the object of this article to describe and illustrate the principal electrical household utensils now in use more especially the cooking utensils, so that those who have not already become acquainted, by actual experience, with the advantages and economy of electricity may gain a fair idea of the great progress which has been made in the development of these devices, even in the short time that they have been before the public.

To begin with, What are the particular advantages of electrical household utensils? Why should the housewife be interested in adopting them in place of the old and tried methods that have been in vogue for years? These questions may easily be answered by words but much more easily and satisfactorily by actual trial, for no one who has adopted the twentieth century electrical way of doing things will revert to the old methods.

In the first place, wherever fire is employed in the house for culinary purposes danger is present, no matter if the fuel be gasoline, gas or coal. Conflagrations have resulted and always will result through carelessness or accident. With electricity there is absolutely no danger for there is no flame. Again, where a flame is used there is a waste of heat which escapes to the surrounding atmosphere and renders the kitchen almost intolerable on a hot summer day. With electric utensils the heat is generated at the point of application and all the heat is utilized in the process for which it is intended. None escapes to the atmosphere of the room.



HEATING UNITS FOR ELECTRIC UTENSILS.

FRYING PAN.
WATER HEATER.
CHAFING DISH.

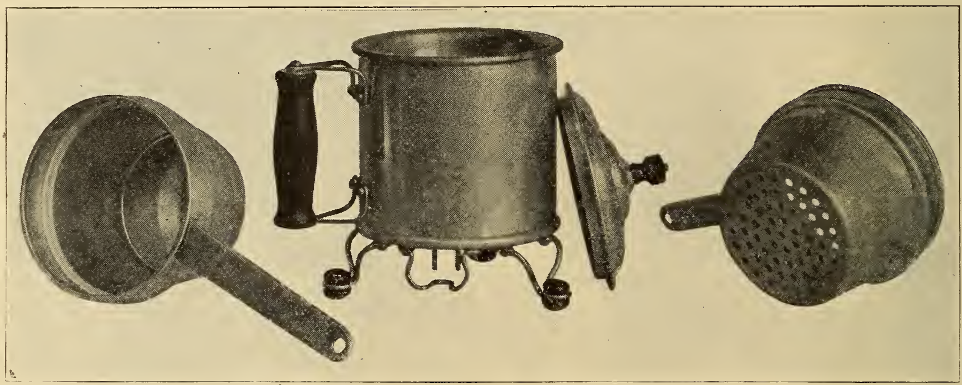
COFFE PERCOLATOR.
TEAKETTLE.

Added to the above advantages electric utensils are more convenient, and the temperature is not only brought up to the proper point in a few moments time, but it can be regulated to a nicety that is unobtainable by the use of fuel.

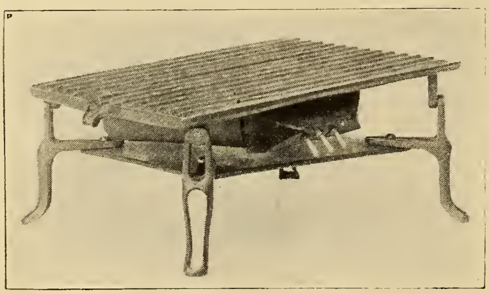
"But how do these devices operate?" "Do I have to be an expert on electricity to manipulate them?" "Must I always be looking out for a 'shock' when using these utensils?" These are some of the questions which may be asked by the uninitiated.

An electric cooking utensil is a simple

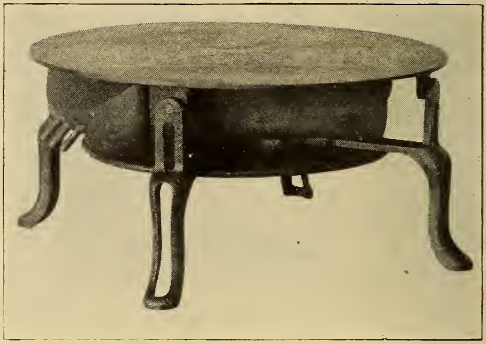
device and any one who can screw the ordinary electric light bulb into its socket is capable of operating any one of them—not a very severe test. In general, each device consists of two elementary parts, the body, which is similar to the devices in ordinary use, and the heating unit. The heating unit is simply a coil of wire through which the electric current passes, and which, by virtue of its resistance, is heated by the current. As manufactured by the General Electric Company the heating units are of two varieties, the cartridge type and the quartz enamel type. These heating units are, however, hidden away inside the utensil and require no attention. They are provided with protruding terminals which fit a plug on the connecting cord, the other end of the cord being provided with a plug which screws into the electric lamp socket or else in the case of the range, which will be described later, terminates in leads which are permanently connected to the house wires. In any case the attachment may be made in a moment's time.



PARTS OF AN ELECTRIC CEREAL COOKER.



ELECTRIC BROILER.



ELECTRIC STOVE.

The accompanying illustrations show the more common electric cooking devices now in use. The frying pans are made of sheet steel and are wonderfully convenient for light housekeeping. They are made in various sizes from five to ten inches.

With the coffee percolator delicious coffee can be prepared in a few minutes. The process of percolation is said to extract the strength and aroma of the bean without the harmful ingredients. The percolator can, if so desired, be set on the dining room table and attachment made to the lamp socket. There is no flame and no alcohol to spill on polished table tops. Similarly with the chafing dish; this may be used in any room in the house where electric fixtures are installed. The tea kettles are made in any size desired; also the water heaters.

For convenience in the kitchen a form

of cooking and baking table is made for holding the various cooking utensils while in use. There is a substantial wooden stand on which all the utensils, including the electric oven, may be conveniently arranged. As will be noted in the picture, permanent cord attachments are made at the back of the stand, and there are connecting cords enough to plug into all of the utensils. Above each cord is a snap switch so that the current may be turned off from any utensil without removing the cord and plug. The outfit shown takes the place of the ordinary range, but how much easier it is to clean, and how cool to work over.

ELECTRIC COOKING TABLE AND OVEN.

For preparing breakfast the cereal cooker is almost indispensable. One of the illustrations shows the various parts of this device and while it is essentially a kitchen utensil it is so attractive and convenient that many uses can be found for it in the dining room.

Another useful device is the electric stove. This is made of cast iron and the temperature can be regulated. While not as serviceable for heating liquids as the regular water heaters these stoves are a very handy, clean and safe substitute for the ordinary gas heater.

Griddle cakes or a nicely broiled steak can be prepaid on the electric broiler without the necessity of standing over a hot stove. As there is no flame there is no taste of gas or burnt fat.

While not classed with cooking utensils the electric flatiron should not go unmentioned in connection with the devices above enumerated. Electric flatirons are now made in all desirable sizes, the one illustrated being a six-pound iron. The three-pound iron is especially adaptable for all kinds of light pressing and for shirtwaists, baby dresses, collars, ties, ribbons, handkerchiefs, etc. Women who have delicate laces or embroidery which cannot be trusted in other hands to launder will appreciate this type of iron above all. The great advantage of electric irons lies in the fact that they keep an even temperature as long as the current is on. There is no running back and forth from the stove to the ironing board; one minute trying to get the last bit of work out of a fast cooling iron and the next scorching the materials with one that is too hot. No harm is done if the current is left on while the iron is not in use and this is true also of the cooking utensils, though of course for reason of economy the current should be switched off as soon as possible when the work is completed.

While the above described utensils are particularly appreciated during the hot summer months it must be borne in mind

ELECTRIC FLATIRON.

that they are practicable the year around. The convenience which is attendant upon their use is exactly as great in the winter as in the summer, and the electrically equipped kitchen is a blessing to the housewife at any season of the year.

"But is not the expense too great?" is the question which is often asked. This question may be answered in the negative with assurance. At the usual rates for gas and electricity it has been found that the actual cost of the electric current is but slightly higher than for gas, but when the convenience, cleanliness, lack of odor and heat and the greatly decreased fire risk are taken into consideration this slight difference is more than overbalanced.

THE ELECTRIC CURLING IRON.

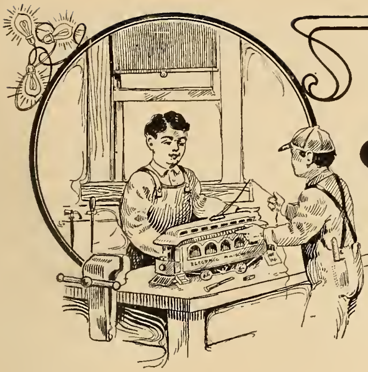
See Front Cover.

The panel picture on the front cover of this issue is devoted to a subject that is interesting to all the readers of this department. It illustrates a new form of electric curling iron which will be appreciated by every woman who has experienced the discomforts of the old-fashioned flame heated iron with the soot the overheating and the discoloration of the hair which are attendant upon its use.

The iron illustrated is electrically self-heated, that is, it is provided with a cord attachment for connection to an electric lamp socket and the heating unit is contained within the iron itself. It therefore should not be confused with the curling iron which is heated in a separate electrical heater. Another feature of this new iron is the fact that the cord attachment may be removed while in use. The iron once heated will retain the heat for a considerable length of time, providing absolute freedom in its manipulation. The detached iron will hold its imparted heat to complete satisfactorily a dressing of the entire head.

The woman who travels will find this electric curler almost indispensable in hotels and on trains and steamships where only electric current is available. She does not always want to depend upon some hairdresser who may or may not be at leisure or at hand. Especially, when she has only a few "side curls" to "do up." Likewise the woman who resides in a modern dwelling and who uses and appreciates electric current for its cleanness, reliability and cheapness will be inclined in its favor so far as to welcome any improvements over old utensils involving as a first advantage the substitution of electric current for gas.

Actresses are not allowed to use flame lamps in their dressing rooms because of the fire ordinances of various cities governing theaters and other places of amusement, sometimes have persisted in the use of the old-fashioned iron in violation of these laws. The electric iron, therefore, will obviate the troubles of these stage people and reduce the time of "making up," at the same time complying fully with the ordinances and regulations.



JUNIOR SECTION

A MARVELOUS ELECTRIC MAGIC BOX.

By means of the electric magic box shown in Fig. 1, a novel and interesting electrically operated optical illusion has been worked out. It is operated electrically as indicated in Figs. 2 and 3, the electrical connections being indicated in the diagrams Figs. 4 and 5.

This magic electric box is utilized with electric lamps so that an aquarium apparently without fish at one moment is in the next instant seen swarming with live gold fish. An empty cage viewed through the opening in the box suddenly has a handsome canary bird singing and in full view, or a cigar box, empty at one moment, is instantly filled with cigars before the observer's eyes the next.

This unique electrical device has been so constructed that any boy may produce some marvelous effects in the family parlor, or a merchant may utilize it as a store window attraction for displaying jewelry or other goods in an attractive and startling manner. The details of construction are simple and the method of operation is given below in detail.

The electric magic casings or boxes are of oxidized copper finish, so constructed as to be readily assembled for parlor use or dismembered and folded or stacked compactly for storing or shipment.

The upper magic box, Fig. 1, is about 12 inches square and about 8½ inches high for parlor magic, and the lower box is 18 inches square and 10½ inches high for use in window displays or at entertainments.

Sections of the casing are constructed of sheet metal and are detachably connected by providing the marginal parts or edges of the top and bottom sections with locking channels, grooves or folds which are adapted to receive hook-shaped tongues or flanges at the upper and lower edges of the rear, side and front wall sections. These channels and tongues engage with each other by sliding lengthwise relatively to each other. The vertical corners are made tight by means of vertical flanges arranged on the corner edges of the wall sections and overlapping each other, as shown in Fig. 3.

FIG. 1. MARVELOUS ELECTRIC MAGIC BOX.

It may be stated that the front wall is made in one piece, but the rear and side walls are each constructed in two normally overlapping pieces to permit of opening the casing at the right side adjacent to the front right corner and at the rear adjacent to the rear left corner, as shown in Fig. 3.

There is a partition arranged diagonally within the casing the full height and extending from the front left corner to the right rear corner which divides the casing into front and rear compartments.

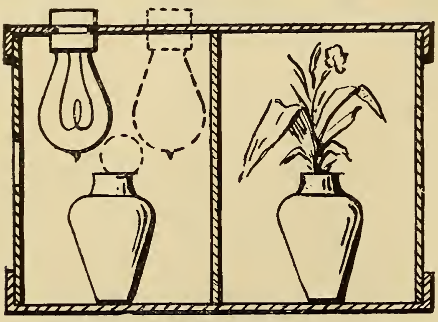


FIG. 2. MOUNTING OF LAMPS IN MAGIC BOX.

The left half of the partition opposite the sight opening of the casing is transparent and the right half opposite the front wall section is opaque. The transparent part of the partition consists of glass and the opaque part of sheet metal, the two parts being joined by a vertical groove formed on the left edge of the opaque partition section receiving the inner opposing edge of the glass partition section, as indicated in Fig. 3.

It may be stated that the interior of the casing and also the opaque part of the partition are rendered non-reflecting by making them of black or dark material, such as charcoal iron, or by producing a dark oxidized copper finish to prevent reflection of light.

For operating this magic box by electricity the top of the casing is provided, adjacent to the right or rear end of the partition, with two openings which lead into the front and rear compartments. Detachably secured in these upper openings and arranged in the front and rear compartments, respectively, are two incandescent electric lamps whereby these compartments may be illuminated electrically. These lamps are mounted as seen in Fig. 2 and the wires enter as shown in Fig. 1.

It will be seen that upon placing an object in one or the other of the compartments in the casing within range of the glass part of the partition, and alternately illuminating the compartments, the illusion will be produced, upon one looking into the casing through the sight opening, that the object is appearing and disappearing.

When the rear compartment only is illuminated by lamp (A), any object (D) arranged within the same, in the rear, is visible if the glass part of the partition is visible to the spectator looking into the casing through the sight opening. But when the front compartment, only, is illuminated by lamp (B) and the rear compartment is dark, the article (D) in rear of the glass partition is obscured and any article (C) in the front compartment is reflected by the front side of the glass partition in the line of vision of the spectator at the sight opening, and is made to appear as if located behind the glass partition.

In case an empty bowl or aquarium is arranged in the rear compartment and

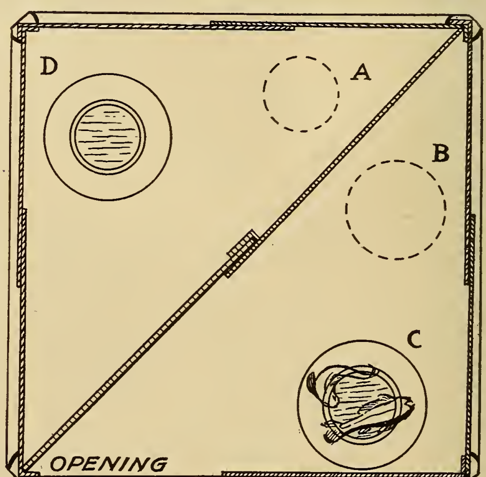


FIG. 3. SECTIONAL VIEW OF MAGIC BOX.

a bowl or aquarium of like character containing fish is arranged in the front compartment, upon illuminating the compartments alternately it will appear to the observer at the sight opening that a fish is alternately present and absent from the same bowl. Like illusions can be produced by using various objects.

If desired the left part of the rear wall behind the glass and the front part of the right wall may be withdrawn and the faces of different persons may be placed therein with curtains hiding the box except the opening, in which case alternate illumination of the compartments produces the impression on the person gazing in the sight opening that the faces of the persons at the side and rear openings of the casing were changing from one to the other at the same place.

When used in the above described manner, this illusion device serves as a toy or magic box for amusement and entertainment, but when it is desired to use the box for advertising purposes, as for instance, in a store window, the price and description of an article may be placed in one compartment and the article referred to in the other compartment within range of the glass part of the partition, the description and article apparently appearing and disappearing in view of the spectator as the compartments are lighted alternately.

With electric lamps for illuminating

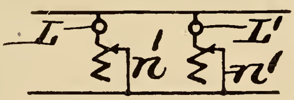


FIG. 4.

the compartments the operation may be controlled by various means to produce different effects. For instance, the lamps may be connected in parallel and each turned on or off by means of hand operated switch or the button on the lamp socket, or, if desired, a hand operated adjustable resistance (n') as noted in Fig. 4 may be included in the circuit of each lamp (L L') in order to produce a gradual fading away of the object or its reappearance.

The lamps may also be turned on and off automatically in various ways instead of by hand. For instance, the lamps may be in parallel on the lighting circuit and both connected in series. Then a thermostatic switch plug (O^2), Fig. 5, may be provided, a heating coil operating to automatically open and close the circuit. Or the two lamps may be connected as shown, in series, (L) being of high candle and (L') of low candle power, and from a point between these lamps a short circuit extends to the side of the lighting circuit which connects with the lamp (L'), the short circuit containing a thermostatic switch plug (O^2). When the contacts of the switch plug are closed the lamp (L') is short circuited, allowing the lamp (L) to burn at full brilliancy, but when this switch is opened the two lamps operate in series relatively to the lighting circuit, causing the low candle power lamp (L')

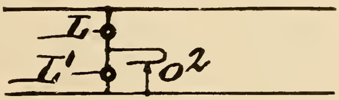
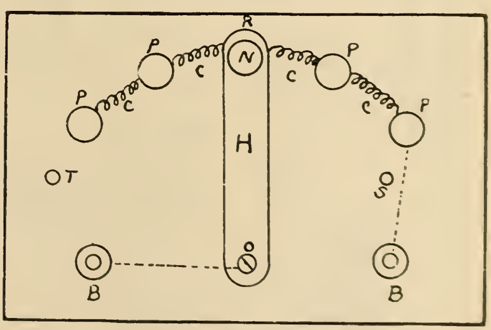


FIG. 5.

to burn with increasing brilliancy and the high candle power lamp to be reduced to a dull red glow on account of the high resistance of the low candle power lamp (L') being thrown in series with it. Thermostats for this purpose may be obtained from electrical supply companies at a reasonable price. As stated above, however, they are not necessary except for automatic advertising boxes, the simple snap switches being better for parlor magic.

RHEOSTAT FOR SMALL MOTORS.

A simple rheostat for controlling the speed of small battery operated motors may be made up with very little trouble. The materials needed are a piece of smooth board six by eight by one-half inches, one strip of thin brass or copper



RHEOSTAT FOR SMALL MOTORS.

sheet four inches long and one-half inch wide, five brass headed nails and about two feet of No. 20 German silver wire. Also two brass binding posts which can be taken from old dry cells.

First fasten the brass sheet (H) to the board by the screw (O), as shown. Adjust this so it may be moved back and forth with ease. At the opposite end drive the brass headed nail (R) into the base, so that (H) may rest upon it. On each side of (R) 1¼ inches apart, place two other nails (P) in place so the end of (H) may rest upon them when swung around. Now take the German silver wire, and after cutting grooves on the under side of the base between all the brass nails, connect each nail to the next one by a coil (C) by soldering it to the protruding nail. Now file off the point of each nail, to make a smooth surface. Place small nails at (T) and (S) to act as stopping posts for (H), and on the upper side of (H) fasten a little wooden knob (N) to serve as a handle. Last of all fasten in the two binding posts (B, B). After connecting these as indicated, you are ready to control your motor with five speeds. To do this connect one wire from your batteries to the motor direct, the other wire from the batteries should run to one binding post (B) on the left of (H) and a wire from (B) on the right of (H) to the other motor part.

Now by placing (H) upon the farthest left point (the lowest speed), and moving it under the other ponts, towards the right the current is increased, the extreme right point being the highest speed.

AMATEUR'S ELECTRICAL LABORATORY.

In the accompanying cut is shown an electrical laboratory built up by an enterprising amateur. On the shelf is the battery of Edison cells, while in the background is shown the switchboard, which consists of voltmeter, two ammeters and switches for the different sources of current.

A wireless telegraph set is also shown, which consists of a half-inch spark coil for the transmitting end and a microphonic detector in connection with a telephone receiver for the receiving end.

Any amateur can build up such a laboratory at small cost, as the majority of apparatus shown herewith was home constructed.

AMATEUR'S ELECTRIC LABORATORY.

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.

WIRELESS TELEGRAPHY.

Questions.—(1) What instruments are necessary to receive up to 100 miles? (2) Which of these two combinations is the best for receiving, electrolytic detector with telephone receiver, or coherer and relay? (3) What instruments are necessary in transmitting up to 10 miles? (4) Is a tuning coil necessary on both transmitting and receiving ends, and if so have they both got to be alike? (5) Are leyden jars necessary in sending? Can anything be used in their place? (6) Is it necessary to use a condenser in sending? What is meant by a variable condenser?—E. J. H., New York, N. Y.

Answers.—(1) The instruments necessary to receive up to 100 miles will depend on a number of conditions such as the height of the aerial, strength of the sending end and type of detector used. From your question we infer that you wish to pick up the messages sent out from one of the government stations which are capable from 100 to 1,000 miles. This will necessitate the use of a tuned receiving set. The tuned receiving set comprises liquid detector, 1,000 ohm telephone receivers, tuning coil, battery, adjustable condenser, and potentiometer. The complete arrangement with letters indicating the various parts is shown in Mr. Laughter's article on "Wireless Telegraphy Made Simple," in the July issue, Fig. 18, p. 160. With this arrangement you could easily pick up the messages sent from any of the commercial stations, even up to 500 miles. The aerial should be at least 100 feet high and of the type described in the August issue. To understand the operation of the receiving set more thoroughly you should read the above article in the July issue carefully.

(2) The electrolytic detector and telephone receiver.

(3) This question is very difficult to answer as the conditions under which a set works will cause large variations in the size, strength, etc. To work ten miles across a city you should use a four-inch spark coil, and about an 80 foot aerial. At the receiving end a telephone receiver in connection with a battery and liquid detector will answer. This distance has been operated across an open country with a three-inch coil which you might be able to duplicate. However, the four inch coil is recommended for satisfactory results.

(4) The tuning coil is only used with the closed circuit sets. This matter was fully explained in "Wireless Telegraphy" in June and July issues. For instance, in answer to your question No. 3, we advised the use of a set that does not employ tuning coils or leyden jars and is known as the open circuit method. While this plant is not so good as the closed circuit, yet it is largely used by amateurs owing to the simplicity. A simple open circuit set was described in the May issue. Two different types of tuning coils are used, the sending and receiving. The sending coil or helix consists of about eight turns of heavy copper wire, and the receiving coil of 300 turns of small wire.

(5) Your question is partly answered in No. 4. Glass plates coated on the opposite sides with tin foil are used to a large extent. Other arrangements such as immersing metal plates in oil are also used.

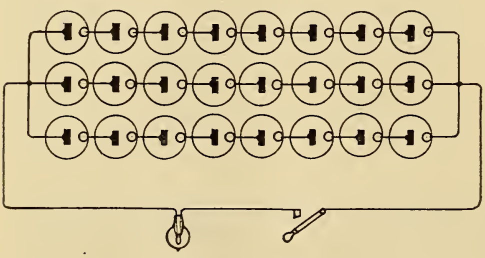
(6) This question has already been asked and answered in No. 5, but we will go into it more fully. The leyden jar is simply a condenser used for high tension work. There are other types of condensers such as paper, mica, etc. The paper condenser you have evidently in mind, which would not do at all in the sending circuit as the high tension current would pierce the thin paper insulation and short circuit, or cross the secondary current destroying the sending efficiency. A variable condenser is one that can be varied in its capacity. Two sheets of tin separated by a strip of mica, with one sheet fixed stationary, the other movable makes a variable condenser. By

sliding the movable sheet back the surface between the two sheets is lessened and the capacity reduced, sliding forward increases as the surface.

ELECTRIC LIGHT FROM DRY BATTERIES.

QUESTION.—Please tell me the best way or ways for connecting dry batteries so that they will give a strong light and keep it up as long as possible. Please give diagrams or examples. —L. G. M., Chanute, Kans.

Answer.—As a matter of fact, the dry battery is very uneconomical when used for even the smallest of continuous lighting experiments. The exhaustion of any battery depends, of course, on the amount of current which it is required to deliver. By connecting cells in multi-



BATTERY CELLS CONNECTED IN MULTIPLE SERIES.

ple, the current drawn from each cell is reduced in proportion to the number of cells connected, and the period of delivery correspondingly lengthened. The average dry cell gives about 1½ volts. You do not give the required voltage of your lamps; but assuming that your lighting circuit is arranged for 12 volts, eight cells connected in series would be needed. A second set of eight cells in series, the whole set connected in multiple to the first set, would double the life of the battery, because it would divide the duties of each cell. A third or fourth set of cells added in multiples would still further increase the capacity. The illustration shows the proper way to connect the cells in multiple series. But even using 24 cells connected in this way for a 12-volt lamp, it cannot be expected that continuous lighting for any extended period can be accomplished. Some form of bichromate cell would not only work more satisfactorily, but with far greater economy, and as these cells give two volts each, only six or seven would be needed for a 12-volt lamp.

PRINCIPLE OF TELEPHONE CONDENSER AND RECEIVER.

QUESTION.—Please explain the parts of a condenser and telephone receiver, and how they are made.—A Reader, St. Mary's, Ont., Canada.

Answer.—An electrical condenser consists of two conducting surfaces separated by an insulator. A Leyden jar, formed by coating the inside and outside of a glass par or bottle with tinfoil, the two coatings not connected in any way, is a condenser. But glass is cumbersome and expensive, and by substituting paper as the insulator the surfaces may be greatly extended and the whole mass rolled or folded into a compact form. Condensers for telephone purposes are made by placing rolls of tinfoil and special paper in a machine which places two strips of paper between every two strips of foil. As the foil is narrower than the paper the two foil strips remain entirely separate; and any required length may then be rolled into a compact form. It is then dipped in melted paraffine and dried under heavy pressure. The finished condenser is usually placed in a flat metal can for protection. The condensers used on spark coils are usually made by cutting sheets of paper and tinfoil to the required size, the foil sheets somewhat smaller than the paper, and then piling up alternate sheets of paper and foil, sometimes to several hundreds. Alternate sheets of foil are then connected to opposite terminals. The condenser is supposed to store up static electricity and the larger its surfaces or the closer they are to each other, the higher the capacity. In fact, the capacity of a condenser may be regulated by a greater or less degree of compression. An excellent grade of very thin paper must be used as the dielectric, or insulator, as if any holes existed in it, the pressure would cause the opposite tinfoil surfaces to touch, causing a short circuit.

The electrical action of a condenser is peculiar, and is best explained by a mechanical analogy. Thus we will suppose (C), Fig. 1, to be a reservoir and (P) a partition dividing it into two parts. The pipes (W W′) represent the two electrical wires or terminals of the condenser. Now imagine that air at any pressure is forced into either pipe by the pump

(D), which may be said to represent the dynamo or battery. A current of air will move through the pipes (W W') for an instant, but will stop when the pressure in the reservoir equals the pressure in the pump. Now if the valve (V) is opened, the reservoir will discharge, and

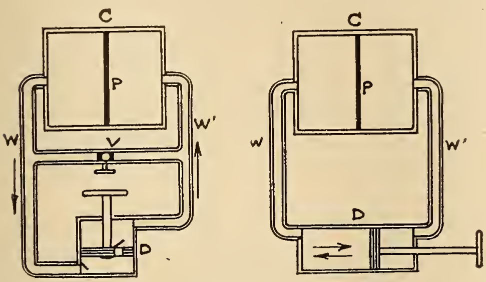


FIG. 1.

a current of air will flow through the pipes in the reverse direction. But if we imagine a pump that will force air alternately in each direction, the alternations succeeding each other very rapidly, the capacity of the reservoir will permit a flow of air back and forth in the pipes, in spite of the partition (P). A condenser operates in an electrical circuit much as the reservoir does in this pipe circuit. The more rapid the alternations the less perceptible is the interference of the partition, or insulator. Fig. 2 is a diagram of a condenser in an electrical circuit.

A telephone receiver consists essentially of three parts, a permanent magnet, an electromagnetic coil, and a vibrating diaphragm. The illustration, Fig. 3, shows clearly how these parts are arranged. The bar magnet (M) is of steel to permanently retain its magnetism. The coil (C) may be wound directly on one end of the magnet, and is of very fine wire. The diaphragm (D) is of thin iron plate, called ferrotype plate. It is fastened by its edges, so that its center is held very close to the end of the magnet, yet is free to vibrate. It is obvious that a current through the coil in one direction will tend to weaken the magnet, and so reduce its pull on the diaphragm; while a current in the opposite direction will increase the magnetism and so draw the diaphragm slightly nearer. As a result, every charge or fluctuation in a current flowing through the coil will cause a flutter in the diaphragm. And if these current changes are caused by the vibrations of a voice against a transmitter, it is obvious that the receiver diaphragm will follow every variation faithfully, and vibrate exactly the same as does the transmitter. The result is that the voice causing the original disturbance is reproduced accurately by the receiver. Different manufacturers have adopted various forms of construction for telephone receivers, and have added a few parts for mechanical reasons; but the principle of all receivers is the same as that shown in Fig. 3.

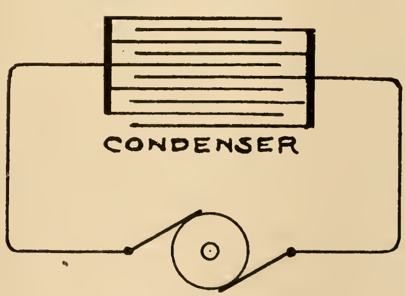


FIG. 2.

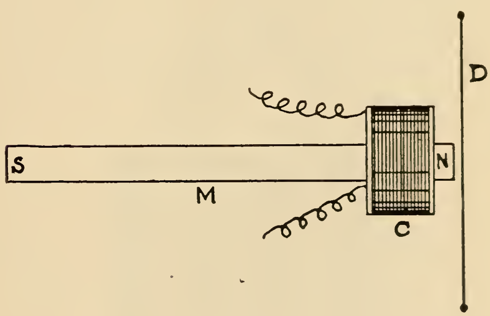


FIG. 3.

110 VOLT TRANSFORMER.

Question.—Will you please explain how to make a transformer for 110 volts.—J. O'N., Niagara Falls, N. Y.

Answer.—The design of a transformer to work on a 110-volt circuit involves calculations which are hardly within the scope of this Questions and Answers department; but an article describing such a transformer with full directions for its construction, using simple materials, will appear in an early number of Popular Electricity.

OPERATION OF A TOY ELECTRIC TRAIN.

QUESTION.—I have a toy electric train, which is run by dry batteries of six volts. I wish to run it by the electricity in the light wires in our house. The current is 104 volts alternating. Have you any suggestion as to how I can reduce and transform this current so as not to burn out my engine?—D. H. A., Southington, Conn.

Answer.—There are several ways of transforming alternating into direct current, but all would be open to your objection that the first cost of the necessary apparatus is comparatively high. The mercury arc rectifier, which is a sort of electrical valve, would be impracticable both on account of cost and because the current required in your case is too small for it to handle efficiently. The electrolytic rectifier, which depends for its principle on the fact that certain electrodes and liquids will conduct a current in one direction but not in the other, delivers direct current by simply shutting off all the alternating current impulses in one direction but transmitting those that go the other way. Its objection for your purpose lies in the fact that even after being rectified, the resulting direct current would still be at 104 volts, and require further apparatus for its reduction. The only practical device for you to use in changing alternating to direct current is a motor-dynamo, that is, an alternating current motor wound for 104 volts, and a direct current dynamo wound for six volts combined in one machine. The simplest arrangement on this principle would be to connect an ordinary alternating current fan or other small motor to a six-volt direct current dynamo either by belt or direct shaft connection.

However, it often happens that the very small motors used on toy electric cars will operate very successfully on alternating current, if the frequency is not too high. If the iron parts of the motor are laminated—that is, the field and armature made up of sheet iron punchings—it will run as well on alternating as direct current. In this case it would only be necessary to step the voltage down from 104 to six by means of an ordinary transformer. Articles describing the construction of a simple transformer, and also of a motor-dynamo, will appear in future numbers of Popular Electricity.

CHARGING SECONDARY BATTERIES FROM PRIMARY BATTERIES.

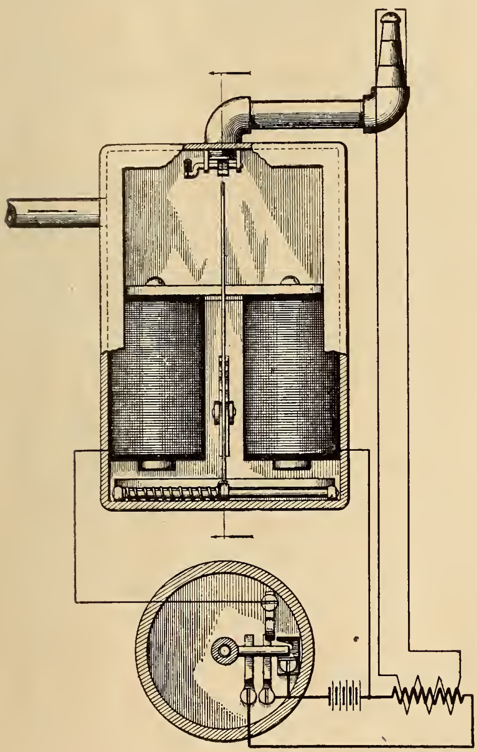
QUESTION.—(A) Can a six volt, 60 ampere storage battery be charged with gravity batteries or Edison primary batteries? (B) What is the difference between a high and low tension magneto?—V. E. H., Cleburne, Kans.

Answer.—(A) No difficulty will be found in charging storage batteries by means of primary batteries, although the process is not at all economical. It is obvious that we cannot get any more energy out of the secondary battery than the primary battery puts into it—nor indeed as much; but it is possible to obtain from the accumulated charge a far stronger effect, for a short period, than could be obtained from the primary battery direct. That is, we may charge the storage battery continuously for say 10 hours, and then entirely discharge it in one hour or less, with a corresponding display of energy. And as such installations are usually made only for experimental purposes, the question of economy is not so important a factor. To charge a six-volt storage battery requires about eight volts, in order to overcome the counter electromotive force. Therefore, as gravity cells give approximately one volt each, eight cells connected in series will be ample. If the storage battery current is to be used with any regularity, the gravity cells should be left permanently connected to its terminals, so that the charging goes on continuously. Inasmuch as the internal resistance of the 60-ampere storage battery is quite low, the gravity cells should be inspected frequently, and the "blue line" kept at its proper level. A second and even a third or fourth set of eight gravity cells connected in multiple to the first set will hasten the charging process. Edison primary cells give about two-thirds of a volt each, so 12 cells would be necessary to give the requisite eight volts. Charging will be more rapid with the Edison cells, as the output of current is greater. Gravity cells will be found quite satisfactory, however. It will be seen that in an installation of this kind the sole function of the secondary battery is to concentrate into a short period of time the prolonged discharge of the primary battery, (B). See pp. 192 and 193, July issue of Popular Electricity.

NEW ELECTRICAL INVENTIONS

ELECTRIC GAS LIGHTER.

By operation of a single push button the gas may be turned on and lighted or may be turned off. The device by which these diametrically opposite results are obtained is shown in the accompanying diagram and is the invention of Raymond A. Rockwood of Monrovia, Cal. Two electromagnets as shown in the cut

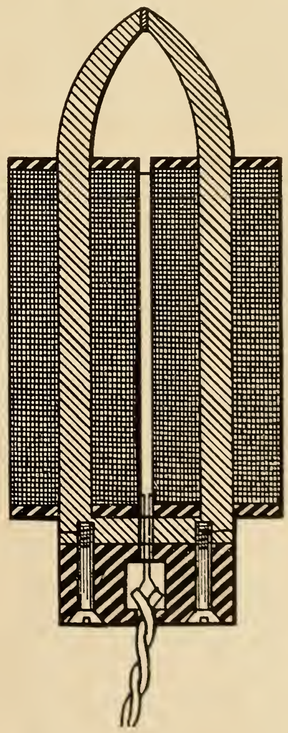


operate not only to open and close a valve leading to the gas jet but also to produce the necessary spark for lighting the gas. These two operations are accomplished by an ingenious arrangement of the contacts operated by the push button. The first pressure on the button closes a circuit which energizes the magnets, which in turn draw up an armature which operates the valve arm. The spark for lighting the gas is produced at the same time. The next pressure of the button reverses the operation and leaves the contacts in their original position.

EYE MAGNET.

Foreign particles of magnetic substances are difficult to extract from the eye, as they are usually sharp metallic substances which work in, rather than out. Magnets are used to advantage in extracting iron filings and the like which are embedded in the eyeball. What are known as electric magnets are used for this work, that is, magnets which are wound with wire, through which an electric current is passed. Such magnets are much more powerful than the ordinary permanent magnet and may be designed to give almost any pull desired.

The accompanying illustration shows



a new form of eye magnet invented by Harold Thomassen of Dayton, O. The magnet is made with a U-shaped core, the points of which converge until they are very close together, enabling the instrument to be brought to bear on the injured surface immediately over the particle to be extracted.

MAGNET OPERATED TRACK SWITCH.

The device illustrated herewith provides means by which the switch on an electric car line may be thrown without the motorman having to leave his station on the platform or reaching out through the window with a switch bar, as is ordinarily the case. It is the invention of W. C. Dunn of Logansport, Ind. It is operated by a powerful electromagnet situated under the car body near the track surface, the magnet being energized by current turned into it by the motorman when he wishes to throw the switch.

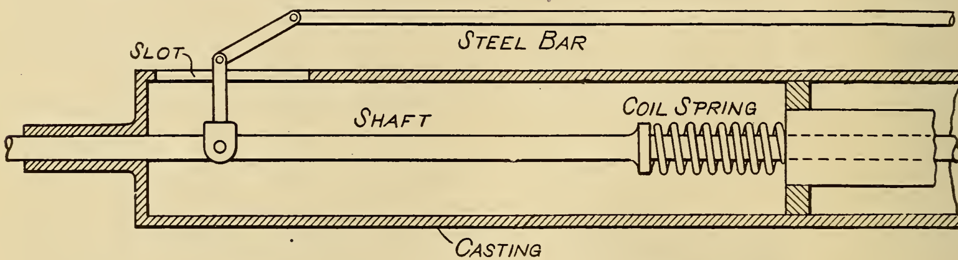


FIG. 1. MAGNET BAR AND SHAFT FOR OPERATING TRACK SWITCH.

Beneath the track at a point somewhat in advance of the switch point is a casing, a vertical section of which is shown in Fig. 1. In this casing is a shaft which moves longitudinally. Attached to this shaft is a lug to which a longitudinal steel bar is fastened by a toggle joint as shown. When the magnet under the car passes over the bar the latter is drawn up, if the magnet be energized, and the shaft thereby pulled over toward the right to operate the switch cam shown in Fig. 2. A coil spring shown in Fig. 1 normally holds the shaft to the left extremity of its throw.

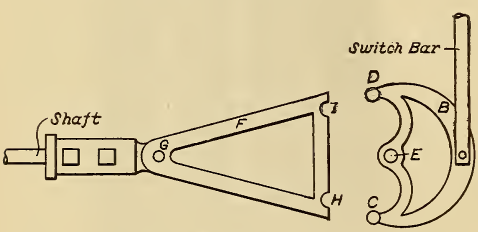


FIG. 2. CAM FOR OPERATING TRACK SWITCH.

Upon examination of Fig. 2 it will be seen that the shaft operates to move the triangular member (F) forward and back. This member is pivoted at (G). Suppose a car passes over the bar and the magnet is energized resulting in the shaft being thrown toward the right, then (F) is moved forward and the notch (H) engages the bearing (C) and turns the cam upon its pivot (E). As the cam turns on the pivot the bar leading to the switch point is pushed forward and the switch is thrown. As the cam turns (H) and (C) are carried downward, (F) turning on the pivot (G), so that (I) does not engage (D). When the car has passed, the shaft, and consequently the triangular member (F), return to their normal position.

When another car arrives at the switch, if it is desired to follow the course of the first car the magnet is not energized as the cam remained stationary after the first operation. If, however, it is desired to follow the other track the magnet is again energized and the shaft moves to the right as before, but this time the cam is in a position, from its previous movement, such that (I) engages (D) and the cam is thrown back into its first position and consequently the switch is moved to its original position.

ELECTRICITY BEATS EGGS.

Electricity having been used for almost every purpose under the sun, now it has recently been harnessed up by a Jersey City man to beat eggs.

In any hotel or bakery where eggs are used in large quantities and where they require beating, as for a cake, this electric beater will be a welcome addition. It not only saves much hard work—for beating eggs is no child's play—but it does the job better and more expeditiously than it can be done by hand.

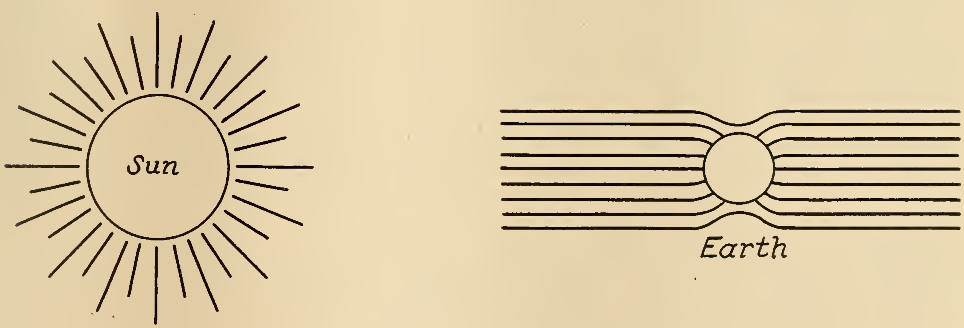
THE THEORIZER'S CORNER.

Many of us have a pet theory that we are aching to give to the world at large. There are others who feel it their duty to run down and "explode" such theories wherever possible. This corner in Popular Electricity is set aside for the theorizer and the "exploder," so that they may meet on common ground, and we await with interest the "fire works" to follow. The department will be devoted to theories concerning electricity and allied sciences.—Editor.

THEORY OF VIBRATORY ENERGY.

After reading the theories advanced by R. S. in the July issue, I decided to give someone a chance to explode a theory I have; not just about lightning and thunder, but the universe as a whole.

I believe the sun to be a mass of active material, such as radium is supposed to be. It is constantly sending out power in the form of vibrations. These vibrations are what we call static electricity. The vibrations are radiating in all directions. Some of them pass through the earth, more than would pass through an equal volume of air alone. This causes a concentrating of the lines of force, as shown in the cut.



THEORY OF VIBRATORY ENERGY.

Suppose, now, a cloud comes between the sun and the earth. The molecules of water that form that cloud retain a certain amount of the force coming toward the earth. This static charge holds the molecules of vapor apart (like charges repel each other) until the potential becomes high enough to jump the gap to the earth. Then the complete charge comes as a current, because the resistance of the air is broken down. The vapor no longer is repellant, so condenses as rain and falls. Thunder is the logical result of rupturing the dielectric (air).

The reason lightning occurs mostly in the summer is apparent: There is lightning whenever the surface of the clouds are at right angles to the lines of force. It is also summer when the clouds are at right angles to the lines of force (parallel to the surface of the earth).

The "ether" is a conductor of vibrations; all kinds, heat, light, sound, electricity, etc. There are vibrations so slow we cannot hear them. There are also vibrations so fast we cannot see them. Some day mechanism will be made to utilize each and every one of these vibrations directly from the sun, as the electrical appliances now use the vibrations known as electricity.

One line of force may have several different rates of vibration, depending upon the medium through which it goes. Thus, iron so changes the rate of vibration of the sun's rays that we feel it as heat. Most physical substances do the same. A burning glass does not change the light rays to heat as much as iron, but allows the light rays to go through, collecting them at one point, and if they are thrown on some substance which has the property of changing the rate of vibration to that known as heat, then by their concentration produces extreme heat in a small location.

Ice probably has the least of the property of changing light to heat rays, providing it is good and clear. The reason some substances appear to be transparent is because they do not change the rate of vibration, hence the light rays come through; other substances change the vibration, so are opaque.

What we call ruby glass changes the rate of vibration slightly, but not enough to stop them all, so only the color is changed. If you look at the side of a ruby glass from which the light is passing, i. e., along the direction of the lines of force, the ruby glass appears nearly black, showing that nearly all of the rays pass in a different direction than toward the observer (few are reflected). Many other causes and effects will be apparent to anyone taking the time to inquire into the subject. E. K.

AS TO THE CAUSE OF THUNDER AND LIGHTNING.

Just a word as to R. S.'s theory about the cause of thunder and lightning, which appeared in the July issue of this magazine. R. S. says that "where the atmosphere ends the ether must begin." That implies that there is no ether except outside the atmosphere. But this is not so, for how, then, does light, which is nothing but a wave motion of the ether, come to us from the sun through the atmosphere? And how does R. S. account for wireless telegraphy, if it be true there is no ether where there is atmosphere?

Ether, according to the most widely accepted theory, penetrates everything. It is stationary in one sense, as R. S. states, but never before have I heard of anything producing a friction by "rubbing against" the ether. Nothing can rub against the ether, for it intermingles with all matter. When we move we push the air aside, but the ether passes right through us like water through a sieve.

Again, the theorizer says that a "vacuum is left between the atmosphere and the ether." There is no vacuum without ether. This is proved by the fact that light passes through a vacuum, which could not be so if the vacuum were void of ether, since light is a wave-motion of the ether. If R. S. really holds that there is no ether except outside atmosphere, then he must change the theory as to light, and accordingly heat, and so on, until we have a new set of theories in existence. But, since our present theories hold together so well, why should we change them when one man thinks that thunder and lightning are caused by the friction of the atmosphere with the ether? H. L. C.

In the July issue of Popular Electricity I read the theory, "Cause of thunder and lightning," and being interested also in the "fireworks to follow" I humbly offer this contradiction of mine.

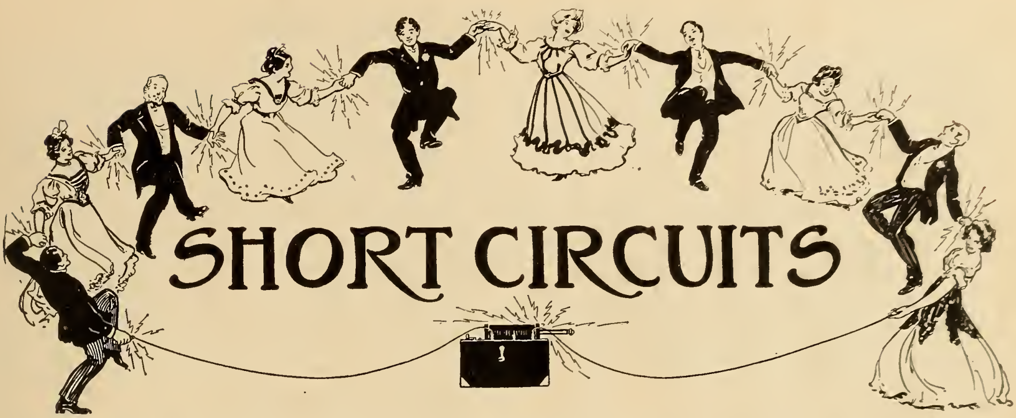
First, we know that as the atmosphere contracts and expands with variation of temperature, the said friction would be perpetual. Therefore it seems evident that we should always have thunder and lightning.

Second, if the atmosphere contracts, why should it leave a vacuum? It would not contract instaneously, therefore would not the ether and atmosphere act together sychronously, according to the expansion and contraction of the atmosphere, thus leaving no vacuum whatever? If this is not true I await the criticism of the author. E. H. L.

While at first sight interesting, R. S.'s theory as to the cause of thunder and lightning cannot be based on very deep thinking. In the first place, he would have it that these two phenomenon are entirely independent of each other, the one being caused by atmospheric changes and the other by the rubbing of the ether against the atmosphere. This is, of course, obviously untrue, a clap of thunder almost invariably following a flash of lightning, as is proved by observation.

Secondly, according to this theory, thunder and lighting originate at the outer boundary of the atmosphere, where the ether begins. This is absolutely erroneous, since it is positively known that the source of thunder and lightning is the clouds, which are far below the outer edge of the atmosphere.

H. W. G.



SHORT CIRCUITS

"Have ye anny ancisters, Mrs. Kelly," asked Mrs. O'Brien.

"An' phwat's ancisters?"

"Why, people you shprung from."

"Listen to me, Mrs. O'Brien," said Mrs. Kelly impressively, "I come from the rale sthock av Donahues thot shpring from nobody. They shpring at thim!"

* * *

"What is your name?" asked a teacher of a boy.

"My name is Jule," was the reply; whereupon the teacher impressively said, "You should have said Julius, sir. And now, my lad," turning to another boy, "what is your name?" "Billious, sir," said the boy, trembling.

* * *

"Is this section prosperous?"

"You bet it is," answered the Oklahoma farmer. "I kin spread a net any time and snake a grand piano out of a cyclone."

* * *

Our page of electrical definitions suggests the "Electric Courtship" to one of our readers, which is as follows: Two young things—twilight—strolling through field (of force)—resistance—positive declaration—insul(a)ted—negative reply—slapped (battery)—great induction—magnetism—closed circuit—heavy current (alternating)—w(h)att hour—1 o'clock a. m.—Let's go ohm (home), Charlie.

* * *

"Pa, what is a political leader?"

"A man who is able to see which way the crowd is going and following with loud whoops in that direction."

* * *

"Did you hear about Isaac?"

"Vy, vot happened to him?"

"He had his appendix taken away last Saturday."

"Vot a fool; vy didn't he have it in his wife's name?"

* * *

The wireless operator on one of our coast liners, explaining the working of the apparatus to some of the passengers, told them that the transformer was made up of 75 miles of wire. Shortly afterward an old lady, who had been an interested listener to his discourse, wanted to know with whom he was talking. He replied: "With the steamship City of ———, 25 miles away." "Goodness!" exclaimed the old lady, "how can they call this wireless telegraphy if it takes 75 miles of wire to talk 25 miles?" The operator was too busy to answer.

* * *

They had just installed lights in the home of a farmer. The first night the belt at the power plant slipped a great deal and the lights did not burn regularly. Next morning the farmer called up the power house and asked for a man to come out to his house at once. When the electrician arrived he found the farmer sitting on a ladder trying to take out a few turns in the wire. "Well, what is the matter?" the electrician asked. The farmer answered: "Why, you blame fool, I thought you had more sense than to put the wire up this way. Why, last night the electricity just come around those curves in jerks."

* * *

Agent's Clerk—"How shall I word this advertisement of a house to rent? You can reach the station from it in a quarter of an hour if you run for ten minutes of the way."

Agent—"Advertise it as five minutes' walk from the station."

* * *

Pat—"What was that Chicago convention I hear so much about?"

Dan—"Well, it was something to prevent six Presidents coming in when only one goes out."

* * *

Pat had just arrived from Ireland and had obtained a job as hod carrier. He forthwith wrote home to his brother Mike as follows: Dear Mike—Come on the next ship. I have got an easy job. All you have to do is to carry brick up a ten-story building and the men up there do the work. Hurry!

* * *

Of all sad words
Of tongue and pen,
The saddest are these—
"I'm stung again."

* * *

In a Glasgow car was an aged Irishman who held a pipe in his mouth. The conductor told him he could not smoke, but he paid no heed. Presently the guard came into the car, and said with a show of irritation, "Didn't I tell you you could not smoke in this car?" "Well, O'im not smoking." "You've got a pipe in your mouth."

"So Oi have me feet in me boots," replied Pat, "but O'im not walking."

* * *

Mrs. Boorman Wells, the noted English suffragette, was describing at a dinner in New York a very disorderly suffragette meeting.

"The noise," she said, "can only be likened to the hubbub that I once heard coming from the nursery of a friend with whom I was taking tea.

"Terrified by this infernal turmoil, my friend and I burst into the nursery, breathless. The children, in a close group by the window, the baby in the middle, looked up calmly.

" 'What on earth are you doing?' the mother demanded.

" 'We've found,' said the oldest boy, 'poor grandma's teeth, and we're filing them down and fitting them on the baby.' "—Evening Wisconsin.

* * *

Wifie—"Be sure to advertise for Fido in the morning newspapers."

Next day the wife read as follows in the newspapers:

"Lost—A mangy lapdog, with one eye and no tail. Too fat to walk. Answers to the name of Fido. If returned stuffed, large reward."—Philadelphia Inquirer.

ELECTRICAL DEFINITIONS.

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

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

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

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

Circuit.—Conducting path for electric current.

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

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

Condenser.—Apparatus for storing up electrostatic charges.

Direct Current.—Current flowing continuously in one direction.

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

Electrode.—Terminal of an open electric circuit.

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

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

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

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

Galvanometer.—Instrument for measuring current strength.

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

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

Kilowatt.—1,000 watts. (See watt.)

Kilowatt-hour.—One thousand watt hours.

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

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

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

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

Poles.—Terminals of an open electric circuit.

Potential.—Voltage.

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

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

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

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

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

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

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

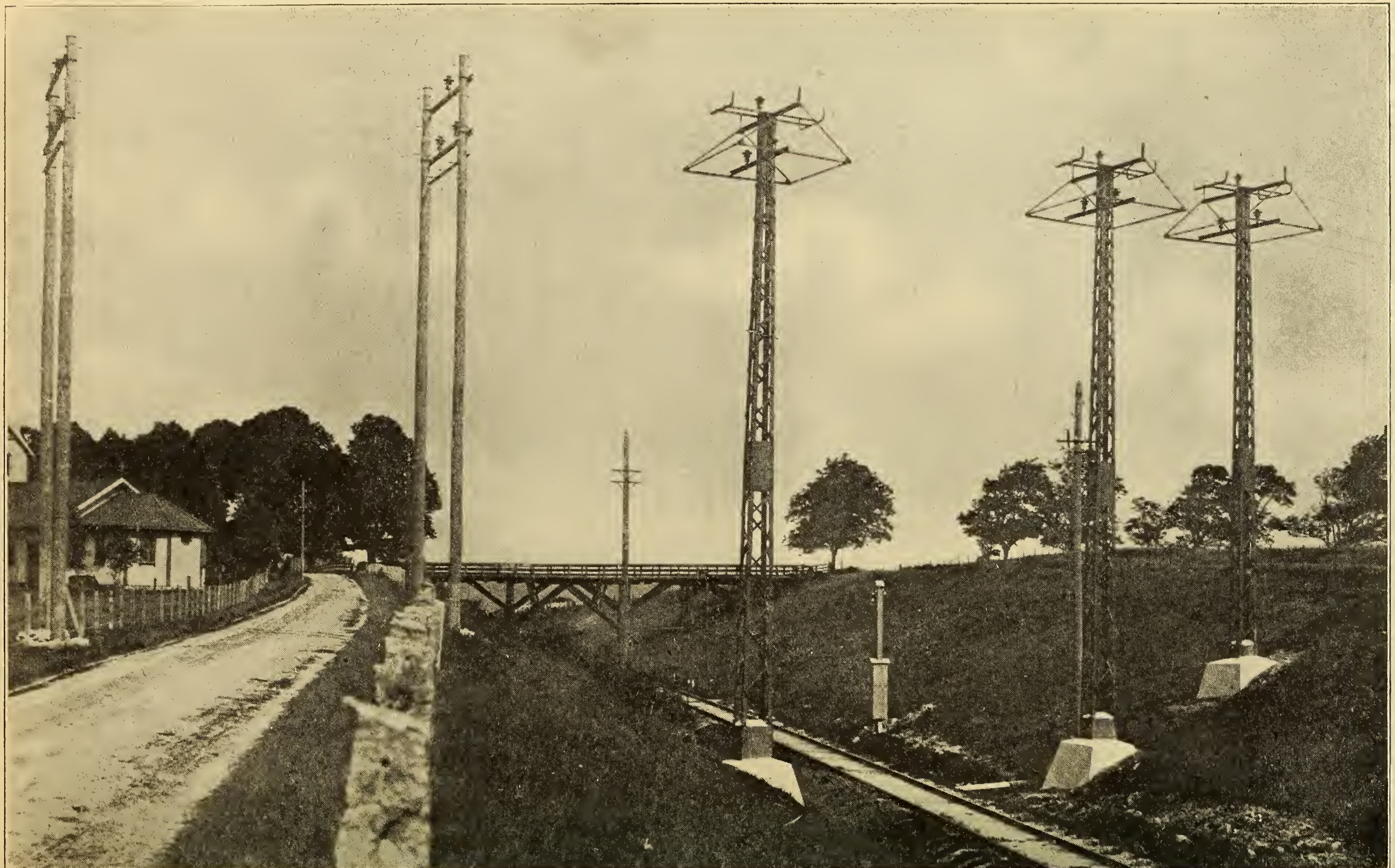
Transformer.—A device for stepping-up or stepping-down alternating current from low to high or high to low voltage, respectively.

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

Voltage.—Potential difference or electromotive force.

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

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



FIFTY MILE HIGH TENSION TRANSMISSION LINE IN NORWAY.

See Page 350.