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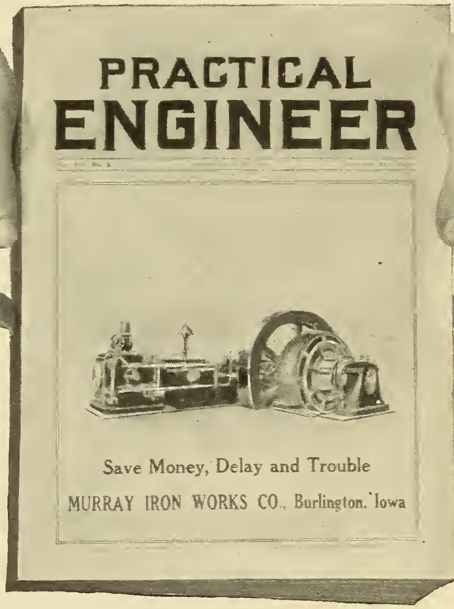

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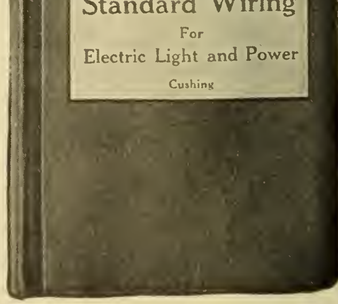

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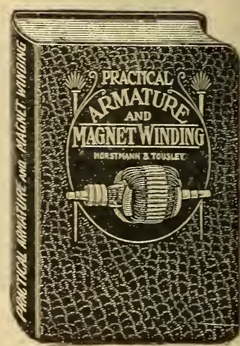

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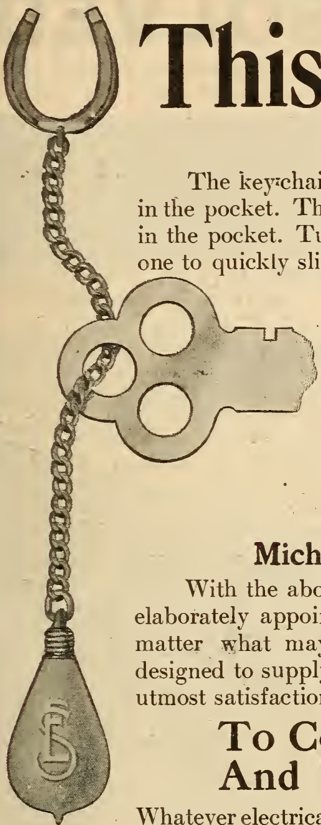

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POPULAR ELECTRICITY

IN PLAIN ENGLISH

HENRY WALTER YOUNG, Editor

Vol. II JULY, 1909 No. 3

CONTENTS

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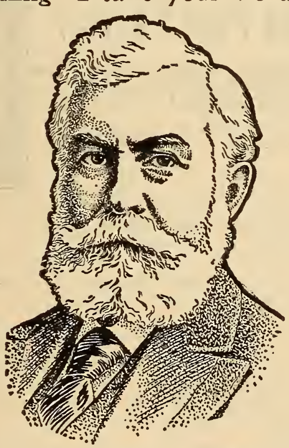

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In do not retail cigars nor sell sample lots. It costs more to do so than to ship the original package, and in addition, one or two cigars is not a real test. Moreover, I might be charged with sending samples better than the goods prove to be. I ask smokers to give the actual cigars a fair trial, and if they are not pleased, to return the remainder. I cannot afford to have any one displeased.

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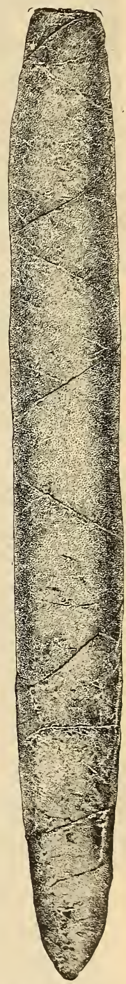

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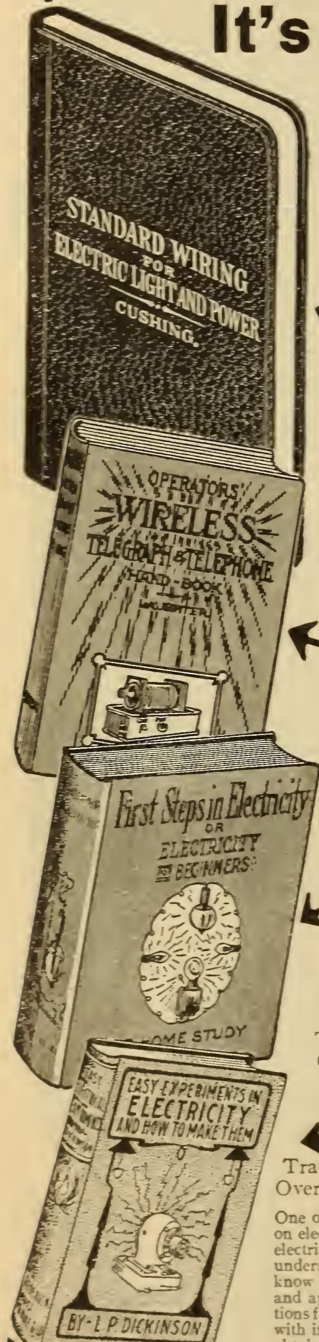

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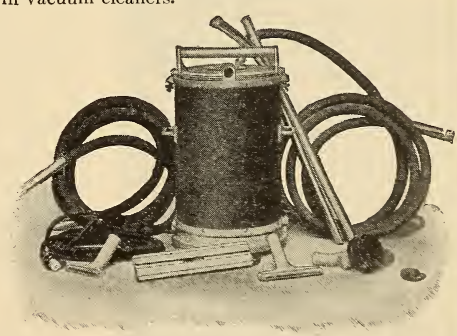

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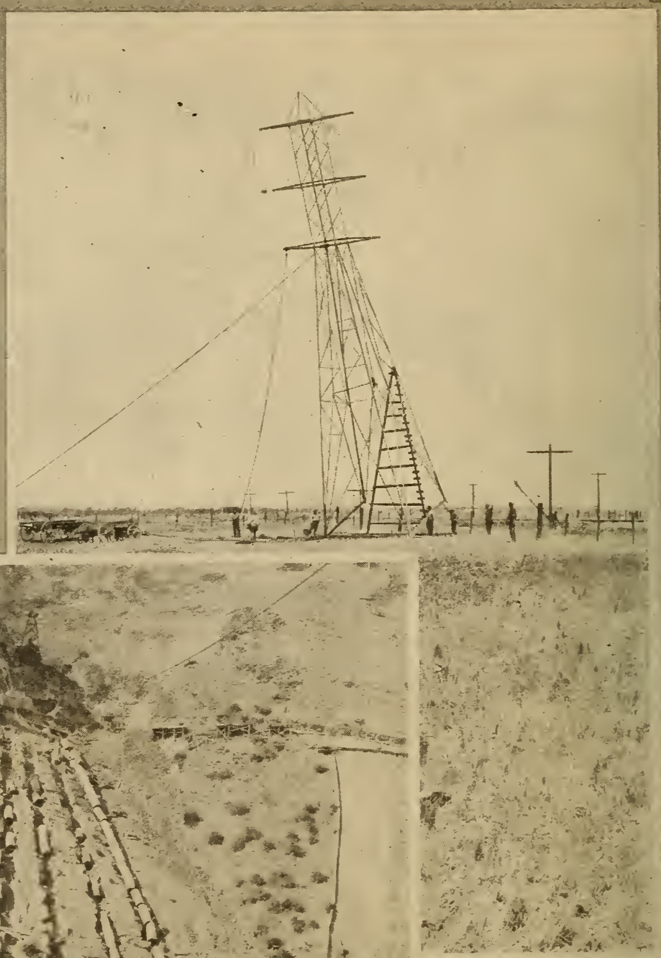
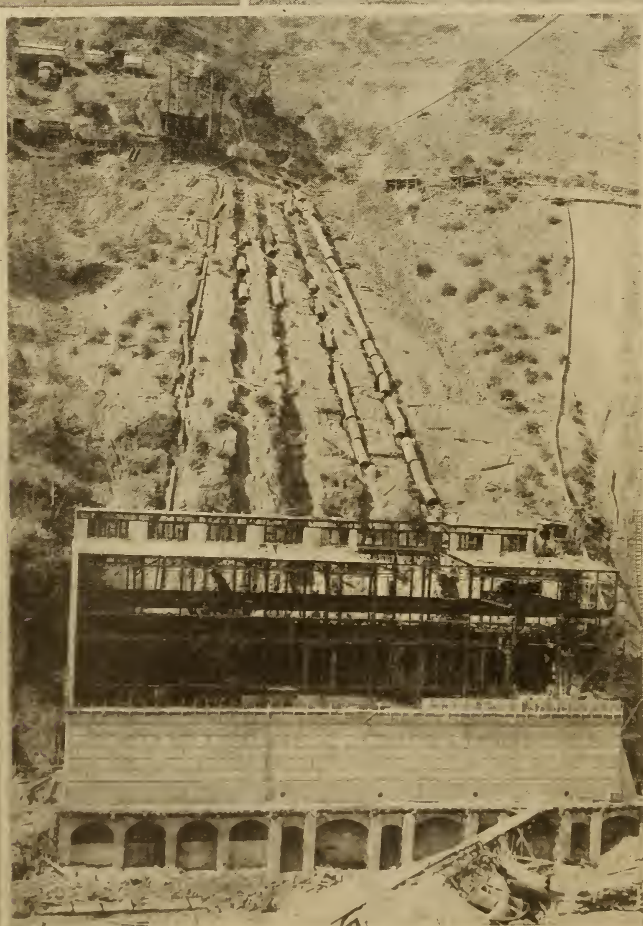




The Big Bend Power Plant

CALIFORNIA'S GREAT POWER PLANT

POPULAR ELECTRICITY
IN PLAIN ENGLISH

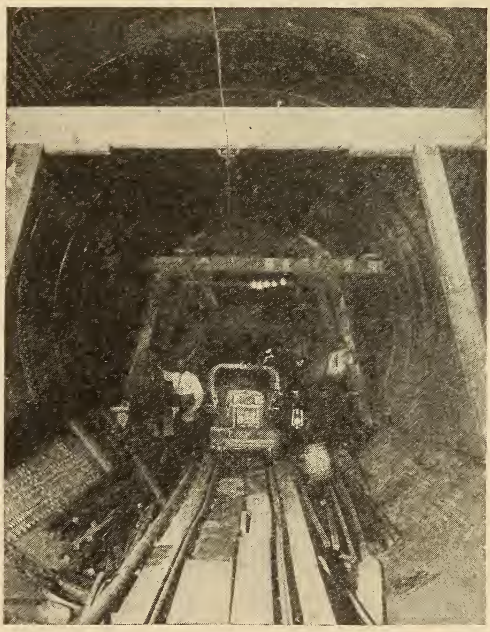
VOL. II JULY 1909 No. 3

CALIFORNIA'S GREAT POWER PLANT

BY DODD CURTIS.

Up among the foothills of the Sierras in Butte County, Cal., the fierce little Feather River tears its way for miles through canons and gorges, only to emerge at length but a short distance away from the point where it started in to encircle a mountain.

On a topographical map this loop of the river takes the form of a huge horseshoe, and is known as the Big Bend. And just here, at the neck of the Big Bend, is nearing completion a work that promises to revolutionize the future of vast tracts of country spread out over hundreds of miles between it and the sea. The movements of a far-reaching network of railways, the lighting of cities, the motive power to drive the machinery in great ship building plants, and textile manufactories; all these and more, will be controlled by a set of tiny buttons in the switchboard gallery of the power house of the Great Western Power Company at Big Bend.



DRIVING THE WATER POWER TUNNEL

Briefly told, this is accomplished first of all by means of a huge dam at one side of the Big Bend, which backs the waters in the Feather River up to a great intake tower. Here the river enters a tunnel three miles long, driven through the heart of the mountain to the other side of the Big Bend, a gradual fall of 75 feet. At the outlet of the tunnel the water drops over 300 feet, through four large pipes directly to the turbines in the power house below on the edge of the river. These turbines are the largest and most powerful water wheels yet constructed, and the tunnel is the longest water power tunnel in the world.

Within the power house, from each of the turbines, rise gigantic shafts upon which rest the dynamos, which in turn are connected to the transformers, and from the transformers lead out the transmission lines, first to the top of the mountain over the portal of the tunnel, thence by a succession of tall steel towers, down in a direct line, over hills and valleys, through cities and towns, vineyards and wheat fields to the sub-station in the city of Oakland.

The idea of a tunnel across the neck of the Big Bend is not new. In fact when the preliminary survey was made for the

Great Western Power Company, the mountain was already pierced by a small tunnel which had been cut through many years before for the purpose of draining the Feather River in the Big Bend for gold. The man who originated this scheme was a mining engineer named McLaughlan, and another man, Dr. Ira S. Pierce, agreed to furnish the money. About that time the latter patented a medicine which was very largely advertised. With each bottle of medicine sold went a stock certificate in the Big Bend Mining Company. The medicine had a great vogue all over the country, and the funds to finance the tunnel project were raised without difficulty, but when the work was accomplished and the bed of the river laid bare, the miners discovered the abandoned tools—shovels, wheelbarrows, rockers and pans—of the Argonauts, whose work had long been forgotten.

SWINGING A BOILER ACROSS THE RIVER

So the tunnel remained unused until purchased by the Great Western Power Company, and while the initial expense went for naught, the work is amply paid for in this electrical development. With this nucleus of the small tunnel, the work of driving a new tunnel elbow about half as long again, went forward very rapidly, together with the work of enlarging the old tunnel to about three times its original size. Even in these days of steam drills the work of driving a tunnel big enough to carry two lines of an electric railway through three miles of solid rock was a stupendous job, to be accomplished within eighteen months.

The tunnel is lined throughout with concrete, made partially from the crushed rock excavated. At the south portal, where the water has final egress, a hugh steel cylindrical pipe runs a long way into the tunnel, otherwise the terrific force of the escaping water would drive the pipe from the tunnel mouth. Into this pipe are riveted the almost vertical lines of pipe (the penstocks) running down the steep face of the cliff 328 feet to the power house, and also another pipe (called a surge pipe) which is thrust directly up the side of the mountain, and acts as an escape pipe to take part of the first strain off the penstocks. A set of powerful valves, or gates, at the intersection of the penstocks with the main pipe will be controlled by electricity from the switchboard below in the power house.

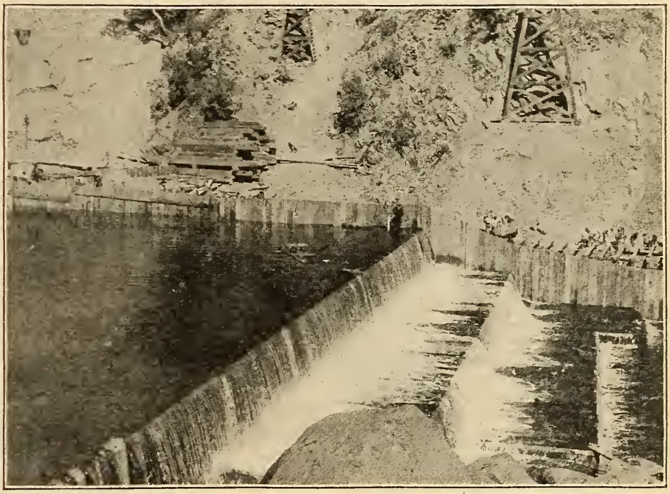
The situation of the power house is superb. Through the narrow canon rushes the river, deep green in color, cruelly swift and strong, and rising abruptly from the water, four hundred feet and more on either side, are wooded cliffs, crowned by lofty pines, and at each end of the canon, open out other vistas of forest and stream and far distant mountains.

On the verge of the river, against this background of imposing grandeur, stands the power house. It looks like a modern castle, massive, but beautiful, in the style of the Italian renaissance. The graceful simplicity of its lines, the arched facade, the cool gray of the concrete, are thoroughly in harmony with the natural beauty of the gorge.

The foundations of the power house are 23 feet below the bed of the river and one of the most difficult and hazardous parts of the whole work was the building of the coffer dam outside of the proposed foundation, in order to lay dry the bed of the river. There were three anxious days in December, 1907, when the river, swollen to a record flood stage, threatened to sweep away the coffer dam. This meant that the previous six months' work of preparation would go for nothing, thousands of dollars' worth of machinery would be destroyed, the building of the whole plant put back a year, not only entailing a loss of half a million dollars, but also having a disheartening effect upon the entire personnel of the company, from the engineers who had planned it all, and the stockholders whose money meant faith in those engineers, down to the workmen who blindly obeyed orders. The tension of that last stormy night on the dam, the white fury of the river, the long, shadowy lines of men, moving ant-like, steadily up and down the face of the cliff filling and refilling the bags of earth to strengthen the dam, is one of the memories not easily forgotten.

On the lowest floor of the power house the draught tubes discharge the dead water from the turbines out under the river, and rising from the level of the river upon the first floor of the structure are the four seventy-inch 18,000-horse-power high pressure turbines running at 400 revolutions per minute. Later, there will be eight such units in operation. These are direct connected through the next floor of the power house by massive vertical shafting, to four dynamos on the top floor, each of which delivers 10,000 kilowatts (13,500 horse-power) of electrical energy. By means of water cooled, oil insulated transformers, electricity is then stepped up in voltage from 11,000 to 100,000 volts, and carried by the transmission lines to the Oakland substation. This high voltage is selected because of the economy that it secures in sending the power a distance of one hundred and sixty-five miles to the coast.

Obstacles to be surmounted in beginning this work were enormous. The nearest railroad was thirty miles away over a narrow foot trail, across the mountains. Roads had to be built first of all, and supplies hauled in from Oroville, or Marysville, the nearest towns. Within the past year, however, the Western Pacific Railroad has come into the canon of the Big Bend, on the opposite side of the river from the Great Western Power Company. The supplies and machinery for the power plant are now taken from the cars at Las Plumas, the Western Pacific station, swung on a powerful aerial cable two thousand feet across the chasm, and landed at will, either at the portal of the tunnel, or down through an opening in the roof directly into the heart of the power house.



THE BIG BEND POWER DAM

THE FUSE FOOL.

There is a most varied assortment of fools on this planet, as any half observant person can easily discover in the course of an ordinary day's experience, says Electrocraft, but of all fools that infest the world, that particular fool who substitutes a nail or a hairpin or some such device in place of a blown fuse is the kind that neither God nor man has any use for. He is a malicious fool, and he has the cunning of the coyote besides. For some other varieties of the genus fool, one's disapproval is sometimes tempered by sympathy for their foolishness. The "unloaded" gun pointer, the boat rocker, the banana-skin thrower are more stupid than malignant, and stupidity is not always incurable. But the fuse "fixer" has not even the poor excuse of stupidity. He generally knows, or he should know, the probable consequences of his act, yet he cunningly sneaks in a device which is almost certain sooner or later to cause destruction of property, and possibly human life as well.

ELEMENTARY ELECTRICITY

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

CHAPTER XV.—ELECTRIC SOURCES. FRICTION.

As already pointed out, all electric circuits consist of conducting paths by means of which the electricity produced by electric sources is passed through various electro-receptive devices so as to obtain some of the many effects electricity is capable of producing. These paths or circuits lead the electricity from the positive pole or terminal of the source through the receptive devices, and then, when it has produced the effects desired, lead it back to the source at its negative pole.

Having described the principal electric circuits and the various effects produced by the passage of electric discharges both through ordinary matter as well as through the residual gaseous atmospheres of high vacua, it remains first to describe some of the more important electric sources, and afterwards some of the electro-receptive devices that are most frequently employed in actual practice.

It might at first sight be supposed that it is very difficult to produce electricity. On the contrary, however, it is so easy to do this that it is extremely difficult to expend energy in producing such mechanical effects as friction, flexure, torsion, elongation, compression, etc., without at the same time producing electricity, and the same is true when energy is expended or caused to do work in producing heat, light or magnetism.

One of the simplest ways of producing electricity is by the friction of unlike surfaces or substances. When certain precautions are taken it is impossible to rub two different surfaces or substances together without producing well marked electric excitement. It seems strange, therefore, that it was not until some 600 B. C. that a Greek philosopher, Thales, discovered the strange power a piece of amber acquired, when rubbed against the clothing, of attracting light objects towards it. But it was still more strange that this important observation was permitted to lie unnoticed until some 2,200 years afterwards, when, in the year 1600, Dr. Gilbert, of Colchester, England, who lived during the reign of Queen Elizabeth, repeated Thales' experiment and found that similar properties were acquired by the friction of a great variety of other substances.

One of the simplest ways in which electricity may be produced by friction is to rub a dry glass rod with a dry silk handkerchief. When such a rubbed rod is brought near small pieces of paper, shreds of straw, or feathers, they will be drawn towards it as shown in Fig. 93. Occasionally, some of these pieces, after remaining

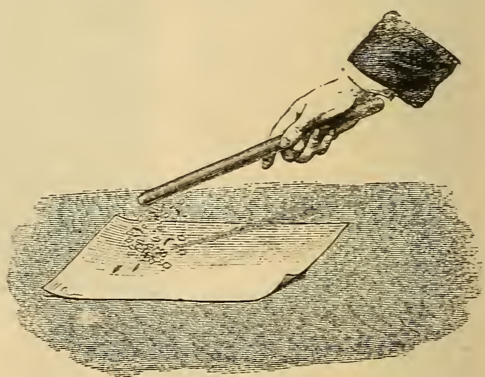


FIG. 93. ELECTRIC ATTRACTION OF LIGHT BODIES

in contact with the rod for a few moments, will be thrown off or repelled from its surface. If, however, a number of small rounded balls formed from the pith of dry elder wood are employed, instead of the irregularly shaped fragments that necessarily contain corners or points, after remaining momentarily in contact with the rod, the ball will be shot off from it and again attracted in an amusing manner.

The approach of a rubbed glass rod to a pith ball suspended by a silk thread from an insulated support, as shown in Fig. 94, results in the ball being drawn towards the rod. After remaining for a moment in contact, the ball will be shot off violently from the rod and can no longer be attracted until it is touched by something connected with the ground.

If a black rubber comb, or a sheet of vulcanite, the substance from which the comb is made, is rubbed with a piece of cat's skin or other fur, similar electric effects are produced.

Perhaps one of the simplest ways in which electricity can be produced by friction is by placing a small sheet of white writing paper, that has been thoroughly dried on the top of a stove sufficiently hot to

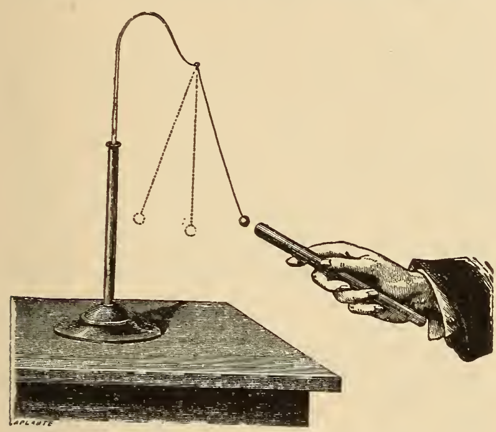


FIG. 94. ELECTRIC PENDULUM

dry it without burning, on a piece of smooth wooden board that has been similarly dried. If the paper is now briskly rubbed with a bit of India-rubber such as is employed for erasing lead-pencil marks, it not only acquires the property of drawing a suspended pith ball towards it, and

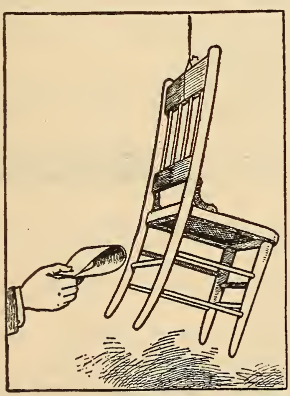


FIG. 95. ATTRACTION OF CHAIR BY ELECTRIFIED SHEET OF PAPER

repelling it, as does a rubbed glass rod, but also of attracting or being itself attracted by unelectrified bodies; for, if brought near the wall of a room it is immediately drawn towards he wall, to which, provided the air be fairly dry, it will cling for several hours. If brought near a suspended chair as represented in Fig. 95, it will attract the chair and cause it to move out of its vertical position.

The glass rod, the rubber comb, or the piece of paper that by rubbing has acquired the property of attracting bodies towards it, or of receiving electricity by friction, is said to be electrified or excited. The condition in which it existed before rubbing is said to be unelectrified or unexcited.

If the rubbed glass rod, piece of vulcanite, or a sheet of paper, is drawn to and fro near the face but without touching it, a feeling is experienced as if cobwebs were drawn over the skin. If a knuckle of the hand be approached to the excited body, in a dark room, a faint bluish spark will be

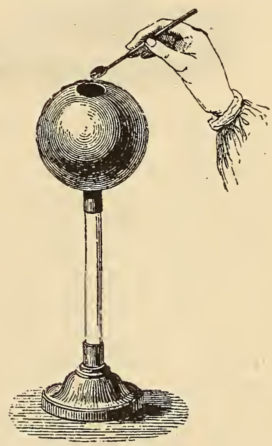


FIG. 96. ELECTRICITY RESIDES ON THE SURFACE

seen accompanied by a feeble explosion or snap, phenomena that in miniature are the same as the lightning and thunder that occur on a grander scale in the atmosphere during a thunderstorm.

If an electrified body is touched to a hollow copper sphere supported as shown in Fig. 96 on an insulated stand, the electricity spreads over its surface as a uniform and exceedingly thin layer. This can be shown by the approach of a small carrier or "proof-plane" consisting of a disk of copper foil supported on a slender glass rod. When this disk, held by the slender rod, is touched to any part of the surface, it takes off a small charge, the value of which can be determined by suitable apparatus. The electricity, however, resides only on the surface of the insulated ball or sphere. None whatever can be found on the inside; for, if the sphere is provided as shown, with an opening, say about an inch in diameter, the proof-plane, touched to any part of the inside, takes off no charge whatever. The electricity imparted to the sphere has spread through its conducting mass until it reaches the surface, where it is retained by the non-conducting power of the air.

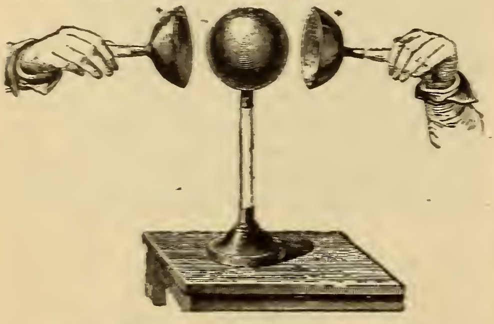


FIG. 97. DISCHARGING A SPHERE

If the diameter of the insulated globe is increased by the close approach of two closely fitting insulated hemispheres, represented in Fig. 97, the charge previously existing on the insulated sphere, leaves it and flows to the surface of the hemispheres. When these are withdrawn they will be found to possess all the electricity, none whatever remaining on the sphere.

In a similar manner if an electric charge is given to a strip of tin foil, wrapped closely in a tight coil around the surface of a metallic cylinder supported by two upright glass pillars, so as to turn on a horizontal axis, a pith ball suspended by a silk thread to a metallic upright connected with the cylinder is first attracted and then repelled from the vertical metallic supports. When, by the movement of the handle, the strip of tin foil has the area of its free surface increased by being unwound, the charge, spreading over the surface, covers it with a thinner film. In other words, the electric density, or the quantity of electricity per unit of charged area, is decreased, as is shown by the decreased repulsion of the ball, which now falls nearer to a vertical position. When, however, the strip of foil is again wound closely around the surface of the cylinder the density of charge again increases and the pith ball is thrown further from its vertical support.

The pith ball in the above apparatus forms what is known as an electrometer, or device for measuring the quantity of an electric charge. It does this roughly by the distance through which the pith ball is moved from its vertical position when at rest.

An electric charge imparted to an insulated sphere possesses a uniform density at all points of its surface. In the case of any other surface, however, the density is greater at some places than at others. In the case of a cylinder, it is greatest at the edges of the cylinder. In the case of an egg-shaped body it is greatest at the end or point of the egg. If there be any sharp corners or points on an electrified surface, the electric density is greatest at the points. Indeed, this increase in density may become so great at a point as to permit a discharge to take place.

The electrified body has received what is known as an electric charge. When touched by a knuckle of the hand, it parts with or discharges its electricity, the electricity flowing through the body of the person to the ground. There are, therefore, two conditions in which electricity may exist; i. e., as an electric charge, or when the electricity on the body is at rest, and an electric discharge or current, or when the electricity is in motion. The value of an electric charge is determined by the extent of the charged surface and the electric density, or the depth of the electric layer; the value of an electric current by the quantity of electricity that passes per minute.

That branch of electricity which treats of effects produced by electric charges, or by electricity at rest, is known as electrostatics.

FIG. 98. ELECTRIFICATION OF METAL

Going back now to the experiment represented in Fig. 93, it can be understood why the irregularly shaped fragments of paper, straw or feathers were not thrown from the electrified glass rod to which they had been attracted as strongly as were the rounded pith balls; for, the surface of these irregularly shaped fragments acquired at the points such an electric density as to partially discharge into the air. The rounded balls not suffering this loss were more strongly repelled.

The discovery that certain substances possessed a conducting power for electricity was made by an English physicist, Stephen Gray, in the early part of the Eighteenth Century. Before this time it had been observed that many substances such as the metals were apparently incapable of being electrified by friction. These bodies were called non-electrics in order to distinguish them from glass, sulphur, hard rubber, etc., called electrics, that were readily electrified when rubbed. Gray discovered that all bodies can be electrified by friction provided they are supported on non-conductors of electricity. For example, a rod of brass provided with a glass handle as shown in Fig. 98, can readily be electrified by friction, if held by the glass handle while being rubbed.

Among a variety of other experiments, Gray showed that an electrified glass rod could readily communicate its electricity to a brass globe supported as in Fig. 99, through a hempen cord for a distance of 765 feet, provided the electricity was prevented from escaping from the cord to the ground by resting it on glass uprights as shown.

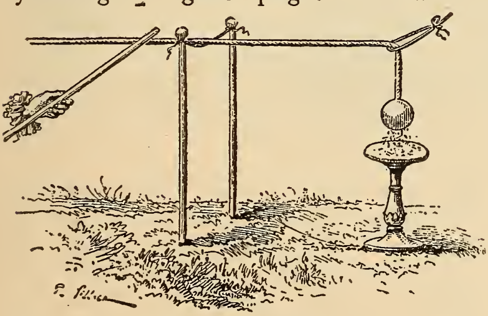


FIG. 99. GRAY'S EXPERIMENTS IN CONDUCTION OF ELECTRICITY

That the human body is a conductor of electricity was demonstrated by Gray by suspending a boy by silken cord from the ceiling of a room, as shown in Fig. 100; for, when one hand of the boy was touched to the insulated cord electricity was communicated to it from the far end, so that the body of the boy became electrified and attracted pith balls to his free hand when held over the plate as shown.

Substances differ greatly in their conducting power. As a rule the metals are good conductors of electricity. They differ, however, greatly among themselves, some, like gold and silver, being excellent conductors, while iron, lead and antimony are poor conductors. On the contrary, glass, wax and hard rubber are poor electric conductors or non-conductors.

The substances in the following table are arranged in the order of their electric conducting power, being good conductors, semi-conductors and non-conductors or insulators.

CONDUCTORS	SEMI-CONDUCTORS	NON-CONDUCTORS OR INSULATORS
Metals	Alcohol	Silk
Graphite	Powdered glass	Precious stones generally
Pure acids	Flowers of sulphur	Mica
Dilute acids	Dried wood	Glass
Solutions of salts	Paper	Amber
Ocean water	Straw	Agate
Spring water	Dry metallic oxides	Wax
Rain water	Phosphorus	Solid sulphur
Snow	Porcelain	Resins
Living plants and animals	Leather	Shellac
Linen	Parchment	Vulcanite
Cotton	Dry paper	Dry air or gases
	Hair	Extremely high vacua
	Feathers	

In order to study the effects produced by rubbing different bodies together, two separate pith ball pendulums may be employed. If a glass rod, rubbed with a silk handkerchief, is touched to each of these pith balls it will be found that when brought near one another the balls will mutually

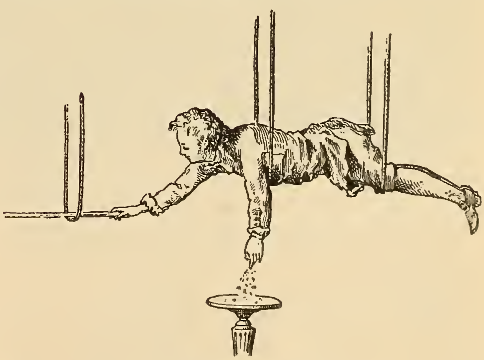


FIG. 100. ILLUSTRATING CONDUCTION OF THE HUMAN BODY

repel and move apart. If, however, one of the balls be touched by a glass rod electrified by rubbing with a silk handkerchief and the other by a rod of sealing-wax rubbed against a piece of flannel, then when the balls are brought near one another they will attract as shown in Fig. 101.

Now it can be shown that the almost countless bodies that can be electrified by friction act either like the glass rod rubbed by silk, or the sealing-wax rod rubbed by flannel. It is evident, therefore, that there are only two different kinds of electricity, one of which was formerly called

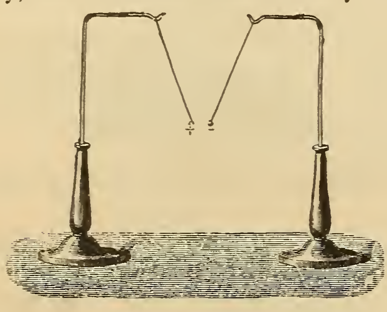


FIG. 101. OPPOSITE CHARGES ATTRACT EACH OTHER

the vitreous electricity or that produced by glass, and the other resinous electricity or that produced by resin. Since, however, it can be shown that the electricity produced on any body by friction depends not only on the character of the body itself, but also on the character of the body by which it is rubbed, the two different kinds of electricity are now known as positive electricity, or that produced in glass rubbed by silk, and negative electricity, or that produced by resin rubbed by flannel.

In the following table, a list of substances is given so, arranged that when any two of them are rubbed together the one standing nearer the top of the list becomes positively electrified, while the one standing near the end of the list becomes negatively electrified.

1. Cat's fur	8. The hand
2. Flannel	9. Wool
3. Ivory	10. Metals
4. Rock crystal	11. Sealing-wax
5. Glass	12. Sulphur
6. Cotton	13. India-rubber
7. Silk	14. Hard rubber

Thus, glass, when rubbed by silk, becomes positively electrified, but when rubbed by cat's fur, negatively electrified.

It can be shown that oppositely electrified bodies attract one another but similarly electrified bodies will repel one another. Or, in other words, like electricities repel, unlike electricities attract.

When two bodies are electrified by friction one becomes positively electrified, and the other negatively electrified. Moreover, the amounts of these opposite electricities are exactly sufficient to neutralize each other if allowed to come together.

It would appear, therefore, that the friction of one body against another produces electric excitement by breaking up something that exists in the bodies before friction.

Various theories or hypotheses have been framed to explain the nature of electricity. The two theories most commonly adopted are known respectively as the single-fluid theory and the double-fluid theory. Neither of these is very satisfactory. It will be well, however, to explain them briefly since reference is constantly made to them in electrical works. We will discuss this subject more fully in a subsequent chapter on modern ideas concerning the nature of electricity.

According to the single-fluid hypothesis framed by Franklin it is assumed that there exists a single electric fluid, the particles of which are mutually self-repellant, but are attracted by all kinds of matter; that when these particles are combined with ordinary matter they lose their self-repellant tendency; that this electric fluid is present in all bodies, to an extent varying in each body; that all matter when in an unexcited state has exactly the quantity of electric fluid it is capable of holding without manifesting its presence; that a body becomes negatively excited when it parts with some of this fluid or when there is a deficit, and becomes positively excited when there is a surplus.

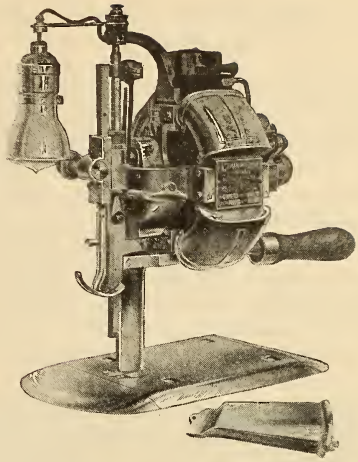
According to the double-fluid hypothesis proposed by Symmer or Du Fay there are two exceedingly tenuous, imponderable electric fluids, the particles of each of which are mutually repellant, but possess a strong attraction for one another; that is, particles of positive fluid repel particles of positive fluid, the particles of negative fluid repel particles of negative fluid, but particles of negative and positive fluids attract one another; that when they combine they hide or mask each other's presence; that a body is electrified by friction because of the breaking up of this union between the positive and the negative fluids, the positive fluid going to the positively excited body, the negative fluid to the negatively excited body.

The electrification of a glass rod by a silk handkerchief is thus explained according to the single-fluid hypothesis; the glass becomes positively excited because it takes some of the electric fluid from the silk which is thus left negatively excited. According to the double-fluid hypothesis the neutral fluid in both the glass and the silk becomes separated, all the positive fluid going to the glass, and the negative fluid to the silk.

(To be continued.)

ELECTRIC CLOTH CUTTER.

In establishments where "ready-made" clothing is manufactured there are of course hundreds of suits cut from the same pattern and it therefore becomes of advantage to use a cloth cutting machine which will cut many layers at once. Such a machine is shown in the illustrations. It is a portable device and can be moved around over the cutting table. It is operated by an electric motor and is provided with an incandescent lamp for illuminating the work at close range when desired. The motor actuates a reciprocating knife which cuts through several inches of cloth with incredible rapidity.



ELECTRIC CLOTH CUTTER

ELECTRIC CLOTH CUTTERS IN OPERATION

An overhead track from which the machine is suspended may be added to facilitate its operation.

GROWTH OF ELECTRIC PLANTS.

Illinois has the largest number of electric plants, 398, though outside of Chicago few of them are of considerable magnitude. New York has 358 and Pennsylvania 346, the last state gaining 14 in the six months, which is rather remarkable for so settled a commonwealth. Ohio has 289, Michigan 253, and Texas the large number of 288, surpassing Indiana with 218 and Iowa with 207. Oklahoma has already 76 and New Mexico 15.

RAPID PRODUCTION OF STEREOTYPE MATRICES.

In the modern newspaper office, time is of great importance, particularly in the production of the frequent editions of the afternoon papers. These papers find it necessary to get out editions at close intervals, and unexpected events are liable to entail sudden and radical changes in the makeup. Each change in the makeup of a page requires a stereotype matrix from which the plates for the presess are cast. The sporting edition, in particular, is a source of daily trial and worry.

Owing to this daily race with time the newspaper offices are the most progressive in the world. The pressroom and the composing room have been speeded up by the use of the most modern machinery. The casting of the stereotype plates is done by an automatic machine that finishes them ready for the press. The making of the matrix for these plates has remained the longest step in the process, owing to the time required to dry out the matrix.

ELECTRIC MATRIX DRIER

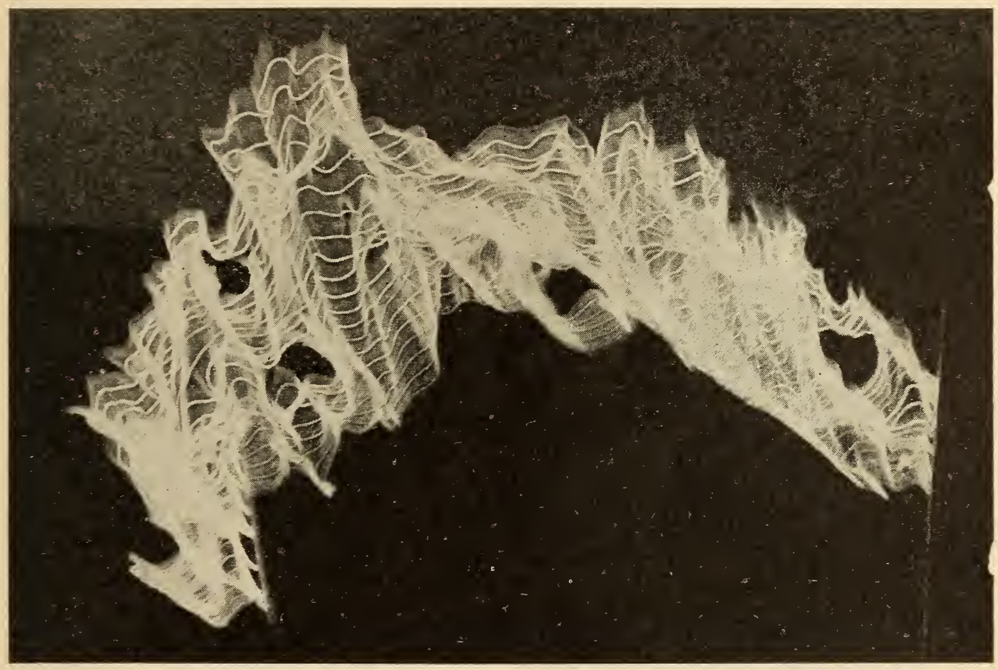
Steam and gas heated matrix driers have been, heretofore, the only matrix driers which successfully withstood the service in newspaper offices. A number of attempts have been made to increase the speed at which matrices could be dried out, including attempts to apply electric heat to the process. Owing to the localization of the heating element so as to transmit the heat directly to the type and matrix, it was evident that this method would be more rapid than any other, which was finally demonstrated.

In order to understand the difficulties to be overcome, it is necessary to consider that the matrix should be completely dried in from three to five minutes. This requires an excessively high working temperature. When the attempt was made to work with the high temperatures on a steam or gas heated matrix drier, the type or slugs were damaged. The beds of these presses were made as thin as practicable in order to transmit the heat rapidly. This made it necessary to raise them to an exceedingly high temperature so that they would be able to heat the type rapidly. In practice it was found that in order to cut down the time of drying the matrix, these beds had to be heated to a temperature that caused serious damage to the type. In 1903 the first installation of electrically heated matrix driers was placed in the Government Printing Office, Washington. Since then several very successful installations have been made, among them are the Peoria Journal, Peoria, Ill.; the Louisville Courier-Journal and the Brooklyn Daily Eagle. The time for thoroughly drying a matrix has been reduced to less than three minutes in an installation of matrix driers at the plant of the Philadelphia Bulletin.

These driers are equipped with safeguards to prevent their overheating, and in spite of their high working temperature cause no damage to the linotype slugs. One of them is shown in the center of the illustration. The ability to maintain a high working temperature in the matrix drier arises from the heavy cast iron bed plate in which the heating element is hermetically sealed. This bed acts as a thermal storage reservoir and its upper surface is maintained at a very high heat by the heating element embedded just below this surface. The comparatively cool form rapidly absorbs this surface heat and is quickly raised to a temperature sufficient to thoroughly dry out the matrix in a trifle less than three minutes, or in from one-third to one-half the time required by steam or gas heated matrix driers.

THE PROBLEMS OF HIGH VOLTAGE TRANSMISSION.

With the advent of high voltage power transmission lines, electrical engineers have become more familiar with the operation and peculiar phenomena incident to the high tension discharges, and the construction of transformers for this work has been ahead of the demands until it is now proposed to transmit power to Cape Town from Central Africa at 500,000 volts. This would have seemed impossible a few years ago, but now practical transformers for this pressure are built with modern materials and tools.



DISCHARGE AT 1,000,000 VOLTS PRESSURE

The arc shown in the picture is a reproduction of an actual photograph taken from discharge of a 1,000,000 volt, 150 horsepower transformer, designed and built by C. H. Thordarson of Chicago, who is well known as one of the electrical "wizards" of the day and whose laboratory experimental work has done much to add to the present knowledge of high-voltage and high frequency phenomena.

Indications are favorable for much future progress in the field of high tension power transmission. The problem is now largely a mechanical one; that is, to construct insulators for the line which will stand the pressure that modern transformers can be made to develop. The new suspended type of insulator, which is really one insulator above another like beads on a string, seems to offer a solution, and even now is carrying voltages that a year ago would have been thought impracticable.

THE ELECTRIC IRON IN THE TANNERY.

It is not generally known that the finish upon fine leather is largely produced with electric irons. A hide or skin, after it comes from a tanning wheel or vat, is far indeed from the handsome appearance it presents after being made up into shoes, pocketbooks, traveling bags, etc. It looks more like an old dishcloth and smells like the dead past and a boiled dinner.

A hide is finished in about the same manner as a fine shirt is laundered. First the leather is hung out to dry. Then the pores of the skin are filled up with dressing which gives substance to the leather in the same manner as starch is applied to the family washing. After this process is completed the leather is smoothed and ironed with the electric irons until it is smooth and glossy.

STARTING A TROLLEY CAR

BY ALBERT WALTON.

The engineer at the throttle, tense, watchful, alert, has always served as the example when defining the word "responsibility." Upon his keenness and his faithfulness depend the lives of the scores of men, women and children rushing headlong through space, trusting solely to him for their safety. No less nerve-racking are the duties of the thousands of men who stand for 10 and 12 hours at a stretch in our cities on the front platforms of our electric street-cars. Not only does the motorman have the safety of his passengers constantly on his mind but also he must be eyes, ears and brains for the reckless teamsters, the absent-minded men, heedless children and nervous women. This thought comes to all of us at times and we praise the true eye and steady nerve of the man in blue who brings us safely through the maze of traffic, but who of us realizes that the human element is only half of the story and that our ride and its safety depend fully as much on the successful operation of the mechanical devices operated by this man whose deft hands bring them into action.

It is not enough that the motorman never for an instant takes his hand from brake or controller handle. Brake and controller must do their part, likewise, with never failing precision. A bolt loose here, a contact finger failing there, may mean wholesale death and destruction.

What, then, is this controller upon which so much depends? What is inside the mysterious black box with the brass crank on top? How and what does the controller control? We have seen the motorman move the crank handle a notch to start the car and then in an instant another notch—a little later another and another, and if we have been observant we have noticed he let the handle rest in the fifth notch unless he wanted to run the car at top speed, as he does sometimes after he leaves the crowded city. If he does want his car to make its best time he quickly passes from the fifth to the sixth notch and then slowly again from notch to notch up to the last point, which is usually the ninth notch. But a good motorman runs his car on the fifth or the last notch, according to whether he wants half speed or full speed, and never lets the handle dwell on the other notches more than a few seconds. If there is some reason why he may not go full speed, he will go half speed. If he may not run at half speed he will give the car a start by using the second or third notch and then quickly shut off the power entirely, letting the car "coast" along by itself slowly until another impulse is needed. But you never see a good motorman run for any length of time with the controller on these intermediate notches. Why?

You will understand this better when you know what the controller is designed to do. Its function is to control the amount of electricity supplied to the two motors under the car so as to control the speed of the car itself. This it does by regulating the amount of electrical "pressure" applied to the motors. The greater the pressure applied to the motor the higher the speed.

The pressure in the trolley wire is always about the same—500 volts, a volt being a measure of electrical pressure just as a pound is a measure of water pressure. Now, since the trolley has a definite constant pressure, and the pressure on the motor must be varied to change the speed, a way must be found to choke down the trolley wire pressure so as to bring only part of it to the motors, and this is what the controller is for. In the controller is a row of "fingers" arranged on one side from top to bottom of the box. Attached to the motorman's crank-handle is a cylinder or "drum" with projections on it so arranged that when the motorman turns the handle, these projections come in contact with the fingers one after another in a certain definite order. (See Fig. 1). But until he turns it there is a space between the fingers and the projections on the drum. A wire runs from the trolley pole to two of the fingers and carries to them the trolley pressure of 500 volts. When the motorman turns his handle to the first notch, he moves the drum so that two projections on it touch these two fingers and, at the same time, another projection touches another finger of the row further down. In other words it bridges the space between this top pair of fingers and the other finger, and allows the electricity to pass across the gap, for the drum is made of metal and the current can flow through it very readily. From this point a wire carries the current to the motors, first, however, passing through a series of "resistances" (see Fig. 2), which choke down, or cut off part of the pressure. The current then flows under diminished pressure from the last resistance grid to one motor and from that to the other motor. So each motor gets only half the pressure remaining after the resistance grids have cut it down and the car, therefore, starts gently and slowly.

The next notch on the controller bridges between the upper pair of fingers and still

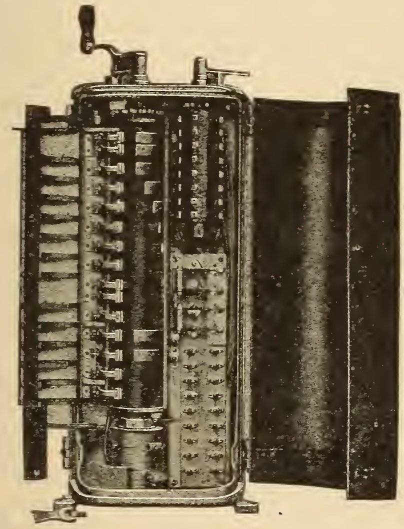


FIG. 1. INTERIOR OF THE MYSTERIOUS CONTROLLER BOX

another one lower down. This second move cuts out part of the resistances and allows the motors to have a little more pressure and develop a little more speed. The third notch cuts out a little more, the fourth still more, and the fifth cuts out the last of it. There is now a bridge to the fifth of the lower fingers and the current from the trolley passes directly with undiminished pressure to the two motors, each of which has half of the pressure, or 250 volts, put upon it, since they are "in series," the current passing from one to the other. On this notch they will therefore run about half speed and no current is being wasted in the resistance grids. If it is desired to run faster the full trolley pressure can be put directly across each motor by itself, when it will develop full power and run full speed. But this is too great a change to make directly. The car would jump violently if full pressure were to be thrown on in one move. It is therefore necessary to use the resistances again to make the steps more gradual. The sixth notch, then, sends the current through all the resistances, again cutting down the pressure so that what remains can be put directly upon each motor by itself instead of the two in series. This is done by the controller sending the current over a divided path over two parallel wires to each motor which thereby gets the full pressure less what has been taken off by the resistances. These are then cut out step by step as before till on the last notch the full 500 volts of the trolley are impressed on each motor and the car comes to full speed, no current at all passing through the resistances. This is called running "in parallel" since the current has two parallel paths, flowing, as it does, through the two motors at once.

The reason, therefore, the motorman does not run on any but the two positions where the resistances have been switched out is because there is a waste of power just in proportion to the amount the pressure is cut down. The power wasted is thrown away as heat. The grids become very hot even when the motorman is careful to keep them in use as little as possible. If he should keep on running on the notches where the resistance is used the grids would get red hot and be likely to melt or burn up. You can see these resistance grids, by the

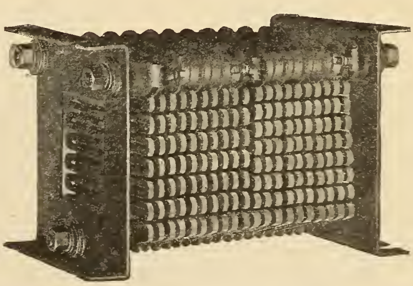


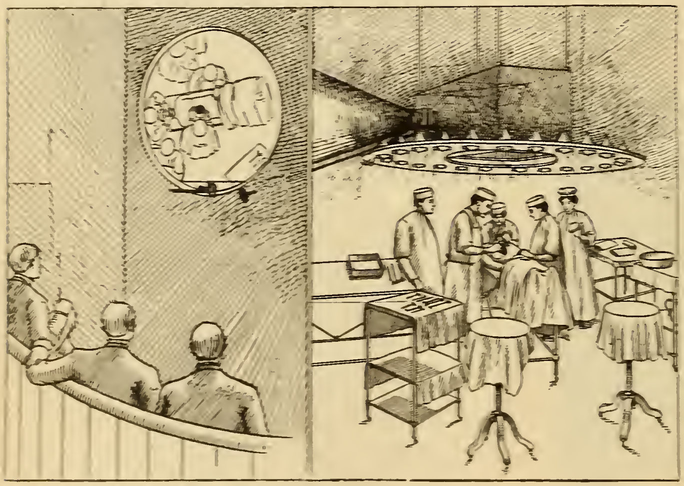
FIG. 2. RESISTANCE GRIDS

way, under almost any car. They are hung from under the car floor and are usually in plain sight right at the edge of the car about half way between the platforms.

Like most other successful inventions, this is very simple and easy so understand and does what is expected of it time after time without hitch or failure, and yet it never occurs to us to mingle with our praises for the motorman's good work a few words, no less deserved, in praise of the geniuses who have worked out and perfected the details of the devices which make our rapid transit possible.

ELECTRIC PROJECTOSCOPE FOR CLINICS.

The present method of witnessing clinical operations is for the students to gather on the high tiers of benches surrounding the operating table. This is not only an unfavorable position for observation but also increases the danger of infection of the patients being operated upon, for the many people moving into the room and to the high benches stir up a great deal of dust which gradually settles over the seat of the operation.



OBSERVING AN OPERATION BY THE PROJECTOSCOPE

A method of observing operations by means of powerful electric lights and a projectoscope has been designed by Dr. Charles H. Duncan, of New York City. The sketch shows very plainly how it is used. Over the table are placed a great many electric lamps which have reflectors to throw the rays downward. Through the circular shield is an opening into a sort of camera-like box. In this box are suitably adjusted mirrors to throw the reflected image of the patient, surgeon and attendants upon a screen as shown. This screen may be placed in the wall of an adjoining room where the students are seated. The operating room is therefore entirely cut off and may be made entirely free from floating germs.

PLATING WITH PLATINUM ON CHEAPER METALS.

There is little or no difficulty in electroplating the noble metals with platinum, but when it comes to producing an eletroplastic coating on the commoner metals, there has been trouble, especially where the body metal is required to resist high temperatures. A new process, however, has been patented in Germany by Baum, of Hanau-on-the-Main, which permits the plating of an object with platinum, thereby forming a substitute for pure platinum which resists high temperatures.

In this process there are employed the metals of the iron group, the members of which, as for instance iron, nickel and cobalt, have a high melting point, but readily form alloys which have a similar coefficient of expansion to that of platinum.

In order to give the metals of the iron group a durable coat of platinum by the electrogalvanic process, the usual way has been to plate them first with copper and then with platinum; or else to give them a coating of an alloy of platinum and some one of the metals of the lower order, as distinguished from those of the "noble" group. This latter process is suited for all cases where the demands upon the platinum coating are not very severe, but if, for instance, it is required to resist a temperature of from 900° to 1,000° C., there is difficulty from the flaking off of the coating. Platinum alloys well with copper (according to Muspratt at 350° C.), but both it and the copper flake off at the higher temperature mentioned above.

According to the new invention there can be attained a good electrolytic coating of platinum on the non-noble metals or alloys thereof, as for instance on nickel, as follows:

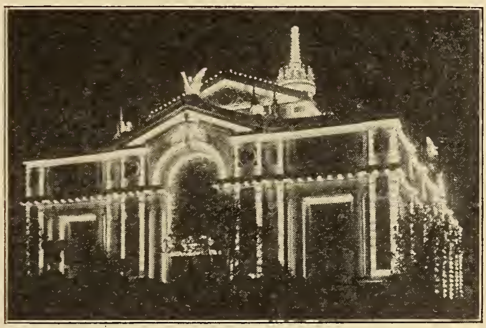
An object of nickel wire or sheet is prepared by the usual methods for electroplating, and then treated in an electrolytic bath consisting of a solution of 25 per cent of platinum and 75 of nickel. By employing a current of the proper tension and quantity (say 0.6 to 0.8 amperes for each square centimeter, with a tension of four to six volts), the result is a coating containing a small proportion of platinum, and a great deal of nickel. This layer is burnished and dried in the usual manner, and the articles then heated to 900° to 1,000° C. in hydrogen. The result is that the coating is welded on the inner metal, the hydrogen seeming to act by catalysis, or rather by penetrating into the pores of the metals and binding them together. The articles thus treated are then placed in a second bath, containing a mixture of equal parts of platinum and nickel and after the deposit here effected is again glowed in hydrogen. After this it is plated for a third time in a bath of 75 per cent of platinum and 25 of nickel, and then for the third time glowed in hydrogen. The article then consists of a core of pure nickel surrounded by layers which merge into each other and which are richer and richer in platinum as they recede from the core.

After this, the objects are plated in a bath of pure platinum and for the last time glowed in hydrogen, this time at a temperature of 1,000° to 1,100° C.

NIGHT SCENES AT THE SEATTLE EXPOSITION

At night the Alaska-Yukon-Pacific Exposition, now being held at Seattle, Wash., presents a scene such as can be produced only by a lavish use of electric lights. What would an exposition be without electricity?

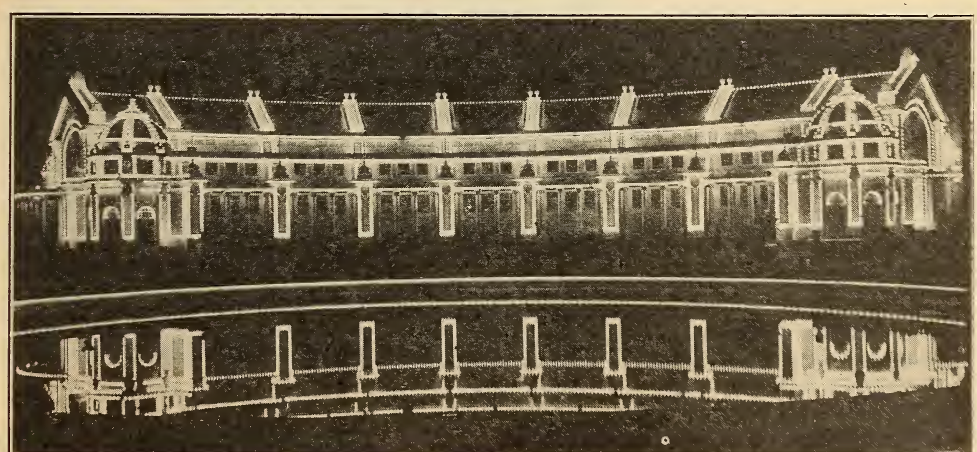
The Agricultural Building stands on the edge of Geyser Basin, and its myriad lamps are reflected with faithful minuteness in the placid waters of the pool. The Oriental Building, crowning a slight eminence on the shore of the basin, sparkles with the brilliancy of some priceless eastern gem.



ORIENTAL BUILDING AT NIGHT

The electical effects for the cascades and Geyser Basin are most beautiful, 8,000 gallons of water per minute being pumped by the electric equipment and brilliantly illuminated, in fountain and cascade efects.

Cascade Court is the central feature of the electrical effects of the exposition scheme. There is a series of dams provided for a distance



AGRICULTURAL BUILDING REFLECTED IN GEYSER BASIN of 500 feet or more, down which thousands of gallons of water run in a raging torrent over thousands of colored electric lamps placed under the water at the lips of the dam. At night the effect of these lamps is startling, for they are placed behind glass of the prime colors with shading from the darker tones on the edges to lighter ones in the center.

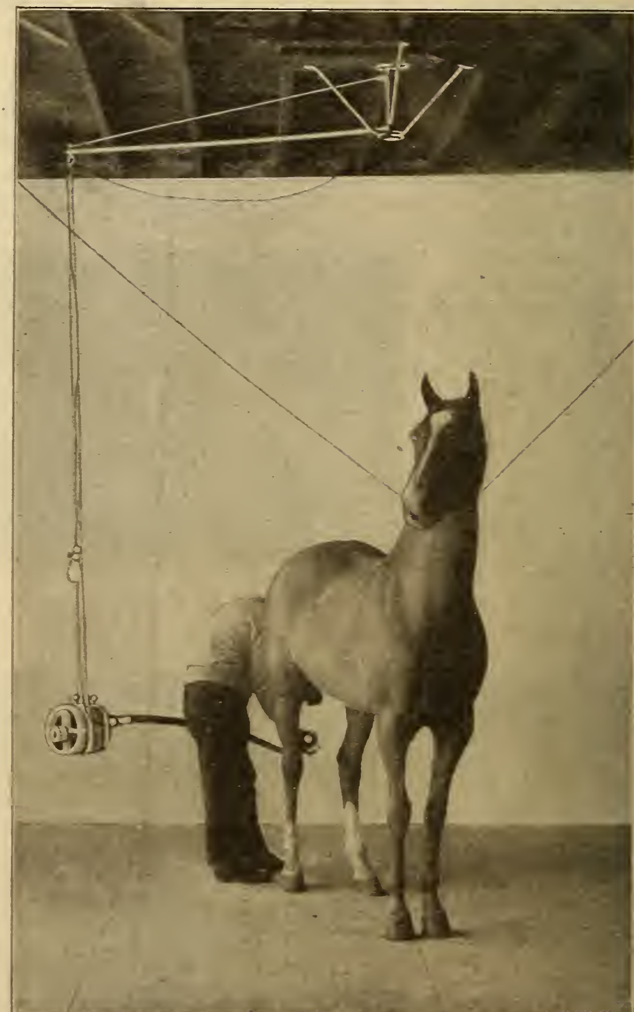
GROOMING HORSES BY ELECTRICITY

Leading horse authorities of the world and the most enlightened and progressive farmers and horse owners of every state and country, agree that horses should be clipped regularly and especially in the spring of the year. If a horse's coat is trimmed it is a simple and easy matter to keep it clean. It dries out rapidly, it does not become the lodging place of dirt, and the horse looks better and feels better. Horse grooming and clipping by machinery has long passed the experimental stage and these operations are regularly performed in this manner in most large stables. To simplify the operation electricity is now made to do all the work by a very simple arrangement which is shown in the accompanying pictures.

The horse clipping and grooming machine consists of a swinging bracket fastened to the ceiling from which is suspended a small motor which is provided with a flexible shaft extension on which may be used either a clipper or a grooming brush. The motor may be operated at various speeds, from 100 or 5,000 revolutions a minute. It operates on either alternating or direct current.

The clipping attachment is exactly like the ordinary clipper except that the reciprocating motion is performed by the flexible shaft from the motor instead of by the usual handles, greatly decreasing the labor and increasing the speed of operation. When using the brush attachment for grooming, the horse may be cleaned wet or dry in an incredibly short time, and the process is a most pleasing one, judging from the expression on the face of the one in the pictures.

Another feature of this electric brush is a pneumatic attachment which is a simple device constructed to utilize the current of air arising from the rapid rotation of the brush to protect the operator from the dust and dirt and deposit it upon the floor.

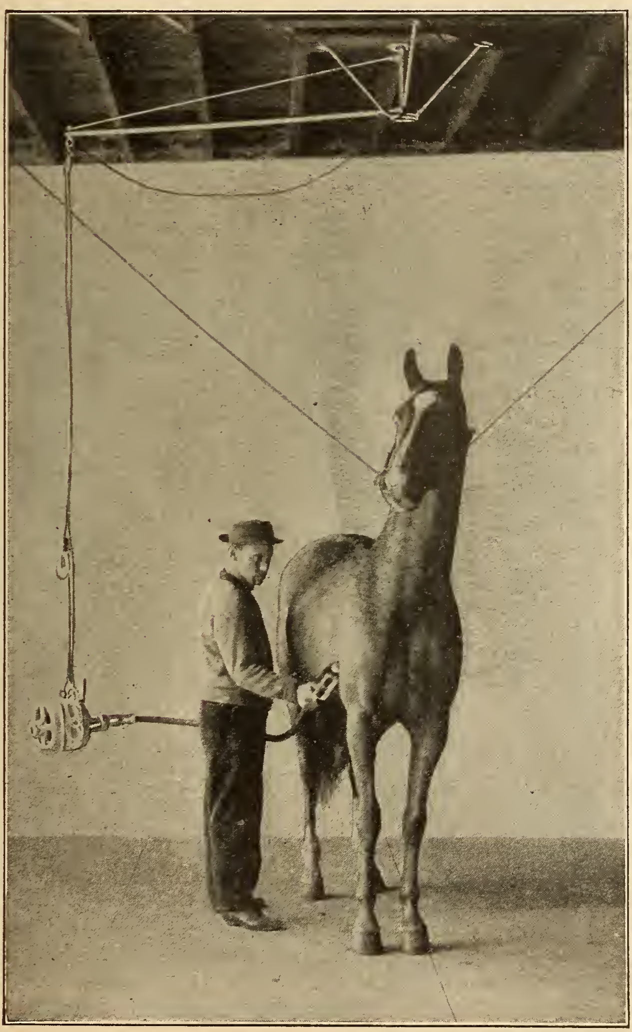


THE HORSE ENJOYS THE ELECTRIC GROOMING

In operating the machine first place the horse under the swinging arm so that when the arm is swung around from one side to the other the motor will pass behind the horse, the best possible position being so that the support for the arm which is attached to the ceiling will be directly over the horse's withers or shoulder.

THE STORY OF TUNGSTEN.

On the work bench in the laboratory of the great electric works, before the powerful electric furnace, sat a small evaporating dish containing a handful of bright, steel gray powder of a peculiar metallic lustre.



ALL DUST AND DIRT BLOWN AWAY FROM THE OPERATOR

"What is that?" I asked with true journalistic curiosity.

"That," answered the scientist, shaking the dish and disturbing the bright metal particles, "why, that is Tungsten, son of Phoebus, who gives us sunshine by night."

I had to confess that I did not understand his metallurgical metaphor.

"That little handful of powder there," he explained, "will make more than a thousand filaments for the new incandescent electric lamps. The filaments made from this rare metal, tungsten, will not only give a pure white light closely allied to actual sunlight but will give the same quantity of light as the old carbon filament lamp for one-third the current. Consider the millions of electric lights burned daily in the world and you can begin to grasp the importance of this wonderful metal which has leaped into such prominence and value in the last few months."

Ever since the discovery of the incandescent electric lamp by Thomas A. Edison twenty-five years ago thousands of inventors and scientists have been trying to improve upon the lamp. The original incandescent lamp filaments were made of carbonized strips of bamboo, which later were discarded in favor of the carbon filaments manufactured from cotton cellulose.

These lamps were the limit of extravagance as 98 per cent of the electrical energy was wasted in useless heat, while only two per cent turned into light. The scientists tried and are still trying hard to imitate nature and produce an electric lamp which will reverse these conditions and utilize nearly all the energy for light in the same way as the natural electric light is produced by glow-worms and fire-flies.

Tungsten, or wolfram, is a metal discovered in 1781 and named from the Swedish "tung" (heavy) and "sten" (stone). It is not found native but occurs as tungstate of iron and manganese in the mineral "wolframite," and as calcium tungstate. The fusing point of tungsten is higher than any other known metal, which enables it to operate at the very high efficiency obtained in the tungsten lamp. One of the laws of incandescent light is that the higher the temperature the better the light and the greater the economy of current consumed.

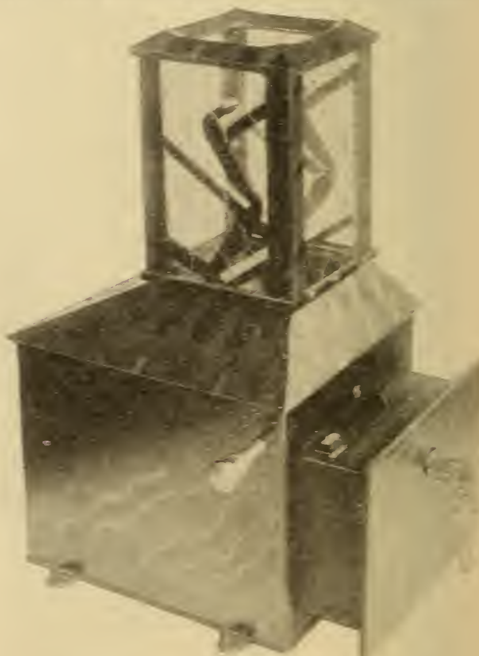
Up to two years ago tungsten was known only in laboratories and then only in a very impure state, and on account of its rarity the price was very high. But latter day prospecting has resulted in the finding of vast bodies of the ore and the price has correspondingly dropped to about $7 a pound. It would be even lower than this but for the difficulties in refining the metal. Only with the electric furnace is it possible to produce tungsten in its pure form. Pure tungsten is hard enough to scratch glass; it is almost impossible to melt it: it is malleable to some extent but not ductile. Because it cannot be drawn into wire the wire-like filaments in the electric lamps are made by the "paste" process which consists of mixing the powdered metal with binding or stiffening agents such as gums, dextrine, etc., until the mass has the consistency of putty. It is then squirted through a very fine orifice in a diamond with a pressure of several tons to the square inch. The result is a somewhat moist thread which has enough coherence to be formed into filaments which do not break while being dried. The filaments are first heated, then subjected to an electric current which causes them to sinter. The process of sintering is carried out in gases which chemically attack all the constituents of the binding agent, without the metal being affected, so that eventually a filament of pure tungsten remains.

The light from the new tungsten incandescent lamps is very nearly pure white. It is the first artificial illuminant by which all colors can be distinguished. Color is an ocular conception. Without light there is no color. A red substance is red only because it has the quality of absorbing all other colors of the spectrum and reflecting the red rays. Artificial lights in which the yellow, violet, or red rays predominate cannot be used to match colors. Under the clear white light of the tungsten lamps violet is not blue, pink is not red; and blue is not black as when looked at under other artificial light. The most delicate tints show clear and true.

The ordinary, now old-fashioned, incandescent lamp consumes 3.8 watts of electricity per candle power. The new tungsten lamp consumes only 1.2 watts or less than a third. This means that if a person is paying $3.45 for 23,000 watt hours (twenty-three kilowatt hours at 15 cents) of electricity consumed by the old lamps, for the same cost he could enjoy three times the light, and the quality would be better.

RECORDING STREET CAR FARES.

With the advent of the new prepayment or pay-as-you-enter electric cars in which the conductor stands on the platform, it became possible to utilize a form of cash register to actually receive the coins, giving an absolute check on the amount received.



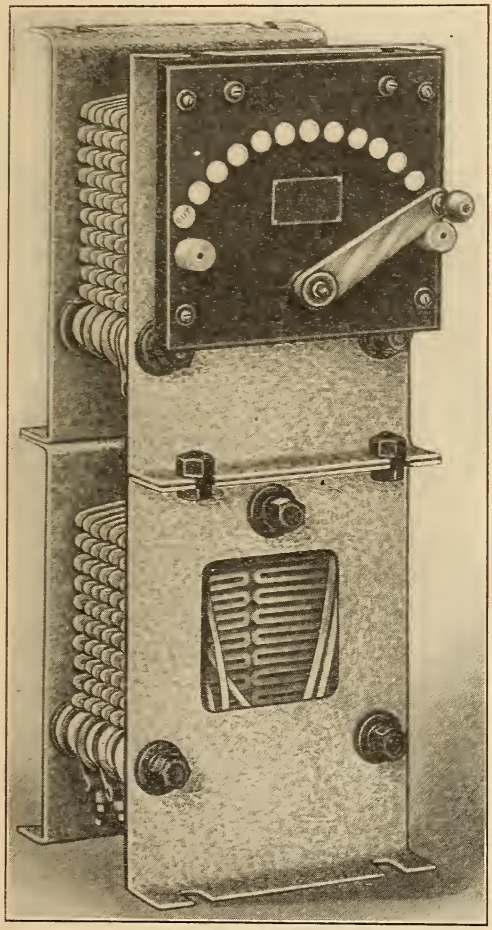
CASH REGISTER FOR STREET CARS

The passenger on entering the car drops his nickel into the wired glass receptacle at the top where it falls onto a shutter-like arrangement. After inspection by the conductor pressure on a thumb button drops the coin into the cash box, at the same time operating the register. A novel feature about this register is that it will not operate except by the presence of a coin in the machine. Without the coin the button may be operated any number of times without affecting the register.

The cash box locks automatically upon being removed from the machine, thus making it impossible for anyone other than an authorized agent of the company to gain access to the cash.

HOW TO CHARGE BATTERIES.

The question of how to charge a storage battery is often perplexing to one having occasion to use one and who is not very familiar with the principle of the operation—for instance, the electric automobile owner. He is told at the beginning



BATTERY CHARGING RHEOSTAT

that, with the ordinary 110 volt direct current available, some form of resistance must be employed in the circuit, since the voltage at the beginning of the charge is less than is required when the batteries are nearly or fully charged, and it is therefore necessary to reduce the voltage, usually by what is known as an adjustable rheostat.

What is a rheostat, he asks; and how is it used? A rheostat is simply a number of coils of wire or small grid-like metal strips through which the current must pass in going from the source of supply to the battery. These resistances, as they are called, are mounted as shown in the cut, and are so arranged that by turning the handle seen at the top, over the little buttons or contacts, the resistances are one by one cut out of the circuit. As they are cut out less and less obstruction is presented to the flow of current into the battery.

To select a charging rheostat for a given service, the circuit voltage, the minimum allowable battery voltage and the charging current in amperes must be known. The required rheostat resistance in ohms can then be computed as follows:

$$\text{Resistance of rheostat} = \frac{\text{Circuit Volts} - \text{Battery Volts}}{\text{No. Amperes Charging Current}}$$

The battery voltage is the product of the number of cells in series and the volts per cell. For example, to charge a battery which has 36 cells connected in series, at a maximum rate of $7\frac{1}{2}$ amperes from a 110 volt circuit, the minimum voltage or the initial charging voltage being two volts per cell, the resistance in the rheostat would have to be as great as

$$\frac{110 - (36 \times 2)}{7.5} = 5.07 \text{ ohms approximately,}$$

and the standard rheostat with $5\frac{1}{2}$ ohms resistance would be required.

COMBINED CIGAR LIGHTER AND LAMP.

Automobile users will appreciate the Presto combined cigar lighter and lamp.

CIGAR LIGHTER AND LAMP

To light a cigar or cigarette, no matter how high the wind or great the speed, simply press the larger button and the little heating element on the side begins to glow. To light the lamp press the smaller button. This lamp is very convenient to use in looking for trouble or exploring for lost articles in the night.

The device may be operated from the ignition batteries on the machine, and about 10 feet of cord will allow it to be used under, around or in any part of the machine.

HOW THE TELEPHONE OPERATES

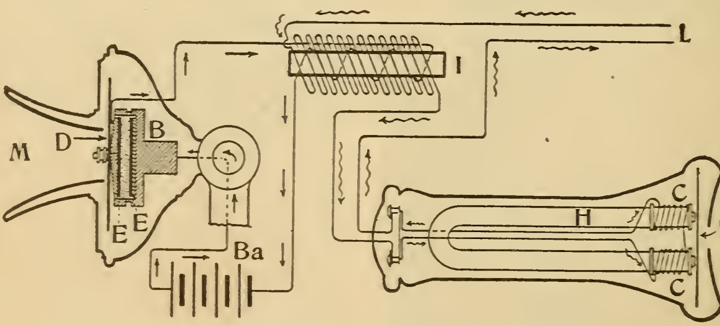
BY PROF. B. A. PERKINS, A. B. (STANFORD).

Perhaps all of us are aware, in a general way, that sound is a sensation due to some sort of a disturbance created in the air. These movements in the air which excite our sense of hearing must be quite clearly understood if we would understand the operation of any sound producing apparatus.

In most cases we can quite readily perceive that a sound producing body is in a state of vibration. These vibrations of a sounding piano string can be seen and felt. But a vibrating body in order to cause the sensation of sound, must transmit its motion to the ear through the medium of the air. When a bell rings, the surrounding air is alternately compressed and rarefied, with the result that pulsations of the air or sound waves are sent out in all directions. As an example, middle C on a piano vibrates waves in the receiver that are in all essential respects like the primary sound waves of the transmitter. As these secondary sound waves from the receiver strike the membrane of the ear of the listener they are heard just as the primary sound waves would be heard.

The transmitter is, of course, that part of the telephone we talk into and the receiver is that part we hold to the ear. Perhaps it would be well to describe these parts in a little more detail by studying the diagram.

The transmitters now in use are called "variable resistance" transmitters. Their essential parts are: The elastic diaphragm (D) upon which the sound waves impinge and behind which lie loose carbon contacts, often in the form of small grains. The receiver consists of a strong permanent mag-



SIMPLE DIAGRAM OF A TELEPHONE SET

256 times per second. This vibrating wire sends out 256 pulses of air per second, all of which impinge on the ear. The membrane of the ear is thereby made to vibrate 256 times per second. These vibrations are transmitted to the auditory nerves and the brain interprets them as sound sensation of definite pitch, loudness and quality.

There is a disk of metal or other elastic material in a telephone transmitter that responds to air vibrations, moving in unison with the air waves that impinge on it. In this respect, it is essentially like the membrane of the ear.

It must not be thought that these vibrations are passed on over the telephone wires. But the telephone, by means of the electric current, does produce secondary sound net (H), a small coil of insulated wire (C) surrounding one end of the magnet, and a diaphragm (D′) (a thin sheet of soft iron) placed very near but not in contact with the magnet and the coil. The essential parts of the transmitter and the receiver are protected and supported by a case.

Through the transmitter, over the telephone wire, through the receiver, and back over a return wire to the transmitter again, there flows a very weak current furnished usually by a few dry cells.

Let us now see what role this electric current plays. We have already noted that the telephone wire does not transmit sound waves. It does transmit pulsating (varying) currents which correspond in frequency to that of the sound waves. It is the part of the transmitter to produce this variation in the current strength.

Those who have had any practical experience with electricity know that the effect of a loose contact between any two parts of a circuit is to increase the resistance and thereby weaken the current. But this effect is very much more than usually noticeable if the parts are carbon, as they are in the transmitter. Sound waves on the diaphragm of the transmitter cause a varying pressure on the carbon grains back of the transmitter and thereby a variation in the resistance to the current that is passing through the carbon grains. The resulting variations in resistance cause instant variations of current.

These fluctuating currents coming over the line pass through the insulated wire coil in the receiver and thus vary the magnetic field strength. This, in turn, varies the normal pull of the magnet upon the thin disk or diaphragm (D′) and as a result the diaphragm is caused to vibrate in accordance with the undulatory currents sent over the line. The like vibrations of the receiver diaphragm produce as an effect sound waves in the air like the casual air sound waves at the speaking end. This persistence of infinitesimal waves in all their sinuosities through repeated transfer and transformation may be regarded as one of the most wonderful and striking phenomena in science.

For operating the call bells on telephones, a small generator, called a "magneto," may be employed. This consists of an armature which by means of a projecting handle, can be revolved rapidly between the poles of a permanent magnet. The current thus produced is led to the distant telephone where there are usually two bells placed near together. The alternating current causes the bell clapper to strike them alternately as long as the handle of the magnet is being turned.

In every telephone we have a "signal" circuit and a "talking" circuit. It is seen that the current for the signal is an alternating current which may be generated by a small dynamo or magneto which we turn by hand. The direct but fluctuating current for the talking circuit is supplied in most cases by dry cells. We may operate either of these circuits at will, but not both at the same time.

When the receiver is on the hook, the magneto and bells are in circuit, hence we "ring up" before taking the receiver from the hook. When the receiver is taken down, the hook flies up, throwing the magneto and bell out of circuit. We are then able to talk to "central." When the subscriber rings up central, the current sent over the line from his magneto attracts the armature of an electro-magnet in the central switchboard and thereby releases a drop behind which is a plate carrying the subscriber's number. When the drop is down, it remains down until central puts it back. Once the subscriber's current has released this drop, no amount of turning his magneto handle will avail him any further. He may sometimes save his temper if he remembers this. When central notices this subscriber's signal, she inquires what number he wishes. Having learned this, she connects up the number desired and by means of a magneto calls the second subscriber to his telephone. When the conversation is completed, one of the subscribers notifies central by means of his magneto. The receiver hook must always be pulled down before ringing.

The system just described is called the local battery system. In the most recent practice, especially in larger cities, the local battery at the subscriber's end is done away with and so also is the magneto. A current to take the place of all the local batteries is furnished by a storage battery at the central station. This system is consequently called the central energy system.

In this system when a subscriber wishes to call up central, he has only to lift the receiver from its hook. This closes the circuit and lights up a small glow lamp on the switchboard in front of the operator. Central calls up the desired subscriber by means of an alternating current from her magneto, which in this case is a little power driven generator in the exchange. As soon as the subscriber replaces his receiver upon the hook the small glow lamp is out. This is, therefore, a notice for central to disconnect the two lines.

A new type of electric locomotive, of which twenty are in course of construction for the New York Central, will be capable of developing 4000 horse-power at high speed, the armatures of the motors being mounted directly upon the driving axles.

ELECTRICITY IN ARTILLERY OPERATION.

The recent reorganization of the United States Coast Artillery Corps has resulted in the adoption of many new electrical appliances. The picture herewith shows one of the portable searchlights with which our monster coast defense guns are equipped. These lights are not unlike those in use on men-o'-war, except that they are mounted on light-wheeled trucks and can be rapidly moved from one position to another. The generating plant is also portable, and can be put in operation almost instantly, as a gas engine is used to drive the dynamo.

ELECTRIC SEARCHLIGHT FOR ARTILLERY SERVICE

These lights are used to locate the enemy, both to direct the firing and to expose mined areas when the enemy is passing over them at night, so as to explode the mines at the proper moment. Searchlight drill, in which from one to three or more of these lights are used, is held at the forts at regular intervals. The drills are spectacular sights where two or more forts, with three lights each, are adjacent to one another, as is the case at some of our Atlantic and Pacific coast artillery districts.

The ranges of search and the commands during drills and in action are given by the battle commander from the secondary or fire commander's station by telephones, the lines being laid in underground cables, to the operator.

Telephone service at artillery posts is a most wonderful and intricate system. There are, generally, two or more of these systems, so that if one is disabled the other may be substituted. The big guns and mortars are sighted and fired by telephone instruction, the commands often being given from a point a mile or more away.

Another astonishing electrical invention used at the gun pits and fire command stations is a small instrument known as the telautograph. This contrivance will accurately reproduce the handwriting of the plotter or range finder, or of the battle commander, who may be a mile or more away from the gun pit, on a sheet before the gun commander in the pit. This machine is designed to record commands given in battle so there will be no opportunity for error, and is seldom used in drill work, owing to the telephone being so much quicker.

In the magazines surrounding the gun and mortar pits nothing save incandescent lights, heavily cased with wire screening, are used. Projectiles are handled by electric hoists and an electric signal system connects the interior of the magazine with the gun crew outside.

ELECTRICITY FROM WIND POWER.

The power of the wind, if it could all be used to advantage, would set at rest our fears concerning the exhaustion of the coal fields, but up to the present time very little has been done, comparatively speaking, to utilize this important force. Windmills, to be sure, are very commonly seen, but they are mostly used in a small way, on farms, for pumping water, grinding feed, etc.

The windmill, or wind turbine as it might be termed, has often been proposed as a prime mover to operate dynamos for the generation of electrical power. Experiments have been carried out along this line, notably in Denmark, and some successful working equipments have been built. Manufacturers of windmills in this country have also spent considerable time and money trying to develop the scheme, but their experience has been that, owing to certain difficulties of applying the power to the dynamo, the system is not a very economical one. The two main difficulties to be overcome in utilizing wind power are the uncertainty of the wind and the variation of its velocity when it is blowing.

Electric current for lighting purposes must be steady and its voltage must not rise and fall to any appreciable extent, or the lights will flicker. Since the voltage is directly dependent on the speed of the dynamo it will readily be seen that to maintain a constant voltage with a wind-driven dynamo, a more or less complicated governing device must be used. Then, too, as the wind will not blow when we want it to, we must provide a large storage battery to store up energy for use in periods of calm.

The problem of wind-generated electrical power is, however, an interesting one and will no doubt some day be satisfactorily solved. A recent installation at Willeston Green, London, England, though small, presents some interesting features. It furnishes current for 150 10-watt lamps and also for cooking and heating. The picture shows the windmill and governing devices.

On the wheel are two vanes or tail pieces which control the wheel and hold its face in a position relative to the direction of the wind such that the force exerted by the wind, and consequently the speed of the wheel, are practically constant at all times, regardless of the wind velocity.

It is asserted that by this arrangement the amount of power exerted by the wind upon the wheel can be kept within that required for the generator and thus enables the plant to look after itself in the strongest gales.

The electric generator is of two kilowatt capacity (about 2½ horsepower). Its armature shaft is placed vertically and is driven direct by means of a belt from a pulley placed at the bottom of the vertical shaft of the windmill. The control of the field circuit of the dynamo is maintained by resistances worked automatically.

WINDMILL ELECTRIC PLANT

ELECTRIC KITCHEN OF AN OCEAN LINER.

It is no small matter to attend to the feeding of the small army of passengers which demands attention during the trips of a large ocean liner. Early in June the "George Washington," the largest German steamship afloat, left the German Lloyd docks for New York City and it is stated that fully four thousand people were aboard this giant steamship.

Without the assistance of electricity it would be a hard task, indeed, to feed this army of travelers four and five times a day. The kitchen and storerooms of the "George Washington" are fully equipped with the very lastest electrical devices to make this enormous task as easy and convenient as possible.

Many of these devices such as egg beaters, potato parers, mincing machines, automatic egg boilers, coffee mills and dish-washing machines are worked by electricity.

In addition to the kitchen there are on board ice houses for meats, bakeries, a confectionery room and scullery rooms. In all the kitchen and provision rooms occupy a space of 47,000 cubic feet.

The cold storage and provision rooms are so arranged that their contents may be readily sent into the kitchens by electrically operated dumb waiters.

USELESS WASTE OF POWER.

BY P. C. HENRY.

The Piedmont section of North and South Carolina is abundantly blessed with water power. The principal rivers abound with many shoals and valuable water power sites. Of late years, most of these valuable power sites have been bought by various companies. A few power sites are being developed; but the majority are still unused. In the course of the next decade, this section will certainly be crowded with factories—especially cotton, furniture and tobacco factories, on account of the cheap power from the nearby rivers and immense raw materials at their doors.

USELESS WASTE OF 25 HORSEPOWER

Catawba County, N. C., resembles the Piedmont section in that it, too, has many and valuable shoals on all the creeks in the county. While these small falls are not as valuable as the shoals in the rivers, they are of late being bought for development.

Quite recently, the writer bought a valuable fall on a strong creek, five miles from a growing city, for $550.00, together with twelve acres of land and water rights to erect a 15-foot dam above the falls. The natural fall is 20 feet, which will give a working head of at least 35 feet, capable of generating 35 to 40 horsepower.

Many developments are being mapped out by which to use the energy of our Kenwood Falls. The first use will be a family laundry, as power, water and heat can be furnished in unlimited quantities and without cost. There will also be electric motor trucks to haul our goods to and from the nearby city.

The second development will be a creamery, in which the milk from the surrounding country will be worked into butter, and porkers fattened upon the by-products of the creamery.

The third improvement is to be an ice factory, to supply the daily needs of a growing city during eight months of the year. And with no rent, no taxes of any consequence, no water charges, no expense for power, no expense for drayage, it would be difficult to compete with us in supplying cheap ice for the inhabitants of two nearby cities.

The fourth development will probably be an overall factory, in which to use the surplus of our electrical energy. Located outside the city, labor can be secured at a minimum figure, raw material at the door, and power for the machines free of charge.

Years ago, every shoal on our creeks was used to grind corn; but as roller mills in the towns made their appearance, the small grist mills lapsed into decay. Now, however, a new use has been found for the power of every small waterfall, so it is reasonable to suppose that during the coming decade electrical energy will be produced at the majority of these shoals.

The electric vehicle is essentially the proper equipment for shopping trips; for the doctor who must depend upon a machine to be in readiness day or night, and which he can manipulate himself without fuss or bother and without calling upon a professional driver. The noiselessness and ease of control of the electric vehicle make it the perfect machine for ladies' use, and for threading through the busy city traffic the business man for his short trip finds it an especially agreeable mode of travel.

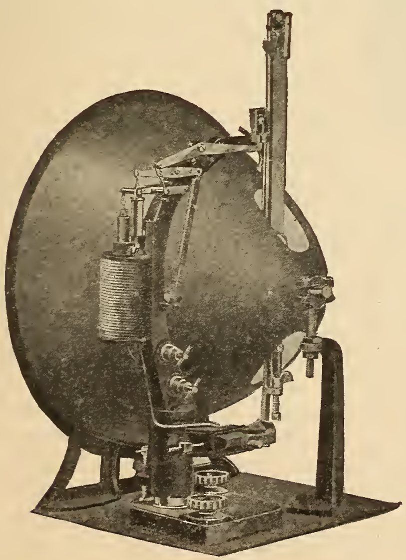
THE LOCOMOTIVE SEARCHLIGHT.

It is an inspiring sight at night to see a hundred ton locomotive go tearing across the country with a speed commensurate with its thousand horsepower and cutting the darkness with a beam of light which turns night into day for a mile ahead along the glistening rails. Or perhaps long before the sound of the train is heard or its whistle reaches our ears we see the glimmer of that spectre light reflected from the clouds.

LIGHT AS DAY FOR A MILE AHEAD

With the increased weight and speed of our modern trains came the necessity of more powerful headlights in order to light the way, for a heavy train going 70 miles an hour cannot be stopped in the same length of time that would suffice for the old time locomotive with its oil lamp and reflector. So of course electricity was again called upon and the result was the modern searchlight.

How is a locomotive searchlight operated, someone asks, and where does it get its current? This is accomplished in various ways, one method being by means of a little steam turbine on the locomotive which drives a dynamo for furnishing current to the arc lamp in the searchlight and also to a number of incandescent lamps for lighting the engineer's cab.



ELECTRIC LOCOMOTIVE SEARCHLIGHT

The turbine, though small, is of the latest pattern, the dynamo is a small compact affair, and the two are sometimes located just ahead of the smoke stack and at the back of the box containing the searchlight, or else at the rear of the sand box and whistle.

The searchlight is shown in one of the illustrations and contains various governing features, well known to electricians, which keep the two carbons of the arc at just the right distance apart for proper burning.

THE MOTOR DISPLACES THE BELT.

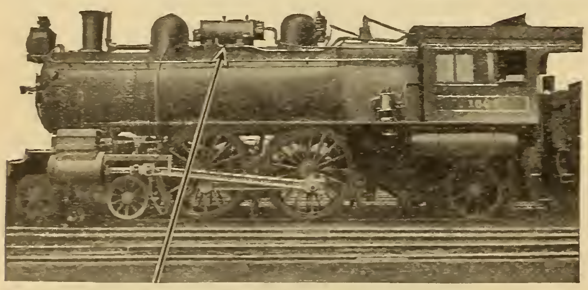
The first application of electric motors to machine tools was made a few years ago, although the idea was suggested by the late John Good, cordage manufacturer, as far back as 1893. In that year Mr. Good took out a patent for a cordage spinning machine driven by an attached electric motor.

Few persons outside of manufacturing employment realize to what extent electricity is now employed in the operation of machinery. Within the last decade it has been applied to machine tools, and the use of tools equipped with motors in big manufacturing plants of the country is growing so steadily as to warrant the assumption that it will at no distant day entirely supersede steam with its group and belt methods of driving machines. Within the last few years the textile manufacturers of the country have also thoroughly tested direct drive in that industry with the result that nearly every textile mill north and south is adopting motor drive for individual machines.

The economies of direct drive are easily seen. When the machines are idle they are using no power. There is no loss in power transmission, no loss in friction of belts, gears and shafting. The light is not obstructed with overhead shafting and connections nor is there any danger from flying belts and shaft ends. The power losses in shaft and belt transmission are considerable and are felt most in the coal bunkers, for it takes fuel to produce this wasted energy. With electric drive all the machines can be stopped but one or two, which use power only in proportion to the work they do, and the whole power plant does not have to run full blast to drive these few machines.

LIGHTING TRAINS WITH TURBINE DYNAMOS.

The lighting of railway trains has been an interesting problem to the lighting engineer since the first days of railroading, but it is only since trains traveled with sufficient smoothness to permit of reading on the cars that the electric lighting of steam trains has become a really important matter.



SHOWING TURBINE DYNAMO ON LOCOMOTIVE

Various systems of electric train lighting have been used with varying degrees of success, embodying, as a rule, an electric dynamo driven from the car axle. One of the latest successful schemes, however, is to light the train from a steam turbine-driven dynamo mounted on the locomotive, which works in conjunction with a storage battery located on each car.

A small Curtis turbine dynamo is mounted on top of the boiler of the locomotive as shown in the cut. A turbine governor takes care of the speed variations caused by differences in boiler pressure, while a small voltage regulator acting on the dynamo field maintains constant voltage. This dynamo may be considered as taking care of the load and giving constant and steady illumination as long as the train is connected to the engine. To prepare for such times as the train is disconnected, each car is equipped with storage batteries which are charged by the dynamo on the engine during such time as the dynamo is not supplying current direct, for lighting the lamps.

There are also various automatic features for connecting and disconnecting the dynamo and batteries and the lighting circuit, involving simple devices known to electricians, such as relays, circuit breakers, etc.

PRECAUTIONARY AND FIRST AID SUGGESTIONS

BY DR. ROBERT GRIMSHAW.

At the last meeting of the Verband Deutscher Techniker in Germany, there was adopted, with the co-operation of the Imperial German Health Department, new text for the rules governing action in case of accident from electric current, a part of which is here given.

Independent of the sensitiveness of the human organism in the individual cases, it can be assumed as certain that the action of the electric current on the human system is in proportion to its strength. For this reason, conductors which are passing a high-tension current are more dangerous than those which distribute low tension current; because under similar circumstances they carry stronger currents. On the other hand, all possibilities must be avoided which reduce the total resistance of the body, and are thereby calculated to permit a strong current therein.

The current in the body is stronger, in proportion to the area and conductivity of the surface which is offered to the electricity at its entry into or passage from the system. In general, a current does not pass when only one part of the body touches an apparatus or conductor which is under tension, but the person otherwise is insulated as where the floor is dry and non-metallic or rubber shoes or very dry leather ones are worn, or the floor is of wood. In this case exit from the body is prevented. If the person in question is uninsulated, the current can pass through his body into the earth.

Moisture at the contacting portions of the body, as for instance damp hands, or a damp floor, lessens the resistance of the body to the passage of the current, and increases the danger. A well-insulated workman can touch the conductor of a low-tension current or even grasp it with the whole hand without danger. If the insulation of the place on which one stands is not perfect, momentary touching of electrified parts is not necessarily risky; but if the conductor or part is grasped with the whole hand, it may be dangerous, as the entrance of the current is thereby much facilitated. There is increased danger where the contact does not take place with the hand, but indirectly by means of a metal tool held therein, for this conducts the current over the whole system and into the body. For this reason, where work must absolutely be done on current carrying conductors, the tools should have insulated handles.

If in case of an accident the injured one is still in electric contact with the conductor the first thing to do is to free him from contact therewith. In doing this, the following should be observed:

(1) Where possible, the conductor is to be put out of the circuit by means of the nearest switch, loosening the safety device for the line in question, or breaking the conductor by a dry non-metallic article, as for instance a piece of wood, a cane, or a rope thrown over the line.

(2) In doing this, those aiding should take care, in order to weaken the force of the current, to stand on a dry board, dry cloths, pieces of clothing, or other dry non-metallic substance, or to pull on rubber shoes.

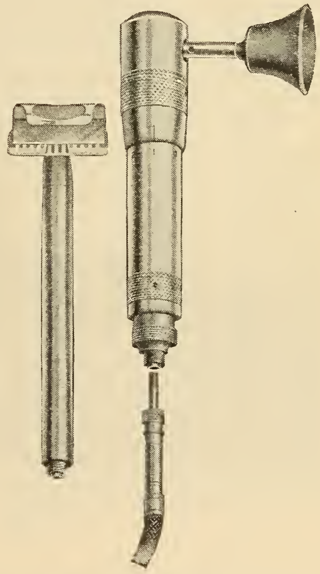
(3) The hands of the one coming to assistance should be insulated with rubber gloves, dry cloth, pieces of clothing, or other wrappings, and in rescuing the injured one he should not be brought in contact with metallic objects in the neighborhood.

(4) The injured person should be lifted from the floor and freed from the conductor. In doing this he is to be lifted by his clothes. One should especially avoid touching any uncovered part of his body. If the injured person is grasping the conductor, his grasp should be loosened, one finger at a time. Sometimes lifting the body from the ground is sufficient to break the current.

(5) The branches of electrical industry where a layman may come to the aid of an injured person are restricted to those in which the tension is not much over 500 volts. As a rule, street railway service keeps within these limits. Where, however, there is an accident from a high tension current, the first thing to do is to notify the nearest office of the plant in question, and to send for a doctor. As a rule, conductors and machines and apparatus for high tension current are marked with a danger signal.

ELECTRIC SHAVING OUTFIT.

Two or three years ago the electric shaving mug, which furnishes hot water for the morning shave in about a minute, was considered a novelty. Now it has become one of the regular utensils in the up-to-date electrical household and the manufacturers have, to use the popular expression, gone it one better, and have turned out an



ELECTRIC SHAVING OUTFIT

electric razor with vibrator attachment for an after-shave massage.

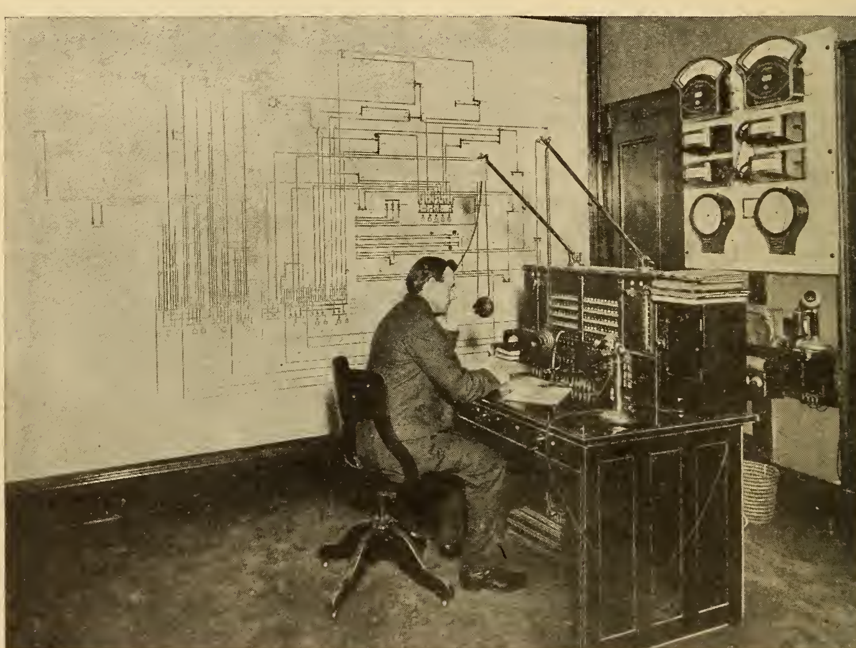
The razor is similar in appearance to the well known safety razor. It is attached to the vibrator shaft in a moment, and a rotary eccentric inside the razor handle gives the blade a vibratory movement which is said to greatly increase its efficiency. When through shaving detach the razor handle from the shaft and put on the vibrator attachment for a facial massage.

THE BRAIN OF AN ELECTRICAL SYSTEM

The electrical system of a great electric central station system such as that of the Commonwealth Edison Company of Chicago, for instance, is a veritable giant with a powerful heart and an intricate network of nerves. To properly control all the parts of this colossus and to harmonize them requires a centralized brain to direct this nervous system, says the Edison Round Table.

Such a brain center is found in the load dispatcher's office. The illustration shows the interior of this office with its two-position telephone board by which the load dispatcher can get into direct communication with all the stations and sub-stations connected with the company's system. He is thus in constant touch with every operating center. At the present time there are about 90 high tension lines carrying current at 9,000 volts and at 20,000 volts from Harrison, Fisk, and Quarry Street stations to nearly 50 sub-stations. There are also a number of lines connecting certain sub-stations together for additional security. In this large network of transmission lines the closing of a wrong switch may result in a serious wreck, so the necessity for placing all authority and responsibility for switching in one man is apparent.

An indispensable aid in the ordering of this switching is provided on the wall adjacent to the telephone boards in the form of a large diagram of the transmission system. Every 9,000-volt generator and bus, every bus switch and line, and every sub-station bus and line switch is shown in its proper location on this diagram, and by means of pegs the position of each switch (open or closed) is indicated. All operators are under strict orders never to close or open a high voltage line or bus switch without direct orders from the load dispatcher and to report to him promptly whenever a line opens automatically. When a switch has been ordered closed or opened and report comes back from the operator that this has been done, a peg is immediately placed in or withdrawn from that switch in the diagram. At times of the day when the load reaches a certain amount the system is sectionalized, that is, it is divided so that part is carried by one set of gen-



THE LOAD DISPATCHER'S OFFICE IS THE BRAIN OF THE SYSTEM erators and part by another set. This leaves many switches in the station and in a number of sub-stations so connected that the closing of them would tie these sections together. Such tying together cannot safely be done unless certain conditions exist and these conditions can be controlled only in the generating station. All such switches are thus danger points and are indicated as such on the diagram by pegs with conspicuous red tops. The pegs denoting closed switches have colored tops to indicate what operating section the line or bus is connected to.

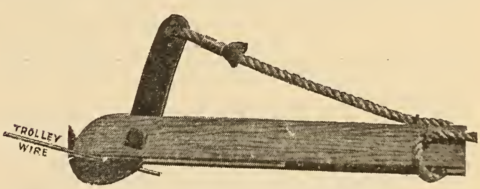
During serious system disturbance authorized members of the operating engineer's office assist the load dispatchers, of whom there are generally two on duty. During such disturbances two men take care of the telephoning, one in each position, another does the plugging on the diagram, while a fourth records on a small portable black board such important information as is called out to him by the men at the phones, such as load conditions, units damaged or put onto the system and similar information.

In a system as large as this it is frequently necessary to disconnect certain parts or apparatus for construction work, repairs or cleaning. In order that proper arrangements can be made safely for such work a system of "load dispatcher permits" was devised. Foremen or test engineers before being permitted to start work or tests on any part of the operating system must first make application for a permit stating clearly what it is proposed to do and what apparatus it will affect and when. Such application is sent for approval to a person authorized to assume this responsibility and, if approved, is forwarded to the load dispatcher. The latter makes the necessary arrangements so the application can be granted, unless operating conditions prevent. Such a system, while it may appear like red tape to the uninitiated, is absolutely essential to the safe performance of work on an extensive high voltage plant.

So much for the load dispatchers' functions with regard to their special duty of keeping the system "going." There is another side to their work which adds a welcome diversion—welcome if it comes not at an inopportune time. To many customers the load dispatchers are "the company," and to others an encyclopedia. Many humorous calls come in evenings, more humorous to the load dispatcher than to the caller, regarding the amount of last month's bill, the safety of certain wiring or the delays on certain construction jobs, and at times information is asked such as "the amperage of the street lights of Burlington, Iowa." The police and fire department also report to the load dispatchers any unsafe condition or damaged circuit which may come to their attention. In all of these calls the load dispatchers remember that during that conversation they are "the company". Police and firemen are thanked, kickers are pacified if at all possible and information is courteously given when possible. The load dispatchers are thus at times the kick receivers, again, the information bureau, or the trouble dispatchers, but at all times theirs are the guiding hands on the levers which keep the powerful giant in leash and subservient to their command, so that this, one of the greatest of central station systems in the world, will function properly and serve the city and its citizens with an efficiency and satisfaction of the highest order.

TROLLEY WIRE PICK-UP.

When a trolley wire breaks and lies squirming on the ground there is consternation. "Live wire!" everyone shouts and there is a general scampering from the vicinity. But the big power plant, perhaps



miles away, cannot be shut down because of a little frayed end way out on the system, so the next best thing to do is to tie up the wire out of danger till the damage can be repaired. A little device for doing this is known as the "trolley wire pick-up," which is shown in the cut. The handle is of wood so that the lineman or motorman can grasp the wire without danger of a shock. A light pull on the cord, a half turn of the cord around the handle, and the wire is safely in the grasp of the pick-up. Then the wire is pulled up by the cord and tied to a convenient pole or tree.

EXPERIMENTS WITH HIGH FREQUENCY CURRENTS.

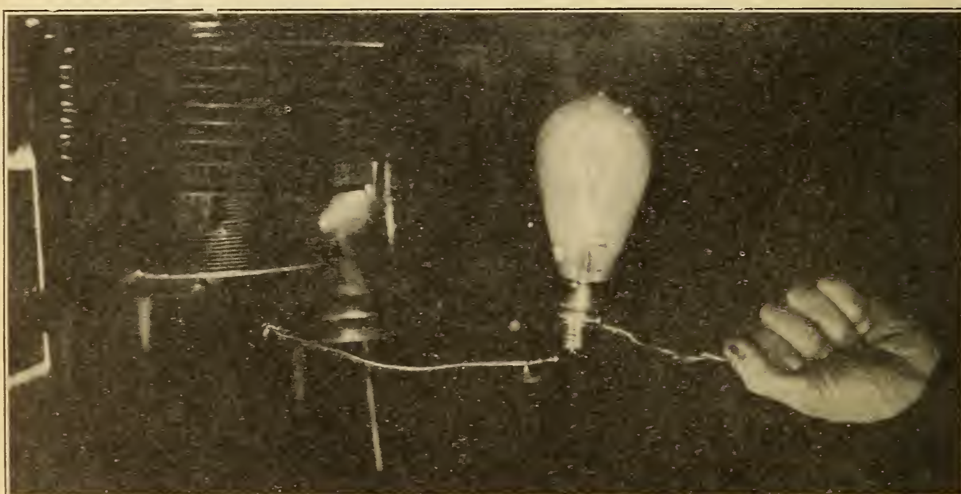
BY H. L. TRANSTROM.

It is generally conceded that the current necessary to produce death is 250 milliamperes, or one-fourth ampere. This is not always true, as some are killed by a fraction of this amount because of the difference of strength of constitution. Direct current produces the most certain death, but alternating currents of the commercial frequencies used, are the most painful. The ease by which alternating current can be changed from a low voltage to a higher one, makes it better suited for electrocution purposes.

Electricians are often heard to remark that they received a burn or shock from a circuit carrying several thousand amperes, the voltage being possibly only 220 to 500 volts. The reason they can withstand the shock is because of the high resistance of the body, and a circuit of large carrying capacity cannot force much more current through the body than a much smaller one if their voltage is the same.

Any electrician will tell you that a 110 volt 32 candle-power carbon filiament lamp consumes one ampere of current. The new tungsten lamp of the same candlepower consumes only one-third of an ampere, but is unsuited for high frequency work because the filament has too much inductance and is too fragile.

If a high frequency coil is constructed with the right proportions, and the condenser, transformer and spark-gap are adjusted to be in harmony, it is then possible to pass sufficient current through the body to light the 32 candle-power carbon filament lamp to full candle power, and even burn it out if desired without the slightest pain or inconvenience. Another remarkable thing about it is that only one wire is used, the body of the person being insulated in every way. The body acts as a plate of a condenser with widely separated plates, the body being one and the earth the other, the air being the dielectric.



LIGHTING A LAMP THROUGH THE BODY

The Tesla coil used for this purpose consists of a primary and secondary wound concentrically. The primary has eight turns of No. 4 copper wire wound eight inches in diameter, the adjacent turns being spaced apart one-fourth inch. The secondary has forty-three turns of No. 17 gutta-percha covered wire wound on a wooden cylinder five inches in diameter and five inches long. One end of the secondary is grounded to a water pipe. Only seven plates of the condenser described in the article in Popular Electricity, January, 1908, were used. The voltage on the primary in parallel was 160 volts, the frequency 60 cycles. I used a variable inductance in series with the primary to prevent the condenser spark from flaming, which would stop the oscillations. Turns Nos. 4 and 7 were the ones connected to the condenser and gap.

HOW TO DO ELECTROPLATING

BY J. R. WILSON.

PART II.

The first consideration in the plating process is the source of electric current. This may be either from a regular plating dynamo, or a set of battery cells. Of course if power is available and one can secure a plating dynamo it would be true economy, but the amateur may obtain good results with a battery.

PLATING BATTERIES.

Cells of either double liquid type or single liquid type may be used for plating. The best single liquid cell would be a "Smee cell" or modification of it which consists merely of two carbon plates with a zinc plate between them suspended from a wooden support in a jar containing a mixture of one part sulphuric acid to eight parts of water. The zincs must be kept well amalgamated. This cell when in action gives about 0.5 volt. If using this cell an addition of two ounces of chromic acid or bichromate of soda insures good steady current.

The Bunsen cell is the best type of double liquid cell to use. This consists of a glass jar containing a hollow zinc cylinder, slit on one side to allow free circulation of the solution. Within the cylinder stands a porous cup containing a bar of carbon. This cell is charged by well amalgamating the zinc cylinder inside and outside, and placing it in the jar. The porous cup with the carbon is then set inside the zinc cylinder. In the outer jar is placed a mixture of one part sulphuric acid to 10 or 12 parts of water (mixture should be cool before putting it in the cell), to cover the zinc or on a level with the liquid in the porous cup. The latter is simply nitric acid. Instead of sulphuric acid for the outer jar, battery salts can be purchased and added to the water. This avoids necessity of amalgamating the zinc, which is a troublesome job. The Bunsen type cell gives a good steady pressure of two volts.

The question now arises as to size of cell or number of cells and arrangement, to get the required current strength for different plating solutions. It is known, as stated farther on, that the various plating solutions offer different resistances to a current. It is also a rule that the surface area of the two elements (positive and negative) in a cell should each equal or exceed that of the anodes in the plating solution and the latter should always equal or slightly exceed the surface area to be plated. Following this rule out one will come very close to the required current for different plating solutions.

If one knows the amperage of his cells, however, or has the necessary apparatus to determine it, then the size or type of cell necessary for a given work is readily known. It must be stated here that the voltage for any certain type of cell is constant, regardless of the size. It also might be stated here that a double liquid cell as described has a 15 ampere hour capacity where the jar measures 9 x 6 x 8 inches.

For all plating work a low voltage with plenty of current is required. This means that the internal as well as the external resistance (or resistance through the entire circuit) must be kept low. Never more than eight volts is required in any plating.

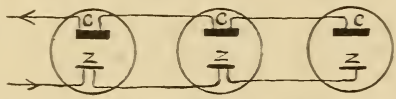
In most cases a combination of cells must be used to get the desired voltage and amperage. By connecting two cells in parallel, that is carbon to carbon and zinc to zinc, the effect is that of using one cell twice as large, for twice as much current is obtained, though the voltage is the same. By connecting in series—zinc to carbon and zinc to carbon, the voltage is doubled but the current is the same as that of one cell.

The following diagrams make this clear, taking a two-volt, four-ampere cell as an example. In using a combination of cells use all of one kind.

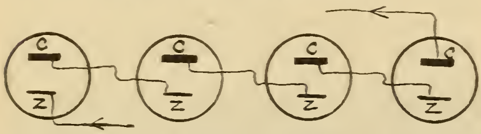
PLATING DYNAMO.

If a dynamo is used it must be a regular plating dynamo which differs in several respects from a lighting or power dynamo. The latter does not answer the purpose. A compound wound dynamo is preferable to a shunt wound. Install it securely on a foundation well insulated from the ground. It should be run by belt from a countershaft or in many cases where electric power is available, a direct connected motor is used. These latter outfits can be purchased in one piece called a motor-generator outfit.

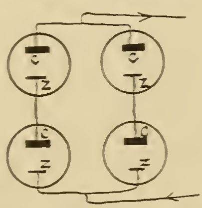
The capacity of a dynamo in volts and amperes is generally known, for a certain speed. Therefore if a dynamo is designed for a certain number of tanks, it is not



THREE CELLS IN PARALLEL GIVE TWO VOLTS AND TWELVE AMPERES



FOUR CELLS IN SERIES GIVE EIGHT VOLTS AND FOUR AMPERES



FOUR CELLS IN SERIES PARALLEL GIVE FOUR VOLTS AND EIGHT AMPERES

absolutely necessary to have a voltmeter and ammeter in the circuit. A rheostat must necessarily be installed at each tank to properly adjust the current for each tank according to the amount of work to be plated. It is more satisfactory however if a voltmeter and ammeter are inserted in the circuit. Rheostats of current carrying capacity sufficient to handle the current at each tank must be used.

ELECTRODEPOSITION

No two metals deposit under like conditions. Some metals require more current than others, some require higher voltage than others. But the chief consideration is not the voltage, but the amperage, because the quantity of metal that can be deposited in a good condition depends largely upon the number of amperes that can get through the plating solution. The strength (called density) of all plating solutions differs also as will be shown later on. Each metal has its own rate of deposit; for instance with a current of one ampere about 60 grains of silver is deposited in one hour on one-tenth of a square foot of surface while under the same conditions only 18.16 grains of copper or 16.9 grains of nickel can be deposited. This shows that silver deposits more readily than copper or nickel. The following table shows the comparative number of amperes

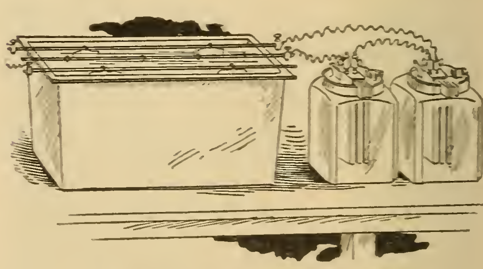
	Required Amp. per square foot	Voltage	Density of Plating Solution
Nickel	4	4	5 to 8° B
Silver	2	2-4	14 to 20° B
Cyanide Copper.	6-8	4	17-18° B
Duplex Copper.	10-12	4	15-20° B
Gold	1	2-4	

per square foot of plating surface and the density or strength of solution required for different metals.

PLATING TANKS.

For large work, especially in plating shops, the tanks are constructed of heavy two and three-inch timber firmly bolted and the inside lined with asphaltum. The preparation of this kind of tank would be unnecessary for small work. Enameled iron tanks or kettles, glazed earthenware jars or crocks, also glass jars such as those used for batteries are all suitable. Do not attempt to use bare iron.

It is safe to calculate that for each square foot of plating surface six gallons of plating solution is necessary. As most amateurs will not have a square foot of surface to plate at any one time much smaller receptacles can be used.



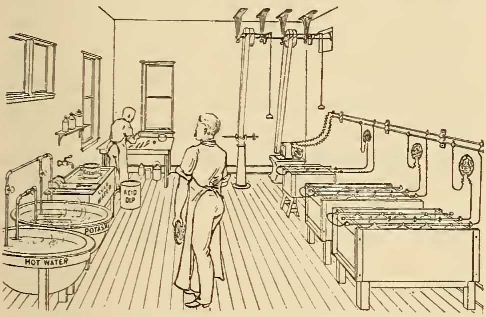
SMALL ELECTROPLATING TANK

The next thing to do is to convey the current from the cells or dynamo to the plating bath. The conductors must be large enough to carry the maximum current necessary to plate the full load of all the tanks. Resistance must be kept as low as possible. Consulting the following table the approximate size of wire may be obtained.

Number of Amperes	Diameter of Wire Required
3	.0625 inch
12	.125 "
27	.1875 "
49	.2500 "

The above figures hold for distances less than 40 feet.

Provide three rods for each tank, two anode rods and one cathode, or work rod, the latter lying between and parallel to the former across the top of the tank. These rods should be copper or brass and the same rule holds as with wire—get them large



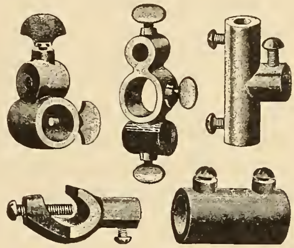
ARRANGEMENT OF THE ELECTROPLATING APPARATUS

enough. Connect the two anode rods at one end by a suitable conductor and then one of the other ends to the wire conductor from the positive terminal of the cell or dynamo. One end of the cathode rod connects with the conductor from the negative terminal. Of course where a dynamo is used the rheostats, etc., must be properly inserted. The circuit is now complete with the exception of the anodes, cathodes or work and the plating solution.

The anodes must be of the same metal that is to be deposited. These are supplied in all sizes by dealers in plater's materials. Suspend them from the anode rods by copper hooks (made by bending substantial copper wire into S-shape). The area of anode surface must be equal to or slightly exceed the surface to be plated and should extend slightly below the bottom of the latter. Maintain a distance of three to six inches between the anodes and cathodes.

The cathode or work to be plated properly prepared as described in Part I can now be suspended in the plating solution by copper wire.

Keep all connections bright and clean. When they become dull brighten them up with a piece of emery cloth. See that all connections are tight, loose connections give poor results. A few good rod connections are shown below.



FORMS OF CONNECTORS

To properly make up plating solutions one must have a book of litmus paper and a Baume hydrometer. The former is for testing the solution to find out if it is acid or alkaline. A strip of it dipped in the solution will turn red if solution is acid, but blue if alkaline. The hydrometer, as illustrated, is a graduated glass stem with a bulb filled with shot. When placed in liquids it floats and the heavier the liquid the nearer the surface the bulb will be. Thus in pure water the bulb will sink to such a depth that the zero mark will be level with the water surface. If salts or anything else is dissolved in the water, thus increasing the density of the solution, the bulb rises and gives a different reading on the stem. Copper, nickel and silver are usually the amateur platers' metals because they as a rule deposit more easily and in a better condition than most other metals. These metals will be considered in the order named.

HYDROMETER

COPPER-PLATING SOLUTIONS.

There are two copper plating solutions, namely cyanide solution and duplex or acid solution. Now it may puzzle the amateur as to which one he ought to use. Let it be made plain here that with iron or steel objects the cyanide solution must be used; with other metals it makes no difference which is used. In fact the duplex solution is easier to keep in working condition and hence is used more extensively. The duplex solution may be used on iron or steel if the latter is first plated for five to ten minutes in the cyanide solution (until it gets a good covering of copper), rinsed in clear water to remove all cyanide and then placed in the duplex solution.

Taking up the cyanide solution first weigh out the following:

Carbonate of Copper, 5 oz.		To each gallon of water
" " Potash, 2 oz.		
Cyanide " " 10 oz.		

Dissolve the cyanide of potash in a portion of water and add the carbonate of copper previously dissolved in a portion of the, water, then add the carbonate of potash, also previously dissolved; slowly stirring until thoroughly mixed. Add this to the rest of the water and stir until completely dissolved. The density of this solution should be between 15 and 20° B. (tested with the Baum hydrometer). If it is below 15°, more salts in the proportion given above and previously dissolved must be added until it is correct. If it is too strong—above 20° B.—dilute with water.

Instead of using carbonate of potash a great many platers use a little ammonia, as this keeps the solution clear.

Now suspend a piece of work from the work rod in the solution for a test. When the circuit is closed a smooth, even coat will be deposited almost immediately if all conditions are correct. The following conditions may occur:

1. No copper is deposited though bubbles come from the object to be plated. There is too much cyanide in the solution in this case and a little carbonate of copper dissolved with some cyanide of potash in water if added to the solution will start the deposition again.

2. The anodes become covered with a green coating. This shows that the cyanide in the solution is being used up. In this case cyanide of potash (dissolved in water) added slowly with constant stirring, will dissolve the green coating and plating will resume. Be careful not to add too much cyanide, however, as condition number one will occur. Just enough to cause the green coating to disappear is sufficient.

Twenty minutes will give a good coat of copper. As said before the object can be left in this bath for only five to ten minutes to give it a fair coat (called strike) and then transferred to the duplex solution. Be sure to get it well covered in the strike or the duplex will eat it off.

The duplex copper solution is made by simply dissolving 12 ounces of copper sulphate crystals to the gallon of water and then adding a little sulphuric acid. If it is too acid the deposit will be streaked. This is remedied by adding some carbonate of copper or even a little ammonia, though not enough to change red litmus to blue. Then test with the hydrometer. This should stand between 17 and 18° B. If below 17° B., add more copper sulphate. If higher than 18° dilute with water. When the solution is correct, immerse a piece of work and test. This should immediately give a good deposit, with moderate evolution of gas at the work. Be sure not to attempt to plate on iron or steel without having first "struck" it in the cyanide bath.

As brass is in such close relation to copper (a mixture of copper and zinc) it may be added here that a good brass plating solution is made by using the cyanide of copper formula and adding carbonate of zinc (5 ounces to each gallon of solution). Of course brass anodes previously annealed must then be used in place of copper anodes.

NICKEL PLATING.

There is only one good nickel plating solution and this is made as follows: Dissolve by boiling, 14 to 16 ounces of sulphate of nickel and ammonia (ask for double salt of nickel when purchasing) per gallon of water in a clean stone jar. When it is all dissolved and cool, test with the hydrometer. This solution should be worked at 5° to 8° B. If lower than 5° B. it is too weak and more salt previously dissolved as above must be added till correct. If higher than 8° B. dilute with water. Nickel solution should always be slightly acid. If, on testing with litmus, it is alkaline add just enough sulphuric acid to just turn the litmus red. If too acid, add a little ammonia. Remember that all solutions need adjusting now and then and it is best to test them a few hours before use so that if they do require doctoring they will have a few hours to stand before again using.

On immersing a piece of work in the bath and the current turned on, a thin white coat of nickel should be deposited in two or three minutes with bubbles rising slowly from the work. If too much bubbling occurs and the work is instantly covered with a thick white deposit which soon turns to a dull gray or black, the current is too strong and the work is being burned. The current must be reduced by taking off a cell, or more work may be placed in the tank.

If no deposit occurs in three minutes, and yet the work turns dark, the current is too weak and either the current must be increased or some work taken out of the bath. A good thick deposit should be obtained in 20 minutes on brass but for iron it requires from 45 minutes up. If the anodes are dirty or if the anode surface is too small, the nickel is not likely to deposit.

Nickel deposits much better if the articles are first "struck" in the cyanide copper bath for five minutes, rinsed and then placed in the nickel bath.

SILVER PLATING SOLUTIONS.

The standard silver solution used by most platers is chloride of silver dissolved in cyanide of potash. Purchase the silver chloride from a dealer in plater's supplies and make up the solution as follows:

Silver Chloride	2 oz.
Cyanide of Potash	12 oz.
Water	1 gal.

Rub up the silver chloride to a thin paste with water and having dissolved the cyanide in the gallon of water add the paste to the latter. Stir till all is dissolved. It is advantageous to filter this bath before using, and remember to keep the solution away from the light as much as possible. Light decomposes silver salts. This solution should be anywhere between 14° and 20° B.

The main thing in working a silver bath is to keep the proper proportions between the silver, the cyanide and the current. This can only be accomplished—and this is true with all plating solutions—after the operator has had experience with his solutions and can judge by the appearance of his work.

If there is not sufficient free cyanide the anodes become coated more or less with a dark slimy deposit of silver oxide and the work instead of receiving a dull white deposit assumes a bluish color.

An excess of free cyanide will be shown when the anodes become white and frosty while plating, whereas they should become gray when the current is on; and the deposit is soft and spongy which when buffing later will strip off. Silver chloride rubbed to a thin paste with water should be added or the anode surface may be increased. Precaution must be taken, however, to test the strength with the hydrometer for if it is too dense (greater than 20°) no salts should be added, but water, to lower its density.

The best way to plate with silver is to first run the work in nickel or copper solution for 20 minutes to give a good plate and after rinsing transfer immediately to a silver "strike" solution for a few seconds and then to the regular silver solution for 15 minutes or more. The reason for this is that silver will plate better over copper or nickel; preferably the latter.

A silver "strike" solution is the same solution as the regular silver except that it must be stronger (about 24° B.).

BUFFING.

The article being plated, remove it, slightly swishing it in the solution first, and rinse in hot water and place it in a box of sawdust, covering it up well. The sawdust should be of some hard wood and, if it can be arranged, kept warm to expel the moisture. Brush the sawdust off with a soft brush and take to the buffing wheel.

Cotton buffs, made of disks of muslin or cotton flannel, must be used for buffing plated articles. The hardest buffs which are best for nickel buffing are made in sections stitched or quilted together, while the softer buffs are stitched only at the centre. Run the work on the buffs the same as was done in polishing before plating, using a suitable buffing compound, which must be applied to the wheel now and then. For silver use fine red rouge composition occasionally dipped in kerosene. For copper and nickel use white Diamond or Acme. These come in stick form.

STRIPPING.

Occasionally, and probably quite often with amateurs, it is desired to replate old articles. The old plate must first be entirely removed and the surface prepared as perfectly as with articles that have never been plated.

Nickel plate is stripped by immersing the article attached to a stout wire in a stoneware jar containing a mixture composed of one pint of water, one pint of strong nitric acid and four pints of strong sulphuric acid. Add the sulphuric acid to the water and when cool add the nitric acid in making this mixture. Keep the article in motion all the time and watch closely, for as soon as the plate is removed take the article out and rinse thoroughly. If the plate is not entirely removed do not replace it in the solution before thoroughly drying (the dip must not become further diluted).

Silver plate may be removed by performing the above operation only using a cold mixture of one part strong nitric acid and ten parts of sulphuric acid. Hot sulphuric acid to which a few crystals of saltpetre are added may be substituted for the above.

A few hints are all that is necessary now.

Use only chemically pure salts in plating solutions.

Always dissolve any salts before adding them to the bath.

Remember that potassium cyanide is a deadly poison.

Have a place for all materials and keep everything in its place. All salts (cyanide, copper sulphate, etc.) ought to be kept in wide mouth bottles on shelves.

It is best to make all plating solutions up hot; salts dissolve more readily in hot solution.

The temperature of plating solutions should not fall below 60° F.

The current for a specified amount of work to be plated, must not be turned on until all the work is in the bath or burning will result. Or if desired an anode may be hung on the cathode rod on each side of the work until all the work is in.

Instead of buffing small articles such as pins, cuff buttons, etc., place them in a canvas bag with good dry boxwood sawdust and attaching one end to the wall or any support shake the bag vigorously. The articles will become nicely polished. They can then be rubbed with a chamois and rouge if desired.

DRILLING TRACK RAILS.

In the construction of electric railway tracks when the rails have been laid and bolted together it is necessary to drill holes through the web of the rail for inserting the ends of some types of rail bonds. These bonds are pieces of copper cable or very heavy copper wire for joining the two abutting rails, in order that the electric current, after it has passed from the trolley wire through the car motors to the rail, may find an easy path around the hundreds of rail joints and so back to the power plant.

The task of drilling these holes for the reception of the bond terminals, either in new track or where old track is being rebonded is a very laborious one if performed by hand, so now electric drills are largely used for the purpose. They consist of a motor with one end of the shaft projecting on which is a chuck to hold the drill. On the opposite end of the motor is a screw

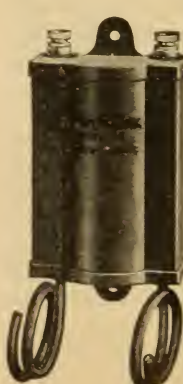
ELECTRIC RAIL DRILL

feed operated by the hand. A "U" shaped piece of steel grips the rail on the opposite side from the drill and also furnishes a shoulder against which the feed screw bears. Turning the feed screw forces the drill through the rail.

A wire cable, hooked over the trolley wire brings current to the motor, the return current being through the rails as in a car motor.

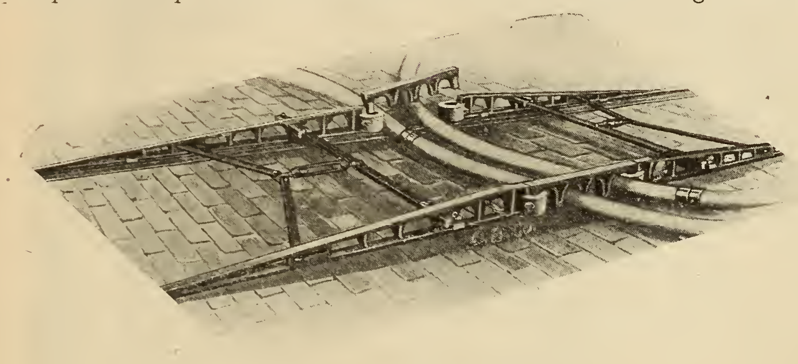
RINGING DOORBELL FROM LIGHTING CIRCUIT.

How often the question is asked: "How can I ring my doorbell from the lighting current instead of from batteries?" If your lighting current is alternating, and nine times out of ten it is, you may do this very readily. A small transformer is made for this purpose, as shown in the cut. It takes the ordinary 110-volt current and reduces it to the right amount to ring the bell. These transformers take so little current that they will not register on a wattmeter, consequently the expense for operation is nothing.



HOSE BRIDGE.

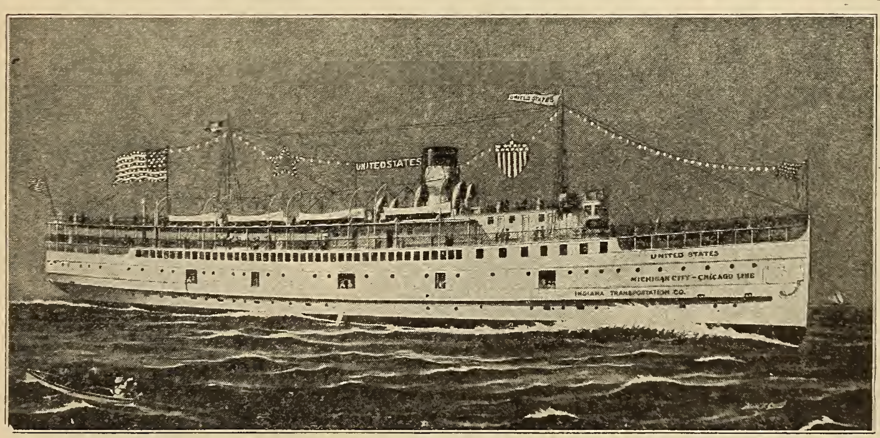
Street car traffic is often tied up for a long time during a fire because of the fire hose stretched over the track. Up-to-date railway companies now provide their "trouble wagons" with emergency hose bridges, and some fire departments use them. They are easily put down on the track rails in a manner shown in the cut and then locked together. This furnishes a slightly inclined path, and the car wheels following this path pass over the hose without cutting it.



HOSE BRIDGE

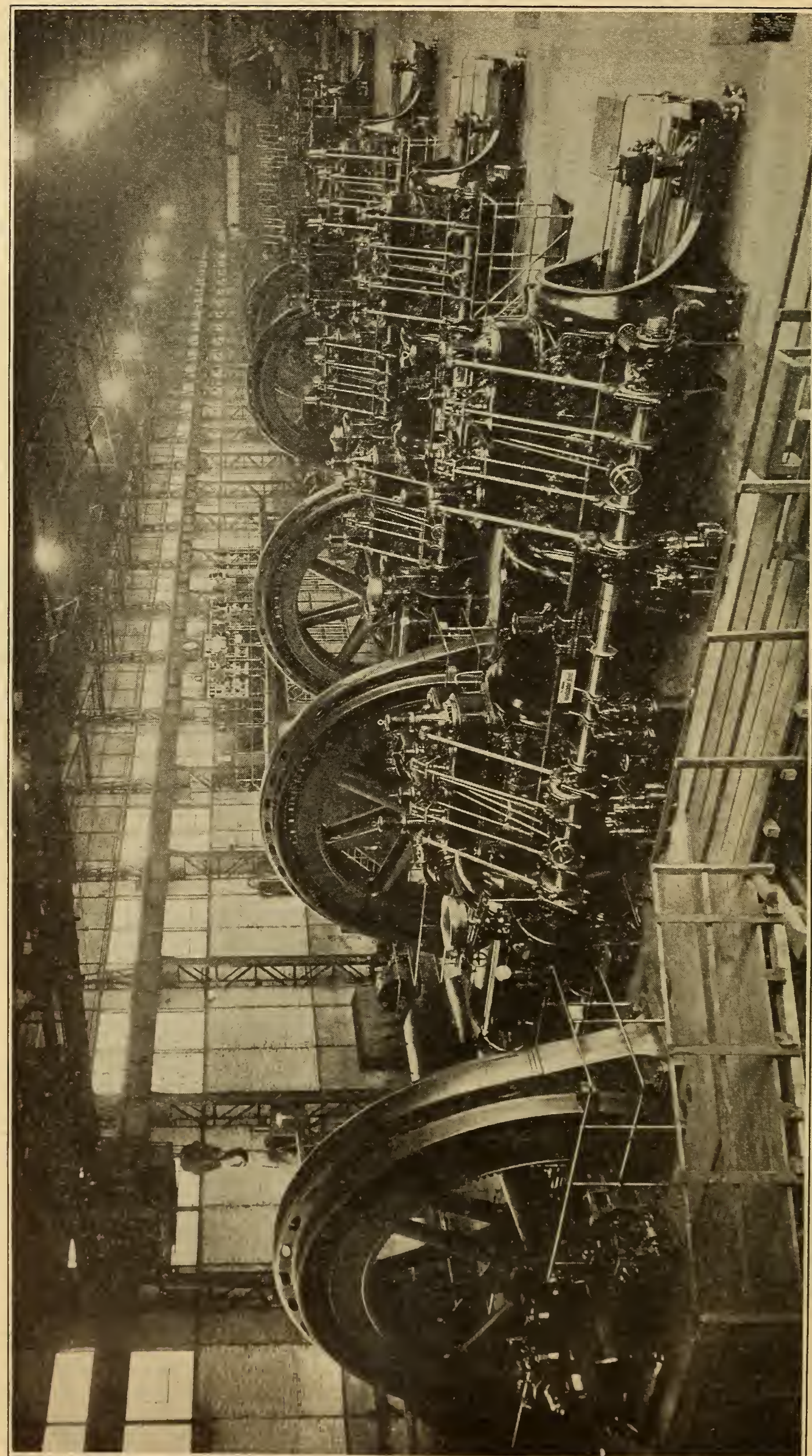
NEW LAKE STEAMER BRILLIANTLY LIGHTED.

Chief among the novel and interesting features of the new steel lake steamer "United States," which recently went into commission on Lake Michigan, is its electrical equipment. Residents along the lake shore will be afforded a marvelous sight this summer as this new vessel proceeds along its way. In addition to the regular lighting, it bears an immense shield decorated with red, white and blue lamps, a large skeleton star outlined with electric lights and a huge double face electric sign reading "United States." This sign flashes the name of the vessel first on one side and then on the other. The crowning feature is an Old Glory flag erected on the stern. It is constructed entirely of metal and is studded with red, white and blue electric lights which are arranged with a flasher giving the effect of a waving flag. To see the Stars and Stripes waving at night miles out on the lake will be, to say the least, an unusual sight. The flag, star, name-sign and shield are connected with festoons in the three colors extending from the masts.



LAKE STEAMER ELECTRICALLY DECORATED

The "United States" is 215 feet in length, 40 feet beam and to the top of the bridge measures 56 feet. It is equipped with the latest wireless telegraph apparatus.



GAS ENGINE ELECTRIC GENERATING STATION

MAKING ELECTRICITY BY GAS ENGINE POWER.

The gas engine is becoming a very lusty young competitor of the steam engine and the latter can no longer be "exclusive" as in days gone by, but is obliged to get out and hustle to maintain its dignified position, even with the assistance of its latest development, the steam turbine. In the last two or three years there have been built some very large power plants for the generation of electricity by gas engine power, both in this country and abroad, and where blast furnace gases are available it has a distinct economic advantage, for these gases were before a waste product.

One large German gas engine electric plant is that of the great iron and steel works in Haspe, and an interesting interior view is shown on the opposite page. There are five of these monster gas engines, each driving an alternating current dynamo having a capacity of 1,100 kilowatts or nearly 1,500 horsepower.

UNIQUE ELECTRIC TRUCK.

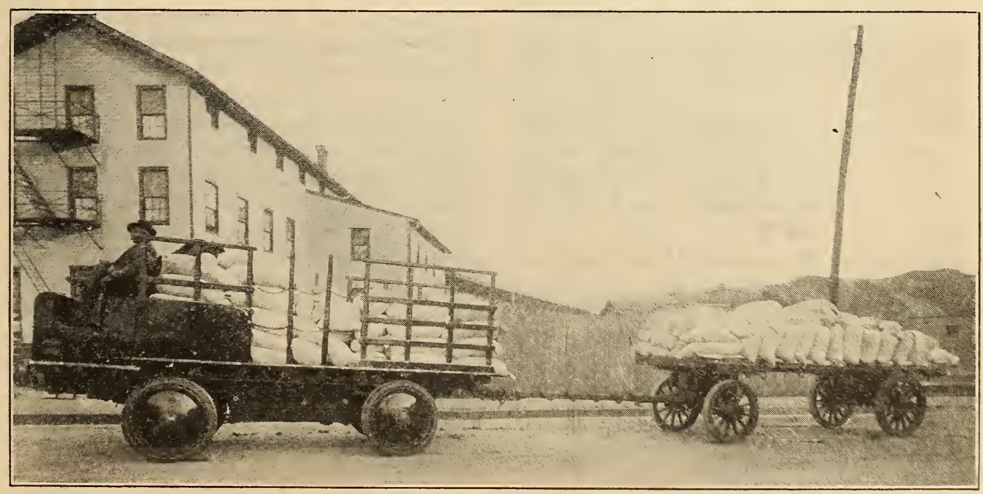
Expense and annoyance of maintaining friction clutches, reverse and sliding gears, and counter shaft sprockets and chains on gasolene trucks are well known. On the other hand the electric truck has a limited range of action owing to the necessity of recharging the storage batteries, and the latter also represent a large dead weight. A combination of the two therefore suggested itself, eliminating these disadvantages. The illustration shows a unique "gaso-electric" truck embodying such a combination.

On this truck there is a four-cylinder gasolene engine which drives a dynamo. This dynamo in turn generates electric current for the motors which operate the truck. This does away with the storage battery; it gives the advantages of electric control with practically no mechanical complications, and at the same time provides for an unlimited range of travel. The motors are located within the wheels themselves and apply the power directly to the rims of the wheels. This is done by mounting each motor rigidly on the end of the truck axle and extending the motor shaft in each direction out to the wheel rim. Here pinions on the motor shaft engage cogs on the wheel rim, and as the motor shaft turns, it exerts a "couple action"; that is, pushes the wheel forward at the top and pulls backward at the bottom.

The truck shown will carry a load of five tons and at the same time draw a trailer with another five ton load.

ELECTRIC SCALES

The customs authorities are trying out a plan to prevent fraudulent weighing of merchandise on the piers, by means of electrical scales. The new system involves the installation of electric dials in the custom house which will be connected with the weighing machines on the docks by wires.



ELECTRIC TRUCK WITH MOTORS IN THE WHEELS

POPULAR ELECTRICITY WIRELESS CLUB

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

SPARK COIL CONSTRUCTION AND OPERATION

BY V. H. LAUGHTER.

PART III.

ASSEMBLING AND MOUNTING.

One of the double sections is now taken from the linseed oil and laid flat on its face on a table or smooth surface. Directly on top of this section are placed four sheets of the filter paper. The filter paper should be placed so that it fits neatly over the surface of the wound section. It is pressed down with a moderately warm smoothing iron.

The next double section is placed on top of the first and the exposed end terminals of the two double sections connected together by twisting and adding a drop of solder. The total number of double sections are assembled in this manner. However, care should be used in assembling the sections to connect them so that the current will flow continuously in one direction around the completed coil. In Fig. 9 is shown the plan to be followed out in assembling. (A), (B) and (C) represent the respective double sections and (D) the core.

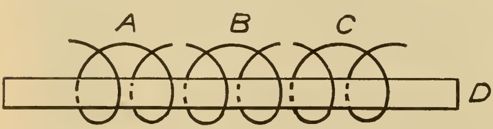


FIG. 9. MANNER OF CONNECTING DOUBLE SECTIONS

When all of the sections have been assembled the insulating tube should be run through the center. The sections are now run up the tube until the ends of the two end sections are at equal distances from the ends of the insulating tube. The primary winding and core are run through the center of the insulating tube. This completes the work on the core, primary and secondary. The next work in view is to mount these parts in a suitable case.

THE CASE.

In the Ruhmkorff type of coil the primary and secondary windings are mounted on top of a base with vibrator and binding posts, the base underneath containing the condenser. This type of mounting gives a very finished and near appearance to the coil but it requires delicate handling in building, and places the parts where they are liable to get damaged. For general all-around use in the amateur's laboratory, the coil should be so built that the delicate parts will not be exposed, and stand an ordinary amount of rough usage. This can be best accomplished by mounting the parts, with the exception of the vibrator, in a suitable case. In fact this method is now generally employed in all the most efficient types of spark coils.

The case for the size coil given here should measure five inches in width, five inches in depth, and ten inches long. This will allow one-half inch space between the secondary and the sides. The base on which the case is mounted should measure 14 inches long by six inches wide. Around this base is built up a second small case which should be about one and one-half inches deep. In this bottom case the condenser is mounted, although this should not be done until the coil has been put into actual use and the exact amount of condenser capacity to use actually determined.

In Fig. 10 are shown the four sides of the coil case and the plan which should be followed out in grooving. Although it is not absolutely essential that the corners should be grooved, this will make the case more rigid and give it a workman-like appearance. The dimensions as shown in Fig. 10 are for the inside measurements, as any thickness of board from one-fourth inch to one-half inch can be used for the building up. Therefore for building up the case will be needed: Two boards (C) (C) measuring five inches wide and 10 inches long, the end pieces (A) (B) measuring five inches by five inches, and the base (D)

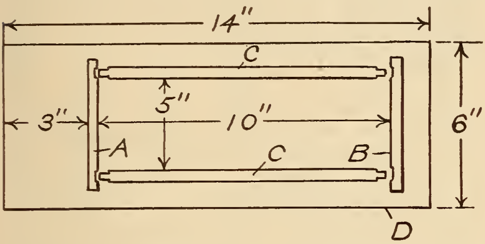


FIG. 10. MANNER OF ASSEMBLING CASE

measuring six inches wide by 14 inches long. The ends (A) and (B) however should be drilled with the holes one and one-eighth inch in diameter as shown in Fig. 11; the hole in (A) being drilled all the way through and in (B) countersunk to a distance of half the entire thickness, i. e., if the piece

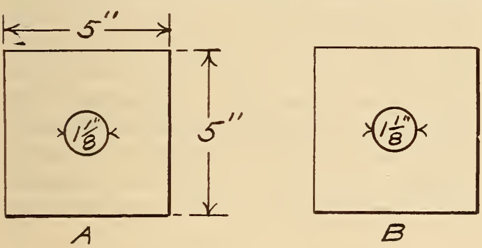


FIG. 11. END PIECE DIMENSIONS

(B) is one-half inch thick the hole should be countersunk one-fourth inch deep.

Around the baseboard is built up a second containing case one and one-half inches deep for the condenser.

The parts of the case are now all assembled, preferably by screwing down with small screws, leaving out however the end piece (A). As shown in Fig. 10 the end (A) should rest, when assembled, three inches from the end of the base (D).

The next operation is to mount the core, primary, and secondary, in the case. Place the whole in the case and let the core end rest in the one and one-eighth-inch countersunk hole in (B) and bring the piece (A) in position so that the core protrudes one-fourth to three-eighths inch through the hole.

Screw (A) up tightly, which will leave the complete parts supported in the case by the ends of the core. Before this mounting operation, however, two holes should be drilled in the base (D), directly under the primary terminals, and the primary terminals led through into the bottom case. To the secondary terminals are next connected and soldered two short leads of No. 22 single silk covered copper wire. This is done in order to prevent handling of the delicate secondary wires.

About four pounds of paraffine and beeswax in the proportions of half and half are now placed in the boiling can. When the solution has reached the boiling state, hold the secondary leads straight up from the center of the secondary and pour the boiling mixture into the case. Pour quickly and evenly as possible. It is evident that the corners of the case should fit tightly, or otherwise the boiling mixture will run out. The mounted primary and secondary is now set aside until the solution "sets," and in the meantime work will be taken up on the vibrator.

THE VIBRATOR.

In Part I we learned that the purpose of the vibrator was to "make and break" the current flowing through the primary winding and thereby induce a current of several thousand volts in the secondary turns. The efficiency of the vibrator plays a very important part in relation to the spark length. No matter how well the coil is constructed, if the vibrator is of poor design the spark will fall far below the calculated length.

In a vibrator it is essential that at each "make," or closing of the circuit sufficient time must be allowed for the current to flow around the primary winding and fully saturate the core with magnetism, and when this point is reached make a sudden break. Unless this cycle is accomplished properly, the spark will be weak and stringy, owing to the fact that sufficient time is not allowed at the "make," for the core to become energized, and the "break" is of such duration that magnetic effects will leak or become dampened. To overcome these difficulties a vibrator of the following type should be used.

The complete vibrator mounted on the base is shown in Fig. 12. (M) represents the end of the core projecting through the end of the coil case. The vibrator proper comprises the soft iron disk (K), the regulating screw (L), the spring brass strips

(J) and (I), the brass base (D), the brass pieces (E) and (F), the screws (N) and (O), the metal supporting post (B) and thumb screw (C) with platinum contact (H) in the end.

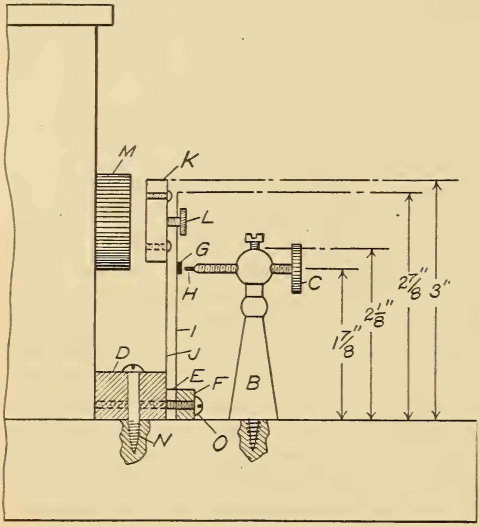


FIG. 12. THE VIBRATOR COMPLETE

To begin the construction first get a brass block made up according to Fig. 13. This is the block as shown at (D) Fig. 12. Two one-eighth inch holes (O, O) are drilled through the block three-eighths inch from each end. A third hole three-sixteenths inch in diameter is drilled through the top for the insertion of the screw (N). (See Fig. 12). The two brass blocks (E) and (F) (Fig. 12) are next made up. (E) should measure one-eighth inch thick, one-fourth inch high and one and one-fourth inches long. (F) has the same dimensions with the exception it has a thickness of three-sixteenths inch. Holes are drilled through blocks (E) and (F) three-eighths inch from each end so that a screw can be run through and will engage the threads at (O) in the block (D).

The spring brass strips (J) and (I) are now prepared. (J) should measure three inches high, one inch wide and 1-32 inch thick. The top is rounded off as shown in Fig. 14. Holes one-eighth inch in diameter (O, O) are drilled through, three-sixteenths inch from the bottom and one-fourth inch from the edges. The hole (P') is drilled through the center three sixteenths inch from the top, and (P^2) is seven-eighths inch from the top. The hole (W) is one-half inch from the top. Each of these holes should be one-eighth inch in diameter although this is not essential, as the size can be made to conform with screws on hand.

The spring (I) measures $2\frac{7}{8}$ inches in length by one inch wide and about 1-64

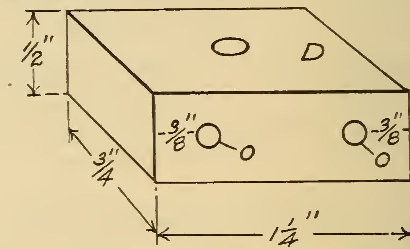


FIG. 13. VIBRATOR SUPPORT

inch thick. This spring is drilled with holes at the bottom the same as the spring (J) and a 1-16 inch hole is drilled at (G) (Fig. 12) and a one-eighth inch hole at (L). At (G) a small platinum button is fixed. This button should measure one-eighth inch in diameter by one-sixteenth inch thick, and as it usually has a small projecting tip, it will only be necessary to insert this tip in the hole and head down. The soft iron disk (K) should measure one inch in diameter by one-fourth inch thick, drilled and threaded as shown in Fig. 12. The brass standard at (B) need not be of the same style as

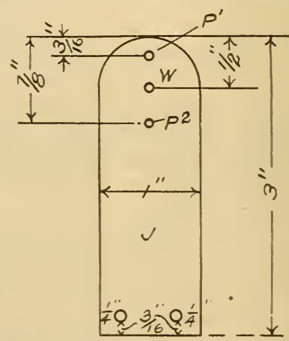


FIG. 14. SPRING BRASS STRIP

shown but it is obvious that it should be threaded for insertion of thumb screw (C) at the indicated height, and be made quite heavy to lessen the vibration.

The thumb screw (C) can be of any convenient length or size with a hole for the insertion of a bit of No. 16 platinum wire in the end.

In assembling, first the brass block (D) is screwed down to the base by means of the screw (N). The soft iron disk is screwed to the top of the spring brass strip (J), and the strip (I) loosely screwed to (J) by means of the screw (L).

These parts are now mounted on the brass block (D) by means of the blocks (E) and (F) and the screw (O). The standard (B) and screw (C) are mounted so that the platinum tip at (H) will rest directly in the center of the button (G).

This completes work on the vibrator and the cycle of operation is as follows: The primary circuit is completed through the points at (G) and (H) which allows the current to circulate through the primary winding and energize the core. The core now attracts the disk (K). The disk in its forward move pulls the head of the screw (L) against the spring (I) and quickly breaks the contacts (G) and (H). The current now ceases to flow and the magnetic pull dies down. This allows the disk to fly back, which again closes the circuit at (G) and (H). The disk, however, in its backward move goes back a considerable distance, as the screw (L) works loosely through the hole drilled in (I), and during this backward swing the circuit is closed at (G) and (H), this gives the long "make." The head of the screw (L) in its forward movement is brought against the spring (I) which gives a sharp and quick "break" at the contacts. Thus, this vibrator fulfills the conditions of a long "make" and quick "break."

The cover of the coil case is made with two binding posts to which the secondary terminals are connected.

Binding posts are also mounted on the base near the vibrator to which the primary terminals are connected.

In Fig. 15 is shown the complete coil, partly in cross-section. For connections refer to the wiring diagram of a spark coil as shown in Fig. 1, in Part I of this series.

ADJUSTMENT.

Considering that the coil has been built up as shown, the final adjusting will be taken up. First see that all connections are properly made and connect 10 dry cells in series with the primary binding post and a common telegraph key. Connect the condensers across the vibrator contacts, having all the capacity thrown in the circuit. Press the key and turn the screw (C) up until the point tips the contact on the brass spring. This will close the circuit and start the cycle of vibration. To begin with, have the secondary terminals separated about one inch and gradually draw apart as the adjustment is continued. Vary the tension of the screw (L), the thumb screw (C) and the condenser capacity until the maximum spark length is the result. This will require time and care, but each adjustment will become easier as we will have our previously learned points to draw from. Considering that right adjustment of the vibrator is made, and the proper amount of condenser capacity has been thrown in the circuit, the spark will jump a full three to four inches across the gap. The complete parts necessary will not cost over $12.00 when completed.

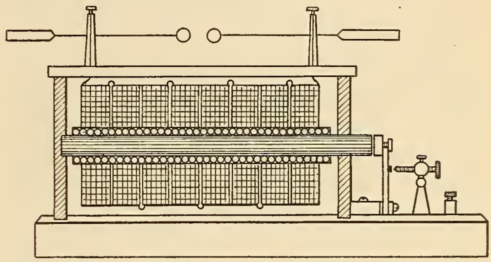


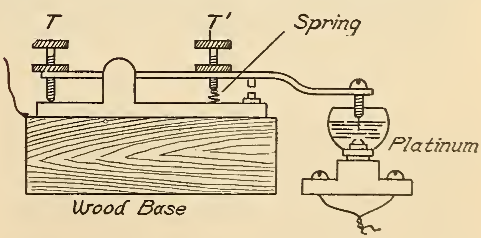
FIG. 15. ARRANGEMENT OF PARTS OF SPARK COIL

(To be continued.)

SENSITIVE DETECTOR.

The advantage of this bare point detector is that the platinum point does not turn as it enters the liquid, as in most detectors of this type, but moves in a vertical direction, and so can easily be adjusted with more accuracy.

A telegraph key is mounted on a wood base. The switch and knob are removed.



SENSITIVE DETECTOR

A screw is inserted in the end of the key, to which is fastened the platinum point, which consists of a piece of wollaston wire

0.0001 inch in diameter. When (T) is turned the platinum point is raised or lowered. The tension on the spring is regulated by turning (T′). The receptacle for the liquid is made by breaking off the top of the bulb of a miniature lamp. Connect both terminals of the lamp together.

BENJAMIN RONSLIN.

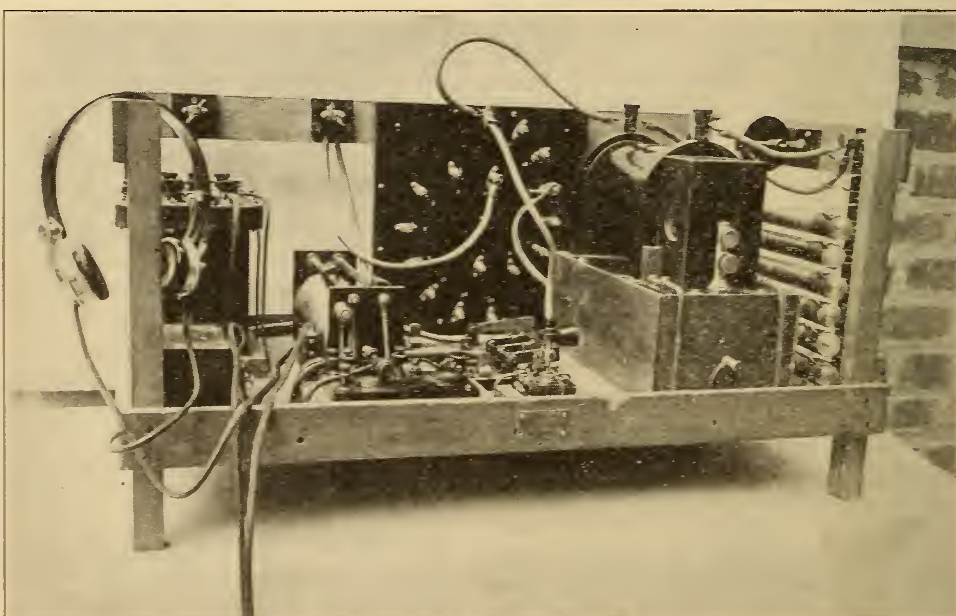
WIRELESS SET FOR AIRSHIPS

BY WALDON FAWCETT

The officers of the Signal Corps of the United States Army are pluming themselves on an achievement which gives evidence that in one important branch of preparedness for war they are in advance of the military authorities of all other nations. This latest proof of Yankee progressiveness in discovering new means of military communication is found in the invention of a wireless telegraph set for use with aerial craft of various kinds and particularly with dirigible balloons which bid fair to play an important part in the fighting campaigns of the future.

From the moment that it was proven that balloons and other aerial craft would be of practical use in warfare under Twentieth Century conditions it was realized that the value of such adjuncts would be tremendously increased if means could be found for utilizing wireless telegraphy in conjunction with these portable aerial observatories. From the standpoint of the layman there appeared to be few if any obstacles to a combination of the functions of these new factors in warfare, but when electricians and aeronauts took up the question they faced several rather perplexing problems.

In the first place it was essential that the entire wireless equipment to be carried aloft be of minimum weight, for the carrying capacity of the average dirigible or other balloon is limited. Secondly it was considered imperative that the telegraphic apparatus be provided with protectors that would preclude the possibility of a spark from the apparatus igniting the explosive gas which, through accident or design, might escape from the bag of the balloon. Some electricians who have studied the subject contend that with the air currents created



WIRELESS SET FOR AIRSHIPS

by a balloon traveling at fourteen miles or more per hour and the character of the spark emitted there would be little danger unless a gas leak should, perchance, occur directly above the telegraphic installation, but Uncle Sam's sky pilots have not been willing to take any chances in the matter. Finally, the disposition of the receiving wires and the equivalent of ground wires presented some problems.

When the electrical experts of the United States Signal Corps decided to attempt to

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SHOWING SMALL SIZE OF AIRSHIP APPARATUS

devise a wireless set that would meet these varied requirements the task was given over to Electrical Assistant H. B. De Groot and his helpers in the Signal Corps shops at Washington, D. C. The primary specification was that the entire outfit should not weigh more than seventy-five pounds and this has been met, the actual weight of the recently completed set being within the limit by a margin of nearly five pounds. In the experimental set just perfected the Signal Corps electricians have also been successful in completely covering the spark gap so as to exclude gas, and in similarly protecting the interrupter contact.

This pioneer balloon wireless set occupies a novel frame, specially constructed of selected white pine and which is 15 inches high, 17 inches wide and 30 inches long. When in service this platform carrying the telegraphic equipment will rest across the keel or skeleton framework of the dirigible balloon, supported upon the two upper horizontal rods of the keel. If need be the entire outfit can be covered with a tarpaulin as a protection from the weather.

The battery is an ordinary eight-volt sparking battery such as is used in automobiles. It weighs only 22 pounds, and what a saving in weight is here accomplished will be the better appreciated when it is explained that the regular standard battery of the same voltage which forms a part of the regulation "field wireless set" of the Signal Corps weighs 50 pounds. Of course this economy of more than 100 per cent in weight entails some sacrifice of the life of the battery, the aerial equipment having 40 ampere hours' capacity as against 60 ampere hours' capacity in the case of the field set.

The aerial of this new outfit is a special construction and thoroughly unique. It consists of three wires, each 150 feet in length, suspended from a cross arm attached beneath the keel or car of the balloon so that instead of the sound waves being caught above the station, as in all earthly installations, they will be caught below the station. In lieu of a ground wire the wire network which holds together the keel or framework of the dirigible balloon is to be used. If it be desired to use this new set in connection with a spherical balloon carrying a basket it will be necessary to wrap around the basket some wire netting or other similar medium to serve as a "ground."

The features of the equipment just described are especially significant because, aside from proof of elimination of the danger of explosions, the main points to be demonstrated by the forthcoming tests of this new wireless set will concern the success of working two aerials—that is the practicability of working between two capacities at high altitudes. The Signal Corps experts themselves have no misgivings on this latter score because for some time past they have been using practically the same expedient in their field work, with entire success. In the field work there is regularly employed an aerial 60 feet above ground and a counterpoise six feet above the ground and the results have been more satisfactory than when the earth itself was utilized.

The protective appliances of the new set are also of interest as absolute novelties. The cover provided for the interrupter contact is a wooden case with felt gaskets at the joints or wherever it comes in contact with the surrounding fittings. There is a small opening in one side of the case, with mica window, which gives the operator a view of the contact and enables him to adjust it without opening the case. The spark gap is enclosed in a glass cylinder with hard rubber ends. The glass is removable when it is necessary to make repairs. The only place where a spark may occur which, under the present construction of the set, is left unguarded, is at the key contact. This is considered in no sense a danger point as the spark is almost entirely eliminated, but ultimately it may be decided to make assurance doubly sure by placing a hood over the key.

HOW TO MAKE A POTENTIOMETER.

BY PAUL N. HAIGH.

A potentiometer and a rheostat accomplish the same results but by different means. The potentiometer changes the applied potential or voltage while the rheostat reduces the current by adding resistance to the circuit. The potentiometer is used widely in wireless in connection with an electrolytic detector or other detector employing a local battery, it being so delicate that a very fine adjustment of current can be obtained. A potentiometer suitable for wireless purposes may be constructed as follows:

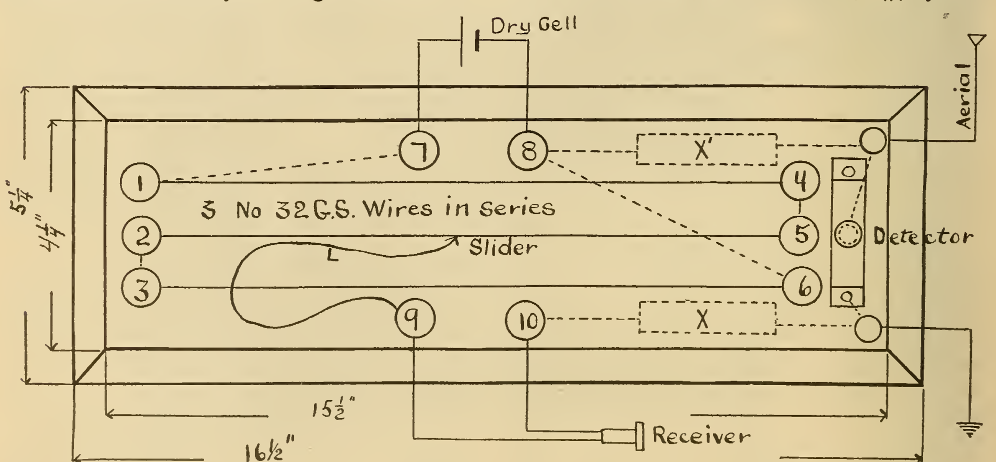
Obtain a base of any suitable wood about 16½ by 5½ inches over all, with a one-inch bevel which greatly improves its appearance. It will also be necessary to obtain ten large binding posts of any form.

Three of these binding posts should be fastened close to one end exactly one inch apart. In line with these and at a distance of 12 inches fasten three more similar to the first three. After this has been done connect posts (4) and (5) and (2) and (3) together with a piece of copper wire sunk in the under side of the base as shown in the diagram.

Three pieces of 32 or 34 B. & S. gauge bare German silver wire must be fastened between the six binding posts and drawn very tightly.

Two of the remaining binding posts (9) and (10) should be placed at a point half way between the two sets of posts at each end. One of these is connected beneath the base through the choking coil (x) to the detector, while the other is joined to the flexible lead (L) by which contact can be made at any point on the three resistance wires.

Two binding posts (7) and (8) should be placed opposite (9) and (10). These must be connected as shown, (7) joined to (1), and (8) to (6); (8) is also connected through the choking coil (X′) to the detector.



CONSTRUCTION OF A POTENTIOMETER

The two choking coils (X) and (X′) are made by winding three layers of No. 22 or 24 B. & S. single silk covered copper wire upon a piece of iron wire three inches long and one-eighth inch in diameter. These should be mounted in small groves on the under side of the base. The detector may be mounted upon the same base.

In order to operate the potentiometer it is only necessary to move the slider along the wire until the signals are the clearest.

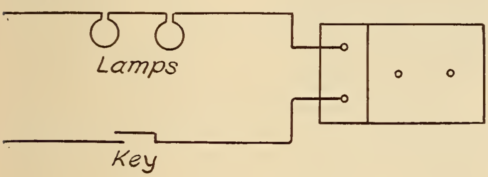
WIRELESS QUERIES

ANSWERED BY V. H. LAUGHTER

Receiving and Sending Radius.

Questions.—(A) What will be the receiving radius of my wireless which is of the following equipment: Aerial center 44 feet in height, made of four No. 14 copper wires strung one foot apart and thirty feet long; auto-coherer and electrolytic detectors; tuning coil and potentiometer, and a pair of 1,000 ohm telephone receivers; also a variable condenser? (B) What will be the sending radius with same aerial, two-inch spark coil, variable condenser, zinc spark gap and inductance? (C) I wish to run my induction coil by direct current from the electric light mains. How can I do this? (D) Will a slight continuous vibration of the table on which the complete set rests affect its efficiency?—L. S., Delta, Colo.

Answers.—(A) From 100 to 500 miles. You have got an ideal equipment for experimental work.



LAMPS IN SERIES

(B) From 5 to 15 miles.

(C) Insert 16 c. p. lamps in series with primary terminals of coil and light mains and key as shown in the diagram.

(D) The table on which the instruments are placed should be free from vibration. The vibration would have no effect on the sending efficiency, but the receiving instruments would be constantly out of adjustment and you would no doubt have considerable trouble in this respect.

Leyden Jars.

Questions.—(A) Would a square jar, with round corners, and a thickness of ⅛ inch, do for a Leyden jar? (B) How could I run a 2-inch coil on 220 volts? (C) How long a spark could I get from a coil with a nine-inch primary, wound with two layers of No. 16 magnet wire and a secondary of five pounds of No. 32 wire, wound in sections?—K. W. W., Fort Scott, Kans.

Answers.—(A) Yes.

(B) See answer to L. S., only use three lamps in series.

(C) Possibly two or three inches. By referring to the article, now running, on sparks coils you can find valuable directions on the exact method of constructing various sizes of spark coils.

Potentiometer and Aerial Elevation.

Questions.—(A) Will you explain the potentiometer as used in wireless work? (B) For experimental purposes in using a kite aerial for wireless work does it make any difference in the efficiency if the wire connecting the kite to the detector is large or small? (C) What is an inductance coil? —J. C., Troy, Kans.

Answers.—(A) A potentiometer is simply a regulating rheostat used to control the battery current that operates the detector. See article in this issue by Mr. Haigh on "How to Make a Potentiometer."

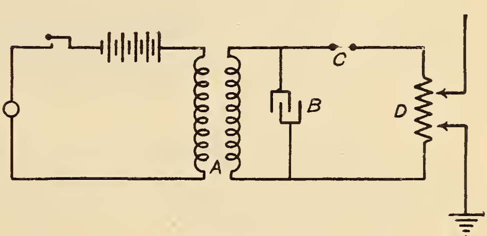
(B) The larger the wire, the more surface offered and the receiving efficiency would be slightly increased.

(C) An inductance coil is simply wire wound in the form of a coil. When placed in an alternating current circuit, it presents an impedance to the flow of the current owing to the inductive effect of the neighboring turns upon each other which creates a sort of "back pressure" which counteracts the impressed voltage.

Condenser; Coherer.

Questions.—(A) How is a condenser connected in series with the spark coil for wireless use? (B) Could a dynamo of 500 watts be used and connected with a two-mile wireless set? (C) How could a magnet be made for working in connection with a coherer?—E. J. B., San Francisco, Cal.

Answers.—(A) Diagram of the complete circuit is given herewith, in which (A) represents the induction coil or transformer, (B) the condenser, (C) the spark gap and (D) the helix.



SPARK GAP BRIDGED BY CONDENSER

(B) It would only be of use to supply current to the coil.

(C) We fail to get the exact meaning of your question. A de-coherer, if this is what you have in mind, is shown in Fig. 2, in the answer to H. H. L., Tacoma, Washington, in the June issue.

Tuning Coil and Potentiometer.

Questions.—(A) Can I wind my tuning coil so as to have the turns a distance apart, or can I wind them close together? (B) Please give me a description of a good contact for the above coil? (C) Which is the best, zinc or brass spark gap? (D) What is a potentiometer used for?—E. L. D., New Castle, Pa.

Answers.—(A) The turns can be wound close together if there is enamel on the wire to provide insulation.

(B) A very good contact can be made by bending a brass spring to an inverted "V" shape, and mounting the spring on a brass rod in such a manner that it will slide up and down. The enamel is now scraped off the wire in a width of one-fourth inch all the way down the frame. The brass rod is now screwed on the frame so that the sliding contact will make connection with the turns when run up and down.

(C) For general use, zinc is conceded to be the best.

(D) To regulate the battery current which flows through the detector.

Condenser Plate Connections.

Question.—In the article on "Spark Coil Construction and Operation" it says that thin brass strips are folded over the exposed portion of the foil strip. Are all the foil strips treated in this way? Or, if not, how are the connections between the plates made?—J. A. D., Winnipeg, Man.

Answer.—As explained in the article the foil strips protrude one inch out from the edge of the bond paper. This will allow all the alternate strips to be connected together. Each condenser or bank should be built up and the brass strip folded over and screwed down as explained. It is only necessary to use the brass strips on each bank.

Hot Wire Ammeter.

Questions.—(A) What good is a hot wire ammeter in a wireless telegraph transmitter? (B) Please give dimensions and diagram for a transmitting helix and size and kind of wire used. (C) Why is it that when you put a 50 or 75 candle-power lamp in series with the 110 lighting current you get more current than with a 16 or smaller candle-power lamp? (D) Does more than one tuning coil help in receiving messages?—S. B., Seattle, Wash.

Answers.—(A) The hot wire ammeter is used to indicate when the set is radiating the maximum amount of energy. By connecting the hot wire ammeter in series with the aerial and pressing the key of the sending circuit an oscillating current is sent surging up the aerial which heats the thin wire of the meter, thereby causing it to expand and move the indicating needle. It is evident that increasing or decreasing the current surging through the aerial will cause a like change of the indicating needle.

(B) We refer you to answers in the May issue.

(C) The larger lamp has a more conductive filament and will allow more current to flow through.

(D) No.

Detector.

Questions.—(A) Must both contacts in an electrolytic detector be platinum or may one be brass, copper, etc., and the other platinum? (B) What size platinum wire should be used? (C) Would the insulation of my coil be the same if immersed in linseed oil instead of boiling out in paraffine?—E. F., Chicago, Ill.

Answers.—(A) Both contacts are usually of platinum, although other contacts are sometimes used. The contact or point, which is connected to the aerial, should always be a fine platinum or Wollaston wire. The objections to using other two kinds of metals is that the acid will soon eat the contact away, owing to the electrolytic action.

(B) Wire .004 inch in diameter is usually employed.

(D) Yes. The spark coil you describe in your letter will give a two and one-half to three-inch spark.

Interrupter Trouble.

Question.—I have been trying the electrolytic interrupter, made per directions in the December issue, but am troubled by the platinum tip heating to redness and then when the current is shut off, the glass cracks and lets the mercury drop to the bottom of the vessel. Current used is 110 volt d. c. about five amperes. How can such an interrupter be made to use on this current wich will avoid the difficulties encountered?—H. J. H., Mattoon, Ill.

Answer.—The trouble you refer to is a very common occurrence with a home-made electrolytic interrupter. In spite of the apparent simplicity the electrolytic interrupter is hard to construct, that is, for efficiency and results. For the usual type the heating effects are avoided by placing a coiled tube in the jar and circulating water through the tube. A second point for trouble might be in the platinum point. In case the platinum point is too small, the heating effects are great. We would suggest that you make several points and use the one which gives the best results.

ELECTRICAL MEN OF THE TIMES

OTTO M. RAU

There is a particular type of man indispensable to the installation and operation of the electrical equipment of any large railway or light plant; a man who not only is thoroughly conversant with electrical and mechanical theory but who is also of a practical turn of mind, resourceful and ready with a cure for every ill to which the equipment is subject; full of ideas, which result in economies here and there in the intricate system which he has at all times within his perspective. Such a type of man is Otto Martin Rau, who holds the responsible position of chief electrician of the Milwaukee (Wis.) Electric Railway and Light Company. To use an expression so common in these days, he is a man "who can do things."

Mr. Rau is not a college graduate, but he knows the theoretical side of electricity and mechanics just the same. He supplemented his public school education by a laboratory course with the Daft Electric Light Company, graduating from the engineering department of that concern well founded in the principles of the work he was to undertake. During 1887 to 1889 he did some experimental work on the third-rail electric traction system of the New York elevated railway. After that he helped put in electric railway systems for St. Clair, Pittsburg, Los Angeles and other cities, all the time gaining more knowledge of electric railroading, which he realized was going to become one of the most important branches of the whole electrical industry.

But electric railways and lighting interests are often associated, so he prepared himself in the latter branch by joining the forces of the Edison General Electric Company, as it was then called, as designing engineer in the lighting department, working on searchlights, arc light dynamos and lamps and distributing systems. Here he laid out the electrical distribution systems of Cincinnati and Milwaukee, becoming resident engineer on the latter work until it was completed. He then accepted the position of chief electrician of the Milwaukee company, in which capacity all construction work in the electrical department is under his supervision, the more important work having been the construction of the electrical equipment for the Oneida Street power plant, the Commerce Street power plant, including the underground distributing system at 13,200 volts and substations, and the electrical work in connection with the Public Service Building of the company.

Outside of his work in connection with the Milwaukee system, Mr. Rau finds time to act as consulting engineer, and the most notable of his achievements along this line have been the supervision of the electrical installation of a hydro-electric plant for the Wisconsin Traction, Light, Heat and Power Company, and of the power plant and substations for the Union Electric Light and Power Company of St. Louis, both important engineering undertakings. He is now engaged on the installation work connected with a tower transmission line which will bring current at 66,000 volts pressure from the new power plant at the famous Dells of the Wisconsin River to Milwaukee, a distance of over 100 miles.

Mr. Rau is a member of the American Institute of Electrical Enginers and of the Northwestern Electrical Association.

ELECTRICITY IN THE HOUSEHOLD

SOMETHING NEW IN DECORATIONS

When it comes to decorative lighting fixtures electricity is far and away the most adaptable form of illumination. It not only lends itself readily to all forms of electroliers where gas could be used, but in addition opens up a new field for those of artistic bent who would design creations of a more elaborate sort embodying floral designs and the like. To give an idea to the hostess who wishes to have her decorations "a little different" from those commonly used, a few photographs are reproduced herewith, showing some very unique designs which have been worked out for the utilization of miniature electric lamps in a variety of pleasing ways.

View No. 1 represents a small electric fountain set in a basket of artificial plants and flowers. The flowers are represented by small electric bulbs all connected to one circuit. By screwing the attachment plug into the lamp socket and turning on the current the fountain commences to play immediately and the lamps light up. View

ELECTRIC FOUNTAIN CENTER PIECE

No. 2 represents a similar fern effect, the fountain being replaced by a water effect representing a pretty fern dell. Another similar design is shown in view No. 3.

Some new metal designs are illustrated in Nos. 4 and 5. One is an oak ceiling fixture with acorn shaped bulbs, another represents a cala lily and the third a double branch poppy. These last designs are made in copper with verdigris or other finish and are supplied by the maker in a form suitable for wall brackets if desired. A wide range of floral designs are also available, outside of the ones illustrated.

ELECTRIC LIGHT AND HEALTH.

BY NOBLE M. EBERHART, M. D.

With the greatly increased use of the electric light in the homes and offices, comes the thought of its possible effect on the health of the community and a comparison between the electric light and gas in this respect. That the incandescent light is immeasureably superior to gas when thus compared, there can be but little doubt.

White light embraces all of the colors making up the spectrum, from the red, which represents the lowest number of vibrations, up to the violet, which is produced by the highest number which the human eye perceives as light or color. The red rays have been shown to influence the body principally through the effects of the heat produced, but the violet rays possess chemical properties and cause changes to take place in the skin and tissues. With them, skin diseases, and even malignant growths have been cured. From a cosmetic standpoint, the complexion of individuals exposed to these rays is greatly improved, and since the higher the candle power, the more of the beneficial rays given off, the superiority of the incandescent light is evident.

Another point of even greater importance is that gas consumes great quantities of the oxygen in the air, and thereby lessens the value of the air to the occupants of a room. This has long been recognized by surgeons who object to the administration of chloroform in a gas-lit room because of this great destruction of oxygen and the increased danger to the patient.

The value of oxygen is too well known at the present time to cause anyone to un-

ELECTRICAL DECORATIVE DESIGNS

necessarily sacrifice any of this life-giving element, so that electricity not only furnishes a light that is more brilliant and more convenient than gas, but one that is of far greater benefit to the health of the community.

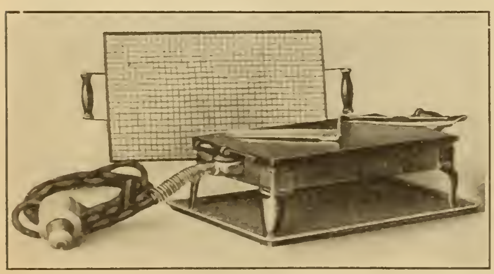
There is another menace to life and health in the use of gas which does not enter into the use of the electric light. This is the effect of its inhalation; or gas-poisoning. This may result from several different causes, such as small leaks from defective connections; intentional inhalation with suicidal intent; accidental blowing out of the gas, and finally, its going out when turned low, from variation in pressure.

Intentional or accidental destruction of life is impossible with the electric light, but scarcely a day passes that we do not read of a case of asphyxiation by gas. Death by this means is so easy and painless that it seems to be a constant temptation to those with suicidal intent. This is certainly an important and vital reason for preferring the electric light.

The effects upon the system of the respiration of small quantities of gas are not so easily estimated, but that they must materially interfere with various bodily functions and gradually undermine the resistance of the system to other diseases or poisons will be readily inferred.

BREAKFAST-GETTING SIMPLIFIED.

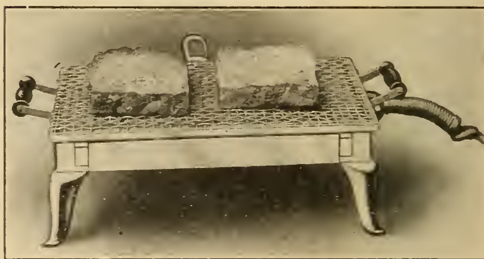
It has been said that positively the last word in the construction of a combination cooking appliance for table use is embodied



ELECTRIC STOVE AND TOASTING GRID

in the electric toaster and stove here shown. However that may be, it is certain that the device has many features which make it appreciated in any household, where it will find innumerable uses. It may be employed in any part of the house where there is a lamp socket, and its manifold accomplishments are available at the turn of a switch.

In the first place there is the little flat-top stove measuring seven by eleven inches, and weighing five pounds. This has an electric heating element underneath the top and is



TOASTING GRID IN USE

set in operation by simply "plugging in" from the nearest lamp socket with the cord attachment which is furnished. It is available for any voltage from 100 to 125, and the voltage of the regular lighting current will come somewhere between these two limits. In addition there is the toasting grid, consisting of a wire screen with suitable handles, which fits on the top of the stove. This insures an even heat on all parts of the slice and insures delicious, evenly browned toast. There is also a broad, shallow tray which may be used to hold the stove on the breakfast table, or as a crumb tray. If desired the stove top may be inverted, turning up a narrow rim which serves to retain fluids on the hot plate.

THE STORY OF THE ELECTRIC FAN.

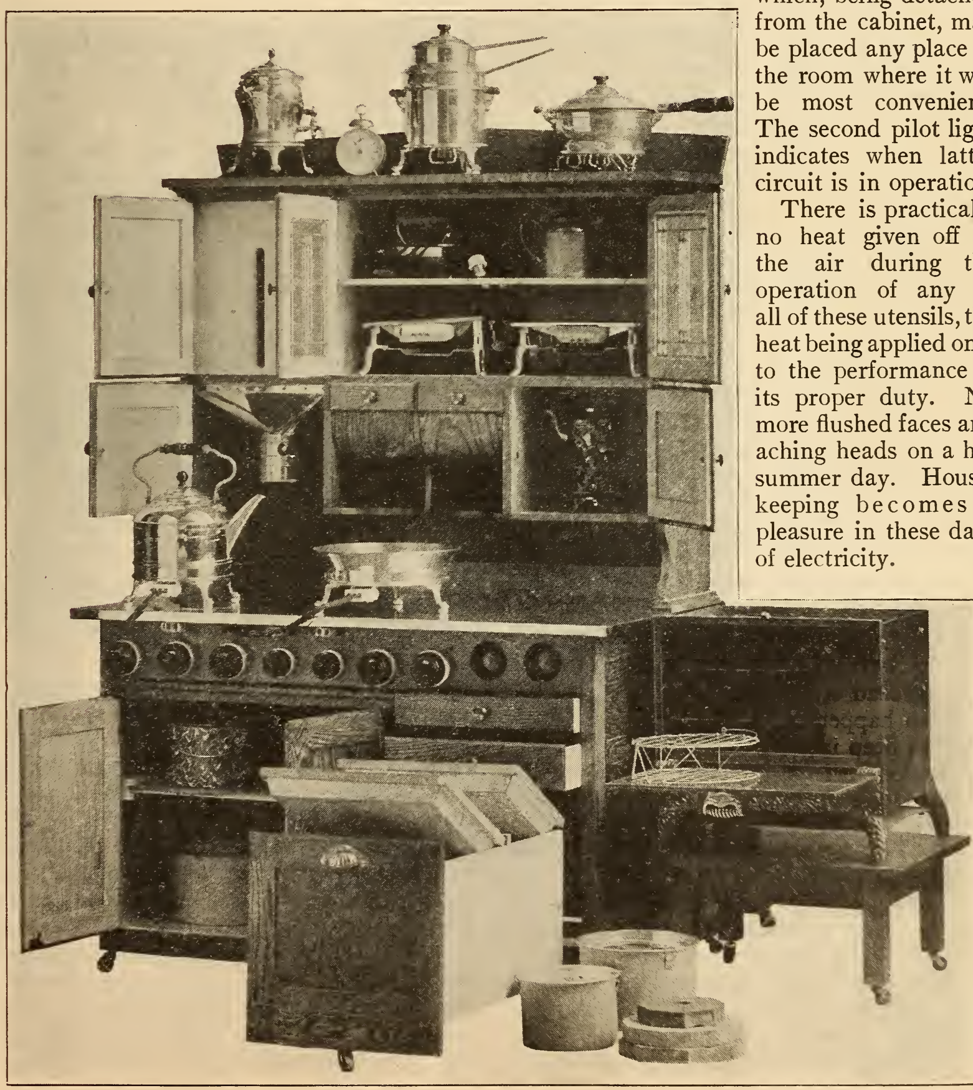
The electric fan was an American invention which has been developed within the last few years until millions of the fans are in use throughout the world. Back in the early eighties Dr. S. S. Wheeler, an electrical engineer of New York, was experimenting with a small electric motor. In the course of his experiments the doctor conceived the idea that steamboats might be run with electricity if the propellers could be direct connected to high-speed electric motors, doing away with all the gears then in use in steam propulsion. With this idea in mind he had a small screw-propeller constructed and fastened it to the armature shaft of his small motor. To his surprise the experiment resulted in a fine breeze of cooling air which more than delighted the experimenter, for the day was decidedly hot. It is needless to add that the experiments with screw-propellers ended right there and the engineer took up the study of the electric fan with the result that he soon perfected the device until it was a commercial success.

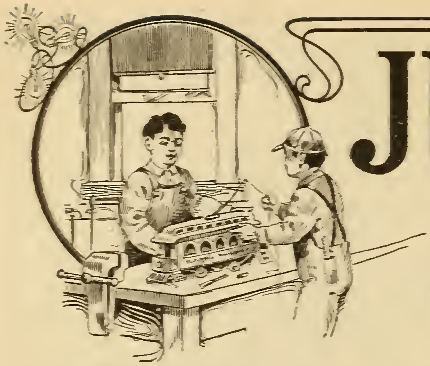
THE FIRELESS COOKER.

A place for everything and everything in its place is a saying which was perhaps never better applied than to the fireless cooker cabinet shown in the picture. A description of this marvelous piece of kitchen furniture (it might be termed a whole kitchen in itself) is hardly necessary, for any woman can appreciate its convenience at a glance. A few pointers concerning its electrical equipment may not be out of place, however.

To begin with, all the wiring is concealed within the cabinet, only the switches being visible and the little flexible cords and plugs which are connected underneath the edge of the shelf and lead to the various electric cooking utensils. The oven at the right is also electrically heated. The first six switches are used for the cooking devices seen on the top of the cabinet and the first pilot light at the right of the switches shows when the current is properly turned on and working. The last switch is for the oven, which, being detached from the cabinet, may be placed any place in the room where it will be most convenient. The second pilot light indicates when latter circuit is in operation.

There is practically no heat given off to the air during the operation of any or all of these utensils, the heat being applied only to the performance of its proper duty. No more flushed faces and aching heads on a hot summer day. Housekeeping becomes a pleasure in these days of electricity.





JUNIOR SECTION

STORY OF THE VILLAGE LIGHTING PLANT

BY REX UNDERHILL

Those who travel across the Empire State by night and chance to look out of the car window while passing a certain rural village of about a thousand souls will be astonished to see the place ablaze with electric lights. The fact that so small a village, located so far from any city or large town, is nightly illuminated with electricity, including the few streets, the stores and shops and nearly every one of the country homes, is a continual source of surprise and wonder to the traveler.

Now this is the story of how that particular village obtained its electric lights.

A certain young man there was who became very much interested in electricity, although he worked every day in one of the stores in this village. This was several years ago and the young man had just graduated from the village High School where the small laboratory had given him his first ideas of electrical machinery. He read and studied everything he could find on the subject of electricity whenever he could find the time to read books.

It so happened that about the time that he was deep in the subject of electric lighting plants for small cities and villages he became of age and a small sum of money left him by a thoughtful grandparent, was placed at his disposal. This, added to what he had saved since he began selling papers and working at odd jobs, gave him almost $4,000, quite a sum of money for a young man of twenty-one in so small a community.

With this money placed to his credit in the bank the young man went straight to three of the best known and wealthiest men of the village and unfolded the scheme which had been framing itself in his mind for years. It was nothing more or less than a plan to establish an electric light plant for the village.

Of course these old men, who walked nightly home in the dark when the oil lights were not lighted or followed the tiny beacons when they were, pooh-poohed the idea from the start.

"Why, such a plant would not pay," they echoed. "If we had a fine water power maybe we could do it but with coal—why, it is ridiculous, preposterous."

Then the young man collected and brought to them whole pages of facts and figures and carefully explained every detail of his experiment. "Now I am willing to risk four thousand dollars, all I have in the world, in this venture, for I believe it will be a success," said he. "If you doubt these figures let me send for an engineer from one of the big electric companies, it will cost us nothing, and he will verify all that I have shown you."

One of the merchants snorted something about "a fool and his money" and left the room. The two others, more to favor the young man than anything else, because they had long known his family, consented to talk with the engineer.

In a few days the engineer came and made a thorough inspection of the village. He found out that coal could be had for about $3.50 a ton; he went over the young man's figures and pronounced them correct except in one or two places, where he had actually been too high; he interviewed the President of the village and the members of the Board and got their consent for street lighting;

talked with the merchants and the householders, then pronounced the venture a good one and advised the men to go in with the boy and build the plant.

After due consideration and investigation they agreed to form a company, place one of the men in as president, the young man as business manager, and turn the sum of $10,000 over to him with which to build and establish a local electric lighting plant.

The young man in question resigned his position in the store and started the work. It was no easy task, for the details of the construction work were even larger, and harder, than he had anticipated, but he met and conquered them all.

HE BROUGHT THEM WHOLE PAGES OF FACTS AND FIGURES

The powerhouse was soon built, a small, neat brick building close to the railroad yard where carloads of coal could be switched in for the coal bunkers. The chimney was the most conspicuous tower in the whole village. By the time the building was ready the machinery was at hand and engineers and construction men from the various manufacturing companies took up the task of setting up the generator and connecting it with the engine.

The engine room of the small power plant contained, when all was finished, one alternating current, 80 horse-power generator connected by a wide belt to a 125 horse-power steam engine. The boiler was of 135 horse-power capacity. The little engine room was spick and span with polished brass, bright paint and shiny varnish.

The village authorities gave the lighting company a franchise to set up the transmission poles along the streets and contracted to have the village lighted with arc lamps. It took some time to string the wires, to get all the instruments and devices for the control of the current, and the protection of the apparatus, in place and ready for work. Then the linemen and electricians began the work of hanging and connecting the 30 enclosed arc lamps of 1,200 candle-power capacity which were to light the streets. Even before the powerhouse was finished the merchants and a few of the house-owners began to send for electricians to come and wire their places of business and their homes.

Then one dark night when all was ready the young engineer threw the switch and the streets seemed to fairly burst into light—such was the contrast over the old oil lamps. Another switch and the village hotel was beautifully illuminated and two of the largest stores. The president of the lighting company was also ready for the occasion and lighted every room in his house so all could see the beauties of electric lighting in the home.

The contrast between electric lights and the oil kerosene lamps for store and house lighting was so great that nearly everyone, except a few who were afraid of electricity because they feared lightning, placed an order to have their store, shop or home wired.

In less than a year's time the little lighting plant was supplying current for thirty-four enclosed arc lamps used in the stores and shops and over a thousand incandescent lamps in the homes. The village itself contracted for thirty arcs and twenty incandescent lamps at a cost of $55 a year each for the arcs and $15 a year each for the incandescent lamps. The houses were all placed on a fifteen cents a kilowatt hour rate.

By judicious buying the young man in charge of the plant worked the fuel cost down to $3.30 a ton and as the plant stopped at midnight each night and did not run during the day the cost for maintenance was very low. He was very studious and careful and kept the plant in such excellent shape that the bills for repairs came seldom and never amounted to very much. In this way the plant began straightway to pay a handsome profit on the investment. Thus the young man secured a fine job at the profession he was devoted to, and his money was invested so as to bring him large returns yearly. The man who made the remark about the "fool and his money" and refused to invest in the concern in the beginning afterwards tried to buy some of the stock, offering a large premium.

PERILS OF THE LINEMAN.

Often persons do not give any thought to the dangers to which linemen of the telegraph, telephone, electrical power and light companies are subjected. The average person does not care. He does not bother his head about the men who, in all sorts of weather, climb the poles and buildings for the purpose of restoring order in the lines after a hurricane.

So long as the winds do not blow severely, or the snows fall heavily or other elements combine to overthrow or overweight the lines and poles, there is not much for the lineman to do outside his regular line of repair work. There is a certain amount of new construction work in progress most of the time, but the work can be done slowly and quietly. But when a storm suddenly comes up the linemen are the first ones to feel the effects. The very first winds take down the weakened poles and wires and from then on until the termination of the storm, it is one series of crashes, breaks, hurry-up calls, trouble, wreckage and hardships. The men have no more rest until the last echoes of the storm have passed. Even then there is much to be done. All the work which broke down and was not re-installed while the storm was yet blowing, must be put up. The lines must be kept open. The newspapers want their wires ready for important messages, and the special wires must be attended to—all in addition to the regular service.

A storm or a heavy fall of snow develops the weak points in the line. As soon as the first indications of high winds or heavy rains appear, the lineman proceeds to get ready for business. He knows that it means a hurry-up call very soon. The call is not long in coming. The lineman responds quickly and in a short time he will be at the point where the winds have broken a tree and the tree has fallen across the wires and the tangle and breakage is fearful to look upon. Workmen are secured to cut away and remove the tree, perhaps limb by limb. New wires have to be obtained and pole climbing and wire stringing goes on in earnest. A pole may have been broken off in the fall and then there will be considerable labor required in order to rig up a means to support the wires.

In one instance the pole was partly broken off near the top, but the partial fracture was not observable from the street. The line man climbed to adjust the wires and his added weight snapped the pole off as in Fig. 1, and, owing to a slight curve, it swung

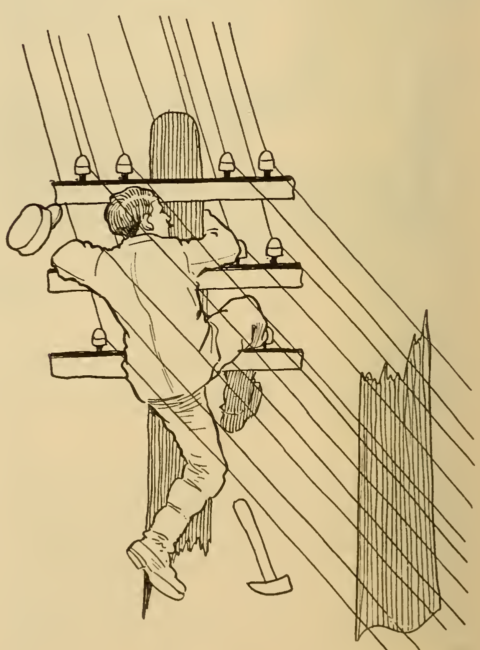


FIG. 1. ONLY THE WIRES TO SUPPORT HIM

out away from the pole. The untrained man would have taken fright and perhaps jumped. That would have meant death or at least a broken bone. Our friend relied upon the wires to support him and in this instance the wires proved faithful to the cause and supported the top of the pole, the cross arms, and the man, as shown. The combination swung to and fro in the high gale for an hour before ladders were obtained to release the lineman. A fire truck company came out and ran up an aerial ladder directly under the man on the pole, and he descended in this manner.

Of course the companies endeavor to supply their linemen with the most perfect equipments with which to work. But the most careful inspection of working apparatus frequently fails to bring to light certain weak points. These weak points occasionally bring death and disaster to the lineman. Not long since a partly decayed round of a ladder snapped in such a way that the lineman fell outward and backward to the ground, straining his back so that he was laid up for months. In another instance, where a man was

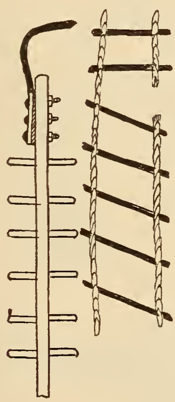


FIG. 2. DANGEROUS APPARATUS

using a ladder hook, of the nature shown in Fig. 2, the wrought iron hook at the top sprung to the extent of slipping off from the ledge of the building over which it had been placed. The lineman making the ascension on this single ladder pole was thrown over backwards with the pole, breaking an ankle.

The companies almost always care for the men who have been hurt in their employ. If the injury is the result of defective devices, lawsuits sometimes follow. Ordinarily, however, the employers and the employees agree and no law suit is filed. The companies pay the wages of the man while he is recovering from a broken leg or arm and also pay the doctor's bill.

Not long since a ladder made out of rope (shown also in Fig. 2) was the cause of an accident to a lineman. It seems that the lineman was ingenious and industrious. One day he contrived a ladder of rope sides and with metal rods extending through loops from side to side. He forgot that metal against hempen rope does not work well.

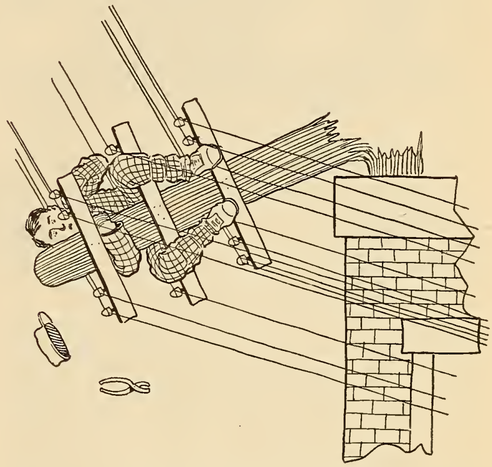


FIG. 3. AN AWKWARD POSITION TO SAY THE LEAST

The metal scored the rope, and thus weakened, one side snapped under strain one day, with the man on it. As this device was con-

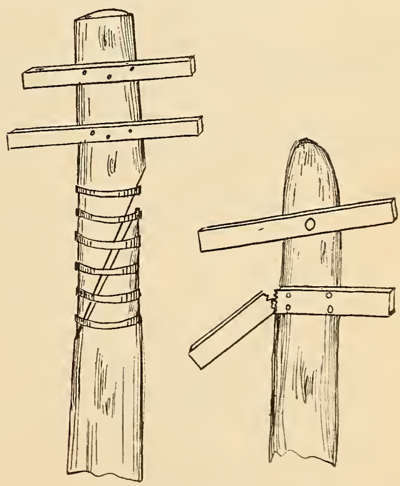


FIG. 4. CROSS ARMS AND SPLICING ARE DECEIVING

structed by the lineman himself, and used for his own convenience, the company could not be blamed for furnishing poor apparatus for its workmen.

Quite a thrilling event happened when a lineman went over the side of a tall building in a strong wind, caused by his weight on a weak pole, the pole breaking off as in Fig. 3.

The top of the pole with its human burden bumped about the cornice of the building for several minutes, with the man clinging thereto, until comrades secured it with ropes and released the man. The lineman has to get used to accidents of this character.

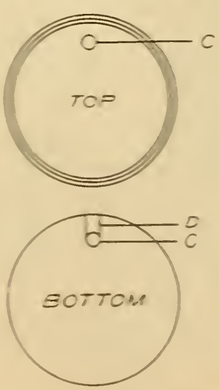
Then there are occasions on which he must be very ingenious and patch poles, so as to keep the line working until the storm is done and a new pole can be put up. Fig. 4 shows one mode of splicing a broken pole with ropes or bands of other material. The pole is adjusted as it was originally and banded, or the uneven fracture is hewn down so that the sides may fit together well.

Cross arms are deceiving as is known, and it is not safe to put too much reliance upon them. Fig. 4 also shows a pole with the top arm bent and the second arm broken. This is a common sight. The wood decays in a few years, and while the coating of paint may make the lumber appear new and strong, beneath the surface all is decay and a pressure may break off the arm and down you may go.

STUDENTS' ELECTRIC LAMP.

BY JESSE FISHER.

Students' electric lamps for use on electric lighting circuits are not very expensive, but any boy who is of a mechanical turn can easily make one for himself. The one here described will operate either on lighting current or batteries according to the kind of bulb used.

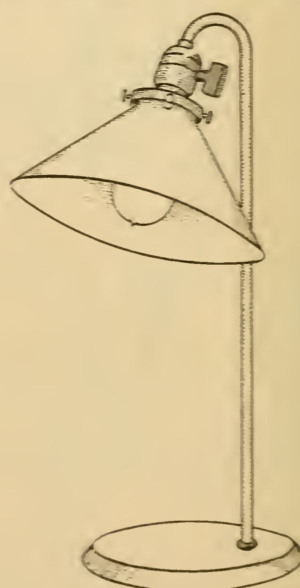


CONSTRUCTION OF BASE

We will first make the base of some hard wood, such as oak or mahogany. It should be about eight inches in diameter and have a ⅜-inch hole bored in it about two inches from the edge, as shown at (C) in one of the cuts.

A small plate is next made from a piece of strap iron. A ⅜-inch hole is bored in the center of it and tapped with threads. Holes are drilled through the plate and it is screwed down directly over the ⅜-inch hole in the base. Then give the base a nice coat of varnish and it is complete.

FIXTURE PIPE STANDARD



LAMP COMPLETE

Next secure a piece of fixture pipe about two and one-half or three feet long and carefully bend as shown. Thread about one inch of the lower end (to fit the plate on the base) and about $\frac{3}{8}$ inch at the other.

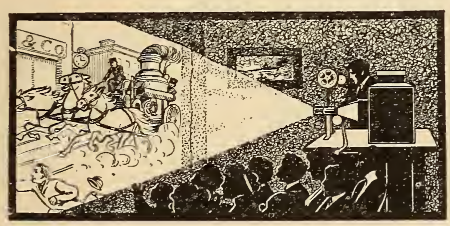
Insert two fixture wires in the pipe, being sure the insulation is good. Attach an Edison key socket to the wires and screw in place at the end of the bend. Then tighten the wires and screw the pipe in place on the base. A flexible cord should be attached to the ends of the wires underneath the base and passed out through the groove (D). The wires at the joint should be separately wrapped with tape, to insure perfect insulation.

Any style of shade may be used, but the tin cone fills the purpose very well.

If you are going to use it with electric lighting circuit use a regular 16 c. p. bulb. If you wish to operate with battery, use a 14-volt miniature lamp, with seven or eight cells of battery in series.

MOVING PICTURES IN THE HOME.

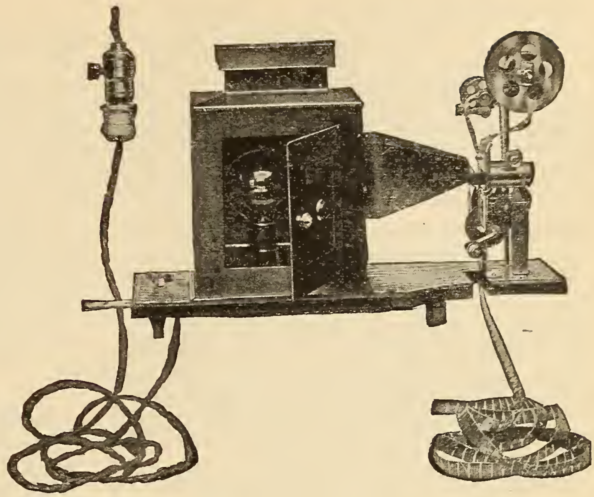
The old-fashioned magic lantern has enlivened many a long evening, but the boy of today wants something better than that, so real moving picture machines are now made in sizes suitable for use in the home. With the Ikonograph, one of the



MOVING PICTURES IN THE HOME

new machines, any boy can furnish an entertainment which is worth going some distance to see.

The Ikonograph throws real moving pictures $2\frac{1}{2}$ to 7 feet high and 4 to 11 feet wide. There is no danger of fire or explosion as a powerful incandescent lamp is used instead of an arc light. Everything is complete, including an automatic film feeding device, automatic shutter, film re-winder and a screw focus for the projecting lens. A special ray reflector throws a sharp clear picture.

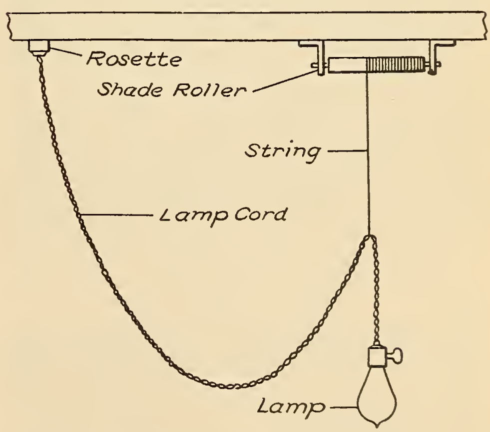


THE IKONOGRAPH

The electric lamp, which is of 100 candle power, burns from the regular lighting circuit and is connected by means of a cord and plug.

ADJUSTABLE LAMP FIXTURE

The boy who is fortunate enough to have his own workshop or laboratory will find an adjustable fixture very convenient for raising and lowering a drop light. It is made



ADJUSTABLE LAMP FIXTURE

by fastening a window shade roller to the ceiling and fastening a string to the roller. The other end of the string can be fastened to the lamp cord somewhat as shown in the illustration. The lamp can then be adjusted in the same way as a window shade is ordinarily adjusted.

QUESTIONS AND ANSWERS

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

Resistance of Copper Wires; Alternating Current Motor Operation.

Questions.—(A) How can the resistance of different sizes of copper wire be figured? (B) In the windings of a three-phase stator how does the current flow and return, as we have only three leads? (C) Is induced current in the rotor of a motor of the same potential as that in the armature coils? (D) Are the phases represented in the rotor? (E) Explain flow of current in delta connections.—L. D., Cincinnati, Ohio.

Answers.—(A) The resistance of a circular mil foot of copper is 10.5 ohms at 75° F. The resistance of a wire decreases as its cross section increases, hence the resistance in ohms of a wire of any length is the resistance of one mil foot of the wire, multiplied by its length in feet, and divided by its cross section in circular mils. To illustrate further, a wire one quarter inch thick has a diameter of 250 mils. The cross sectional area equals 250x250=62,500 circular mils; that is, the square of the diameter in mils (1-1000 inch) equals the area in circular mils. A copper wire 5,000 feet long and 49,000 circular mils in cross section has a resistance of (10.5x5000)=49,000—1.07 ohms.

(B) In a balanced three phase system the currents in the three leads are 120 degrees apart. At all times the sum and direction of the three currents equals zero. When the current in one phase is at its maximum, the sum of the other two currents is negative; that is, either one or two of the three wires are acting as return circuits.

(C) We assume that you mean stator when you say armature coils. When an induction motor is at a standstill the relative speed of rotor and stator is S. and the E. M. F. is the same in both. When the rotor runs at a speed s, the relative speed of the rotor and stator drops to S—s, and the E. M. F. drops in the same proportion in rotor conductors as $\frac{S-s,}{S}$ or if $Q=\frac{S-s,}{S}$ the E. M. F. in the rotor becomes at speed s, Q x E.

(D) The instantaneous values of corresponding stator and rotor conductors are equal to each other, and are opposite to each other in phase.

(E) See answer (D).

Figuring Size of Wire; Protection of Circuits.

Questions.—(A) What should be the voltage of a dynamo to light 20 lamps of 110 volts and 16 candle power? I want to light six lights one and one-half miles from the dynamo, and the other 14 at and near the machines. (B) What fuse protection do I need?—H. C., Sedalia, Mo.

Answers.—(A) Three per cent increase in voltage halves the life of a lamp, while six per cent increase reduces the life by two-thirds. For the above reason to obtain satisfactory operation of the lamps at the machine, the dynamo should operate at practically 110 volts. The drop in voltage allowed on transmission lines is all the way from five to 15 per cent. In this case, considering the lamps at the far end, and providing for a drop of only one per cent, the following formula may be used to figure the size of conductor needed:

$$C\ M=\frac{10.8 \times L \times C}{V}$$

Where V=drop in voltage; L=length of wire in feet; C=current sent over wire; C M=cross section in circular mils. From which

$$C\ M=\frac{10.8 \times 7920 \times 3}{1.1}=16,510$$

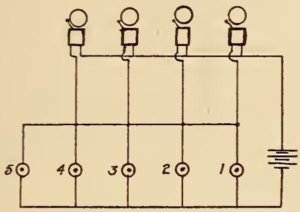
No. 8 wire fulfils the condition.

(B) Leads from the generator should each be provided with a fuse so that in case of a short circuit beyond the fuses these will blow out before current in excess of the generator's rating is sent out.

The National Electric Code requires "that no set of incandescent lamps requiring more than 660 watts be dependent upon one set of cut-outs. The fuses in the branch cut-outs should not have a rated capacity greater than six amperes on 110 volt systems."

Special Bell Circuit.

Question.—Will you please show me how button No. 5 should be connected to ring all four bells at once.—H. A. E., New York.



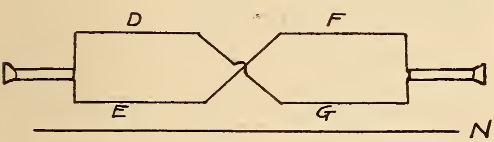
SPECIAL BELL CIRCUIT

Answer.—Connect wire from bell No. 5 as shown in diagram, using about three cells of battery.

Noise on a Telephone Line.

Question.—Will you advise if there is any way to overcome the noise on a telephone line, caused by induction from a high voltage transmission line?—C. C. B., Norfolk, Wy.

Answer.—We assume that the telephone circuit is two-wire metallic. Transposition



TRANSPOSITION OF TELEPHONE WIRES

shown in the diagram will destroy the induction effect. If the disturbing wire (N) passes a current in the direction indicated by the arrow, at some given instant, this current will affect the wires (D, E, F, G) as indicated by the arrows, this effect being about the same in each wire, since the average distance of (D) and (E) from (N) is the same. The receivers, therefore, get the result of the impulses in the same direction on wires (F) and (G), and no disturbing sound follows.

Motor Brushes.

Question.—Can a motor run with only one brush? I have two telegraph instruments (sounders), a battery, and a two-brush motor connected in series. When one brush is lifted from the commutator and the battery cut in the circuit, the motor runs at almost the same speed as when the brush is on.—H. J. M., Spokane, Wash.

Answer.—A two-brush motor should not run with one brush lifted off the commutator. This should break the circuit through the armature. As you say it does run, we can see no reason except that the brush holder is so connected that current is in some way conducted to the armature and fields by this holder and thence to the brush still left on the commutator. Does the same thing occur if this first brush is left on and the second lifted?

Induction Fan Motor; Two Phase Formula; Power Factor.

Questions.—(A) What current does the induction motor mentioned in the December, 1908, issue, page 517, take? (B) What is the formula for finding the watts in a two-phase circuit? (C) How is the power factor of use in a rotary station?—R. T., Jenkintown, Pa.

Answers.—(A) That will depend upon the diameter of the fan. If a 12-inch, about one-half an ampere will be required.

(B) Alternators for use with two-phase systems usually have two sets of windings on their armatures, the voltage of one set being at a maximum, when the other is passing through zero. The output of a two-phase machine is the sum of the outputs of the separate phases. That is:

W=2 V. A. P

where W=V. A. P is the power formula for a single phase circuit.

(C) The power factor holds for use only on the A. C. side of the rotary. The wattmeter reading divided by the product of the readings of the ammeter and voltmeter on this side of the machine; in other words the real watts divided by the apparent watts, gives the power factor of the A. C. side of the system. and indicates how much the current is lagging behind the pressure or E. M. F.

Magnetizing a Cylinder.

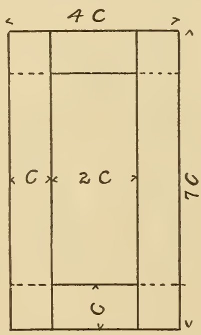
Question.—Is it possible to magnetize the outer surface of a cylinder by having the coil contained inside the cylinder? If so, how?—L. C. T., Elyria, Ohio.

Answer.—By placing a bundle of soft iron wires wound by a coil, inside of the cylinder. The latter would be magnetized by lines of force due to leakage from the coil and also by lines passing out of the north pole and into the south pole. However, the magnetic lines would act very inefficiently, since the maximum number would be within the coil rather than on the outside.

Transformer and Coil Building.

Questions.—(A) In the February, 1909, issue you state how to build a choke coil, but give no definite formula. Are there formulas that may be used? (B) What would be the voltage transformation in the rectifier described on page 692 of the March, 1909, issue? (C) Would it be possible for an amateur with a limited equipment to build such apparatus as voltmeters, ammeters, and wattmeters?—M. L. B., Cleveland, Ohio.

Answers.—(A) Standard authorities are one in the statement that successful designs of transformers and coils are found by the method of cut and try. Manufacturers derive their data from test of new apparatus, and use this in calculating future devices. Each coil, however, has a personality, if we may so term it, of its own.



TRANSFORMER DESIGN

For a transformer, having given the voltages, frequency, and from the voltages the number of turns of primary and secondary, the following formula may be used to determine the cross section of the iron with proportions shown as in drawing:

$$A=\frac{E \times 10}{4.44 \times N \times T \times B}$$

where A = cross section of iron circuit in square inches.
E = primary voltage.
N = frequency.
T = number of primary turns.
and B = lines of force per square inch of the iron cross section.

In small transformers at 60 cycles, a density of 5,000 lines per square inch is deemed best. From the above formula, (A) is readily determined.

(B) For five volts on the A. C. side the D. C. side should give

$$\frac{95}{110} \times 5 \text{ volts} = 4.3 \text{ volts.}$$

For 20 volts the D. C. side should be about 17 volts.

(C) See page 797 of the April, 1909 issue.

A Transformer Example.

Questions.—(A) Please give size of wire, and state what other material should be used in making a simple transformer to step down 220 volts to 50 volts. (B) Referring to "A Simple Transformer" in the November, 1908, issue, please give the size of core and also size of primary and secondary wires to step 100 volts down to ten volts. (C) If 1,000 turns of No. 23 double cotton-covered wire on the primary of a transformer, and 100 turns of No. 13 on the secondary will give 10 volts from a 110-volt circuit, will 1,000 turns of the same (No. 23) to 20 turns of No. 13 give 50 volts?—T. C., St. Joseph, Mo.

Answers.—(A) See answers to M. L. B., this issue; also article referred to in question (B). Wire should be of sufficient size to take off current required.

(B) Answers to your question are given in the article referred to. That is, the transformer referred to has a 10 to 1 transformation and would step 100 volts down to 10.

(C) Yes. The proportional formula for this is:

$$\frac{E_1}{E_2}=\frac{N_1}{N_2}$$

where E_1 = primary voltage.
E_2 = secondary voltage.
N_1 = number of turns in the primary coil.
and N_2—number of turns in the secondary coil.

Dynamo Polarity; Battery Operation.

Questions—(A) How can I determine the positive and negative field poles of a dynamo? (B) Can a storage battery be over-charged? (C) Can a rectifier be made to change 110 volts 60 cycles alternating current to 10 volts direct current? (D) Does the transformer described in the "Junior Section" of the November issue, 1908, change alternating current to direct current?—A. W., San Francisco, Cal.

Answers.—(A) If the north end or pole of a compass needle be brought near the north field pole of the dynomo while running, this end of the needle will be repelled. It will be attracted by the south field pole.

(B) When the active material in the cell is all converted, that is, becomes lead peroxide on the positive plate and spongy lead in the negative plate, continuing to send charging current into the cell produces no effect except to decompose the water, the gases passing off. No harm is done to the plates to continue charging after gassing begins, but the current is wasted.

(C) Yes. Such outfits using mercury in bulbs containing the electrodes are used for charging batteries. An auto-transformer is also a part of the outfit. An attempt to make the apparatus would be, we believe, an expensive proposition.

(D) No. Transformers only step up or step down the voltage of alternating current, the transformation being in proportion to the number of turns the two coils bear to each other.

Changing a Telephone Magneto.

Question.—Can a telephone magneto be changed so it will give direct current without changing armature?—D. W. K., Nevada, Ohio.

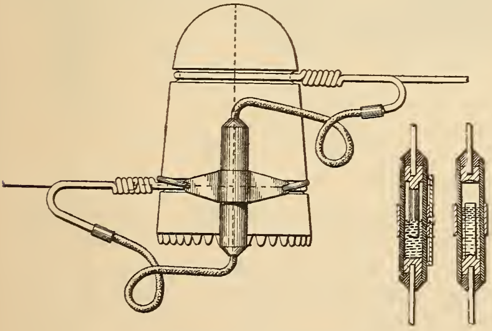
Answer.—Yes, by providing a commutator in place of slip rings on the armature.

NEW ELECTRICAL INVENTIONS

CIRCUIT-BREAKER.

In testing telephone lines and other similar circuits it is frequently necessary to open the wire at some point by cutting it. A simple circuit-breaker to be located at various points along the line in order to do away with cutting the wire has been invented by Lewis C. Steele of Columbus, Ohio.

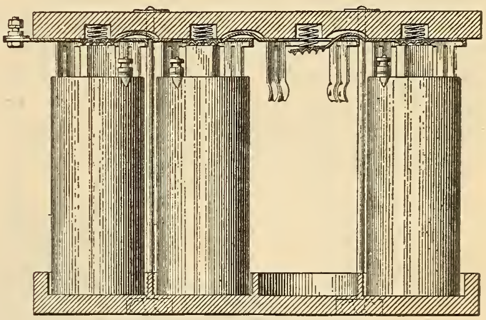
The cut shows an ordinary double groove insulator with wires attached to the upper and lower grooves. This would ordinarily leave a break in the line, but the flexible wires and circuit-breaker bridge across the gap. The circuit-breaker as shown by the sectional views consists of a tube with two electrodes entering top and bottom. In the bottom of this tube is mercury. When the tube stands upright as shown in the left-hand sectional view, both electrodes make contact with the mercury and the circuit is complete. When it is desired to open the line to test, the tube is inverted as shown by the right-hand sectional view. The mercury then runs to the other end of the tube leaving one electrode bare and the circuit is opened without cutting a wire.



CIRCUIT BREAKER

BATTERY HOLDER.

A simple and efficient form of apparatus by which dry batteries may be held together and easily connected is shown in the cut.



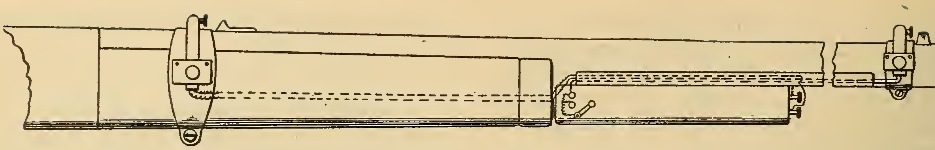
BATTERY HOLDER

The frame or support overlying the batteries is provided with spring clips on the under side which slip over the battery terminals and make contact and save all the cumbersone wiring between cells. The inventor is Charles T. Mason of Sumter, S. C.

ELECTRIC GUN SIGHTS.

The sighting of fire arms at night is a matter of considerable importance and even now our army experts are making exhaustive tests of devices which will permit this to be done. A recent patent along this line is one taken out by Emil O. Deere and Thure O. Jaderbörg, both of Lindsburg, Kansas.

As shown, the gun is provided, in the neighborhood of the front and rear sights, with two tiny electric lamps which are fed by a battery cell fastened underneath the barrel. These lamps are not placed there to illuminate the regular sights but the

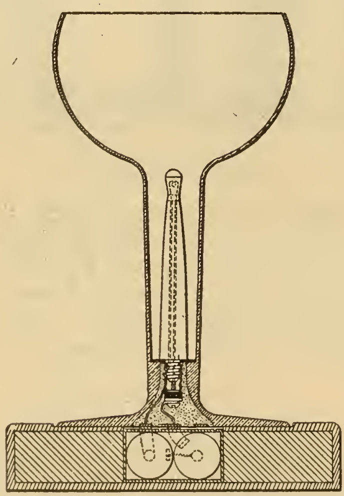


ELECTRIC GUN SIGHTS

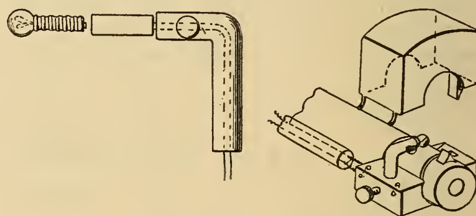
lamps themselves act as the sights at night. They shine as two bright sparks in the darkness, and the two are simply brought in alignment with the target in aiming.

ELECTRICALLY ILLUMINATED DRINKING GLASS

A novel and pleasing effect may be produced by the electrically illuminated drinking glass shown in the cut. The glass is provided with a long hollow stem in which is placed a miniature electric lamp as shown. This is attached to the end of a pedestal in the stem, and the lead-in wires to the lamp pass up through this pedestal. Electrodes projecting out from the bottom of the glass make contact with the terminals of a battery placed in a special base. When the glass is set down on this base the lamp is lighted, giving great brilliancy to the liquid. When the glass is lifted from the base the lamp of course goes out. The inventor is Joseph H. Cahill of St. James, N. Y.



ELECTRICALLY ILLUMINATED DRINKING GLASS



ELECTRIC ANIMAL TRAP.

A unique device for killing wild animals by means of dynamite or other high explosives is the invention of Martin O. Cox of Tygh Valley, Oregon. A dynamite cartridge with an electric exploding device is cunningly hidden in a piece of bait. A double wire for the battery circuit leaves the cartridge and runs to a point some distance away. Here it divides, one wire of the circuit passing through a coiled spring circuit-closing device to one side of the battery. The other wire goes direct to the other side of the battery. When the animal seizes the bait and attempts to drag it away the spring is stretched sufficiently to bring the two open contacts inside together, closing the circuit and sending off the charge.

ELECTRIC ANIMAL TRAP

Within the past few years electricity has been utilized to produce some of the most remarkable stage pictures it is possible to conceive. Without the faithful agency of electricity the theatre would lose half of its scenic attractions.

THE TELEPOST.

Several inventors have in the past devised machinery that would automatically transmit telegraph messages at high speed, and as early as 1879 one of the systems was put into experimental operation. Unfortunately for these earlier inventions, the electricians were unable to cope with their arch-enemy, the "static" charge of a telegraph wire. Atmospheric changes, induction currents and other disturbances also interfered persistently with their operation. But finally Mr. Patrick B. Delany, an expert electrical engineer and the inventor of many telegraphic improvements, announced that he was going after "static," as he believed the problem could be solved by patient effort.

He devoted himself with determined energy to experiments which he hoped would make him master of the principle. He devised new mechanisms and applied new theories to the working out of a system that occupied him for fifteen years before he finally discovered how to deal with "static" (which may be described to the lay mind as the excess electricity with which a wire is saturated, and which must be "cleared" before signals can be sent. It is a very tricky element.) In 1903 he obtained from the United States Government a basic patent on his invention for the control and use of the "static."

PERFORATING THE SENDING TAPE

Remarkable as Mr. Delany's achievement is from a scientific viewpoint, its real importance lies in the fact that it bids fair to clear the way for the almost inestimable boon of cheap telegraphy. The ability to send telegrams at the rate of one thousand words a minute means that the Telepost, as the device is called, can transmit over one wire as many messages as the ordinary telegraph can transmit over seventeen wires. Which is assuming that the methods at present in use permit the sending of sixty words a minute on an average.

There are many notably interesting features about the Telepost beside its speed and cheapness. It has, for example, three quite unique services in addition to that of transmitting regular telegrams. One of these is "telecarding," which is sending a postcard by wire. Though this is not done literally, it is in effect thus: The writer fills in a "telecard" (the same size as a postcard) and hands it in to the Telepost office (or he can drop it into a post-office box to be delivered in due form by the letter-carrier), and the Telepost will wire the message to the point of destination or to the nearest Telepost office to that point, where it will be typed onto a similar card addressed to the person for whom it is intended, and delivered through the mails. By this means "telecard" messages could be written in New York and be delivered to an address in Chicago in two hours, instead of in the twenty or thirty hours required to transport a postcard between the two cities.

Another and somewhat similar service is the handling of a fifty-word letter in the same way, at a nominal charge. The letter is handed in, or sent by mail, to the local Telepost office. The operator there transmits it to the city of destination by wire, where it is typewritten, put in an envelope, properly addressed, and dropped into the postoffice for delivery by the local carrier.

But the service that is most interesting in the point of novelty, and which will prove of especial value to the business world and to those who wish to secure the utmost privacy for their messages, is the "teletape," by means of which one-hundred-word messages can be sent for a few cents, even from Boston to San Francisco. That the reader may understand this device, it must be explained that all messages transmitted by the Telepost's rapid automatic system are, before being fed into the transmitter, perforated on a narrow paper tape by a perforating machine operated by a lettered keyboard very like that of the typewriter.

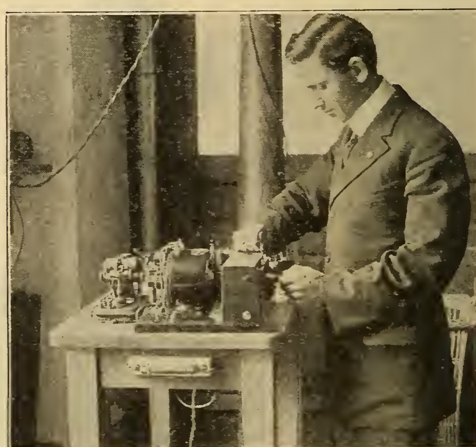
OPERATOR REMOVING SPOOL OF MESSAGES

This machine may be worked at any speed at which a person is capable of manipulating the keyboard, and the message can thus be prepared by anyone, a knowledge of telegraphy not being necessary to its use. The tape so perforated—the perforations being regulated to the dot and dash signals—is fed at the speed of one thousand words a minute.

The advantage of the "teletape" to the business man is that he can have a perforating machine in his own office, just as he has a typewriting machine, and he, or his stenographer for him, can prepare his own types, and can, if he chooses, employ a cipher code in doing so. When the tape is ready he has only to write the name and address to which it is to be sent, sign his name or code word, and send it by his office-boy to the Telepost office. There the operator takes the "teletape" and simply feeds it into the automatic transmitter, and has nothing else whatever to do with the message. At the receiving station the message is electrically printed on a tape in dots and dashes, which is delivered just as it is to the address indicated, where it is first translated by the person for whom it was intended. As anyone of ordinary intelligence can, with a few hours' study, learn the dot and dash alphabet, the recipient of these "teletapes" or his stenographer, will quickly be able to read them off as readily as if they were printed in Roman type.

This feature makes strong appeal to business men, and already firms in cities where the Telepost has begun operating are making application for perforating mochines to be installed in their offices. The supremacy of the Telepost system does not rest on a theoretical claim. Continuous operation through the past winter, over a line stretching from Boston to Portland, Me., demonstrated anew the previously fully established claims of the Telepost as "a means of furnishing rapid and uninterrupted telegraphic communication."

After some months' successful operation commercially in the East the first western Telepost section has been opened up. With



OPERATOR TRANSMITTING MESSAGES BY TELEPOST

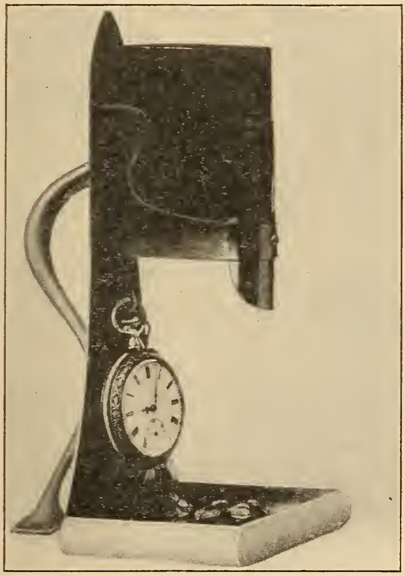
St. Louis, Missouri, as a center, much progress has been made in several directions. The St. Louis-Kansas City line has reached Sedalia, Mo. The St. Louis-Indianapolis line is now at Terre Haute, Indiana, and the St. Louis-Chicago line is nearly completed. Telepost offices are now equipped in St. Louis, Kansas City, Terre Haute, Ind., and Springfield, Ill., and other important points on these lines will shortly be connected up so that it is announced that in the immediate future these cities will be enjoying Telepost service.

The Telepost has already done enough to give practical significance to the descriptive phrase used a few months ago by a distinguished Congressman in describing it as "the telegraph of the future."

TO SEE YOUR WATCH AT NIGHT.

A new type of holder for a watch has recently been put on the market in Germany. The principal feature is that a pocket electric lamp is used for lighting the dial.

As can be seen in the cut the hook for the watch is mounted on a bracket which firmly holds the pocket battery with its little electric lamp in the end. The button for closing the battery circuit rests upon the bracket, but the weight of the battery is not sufficient to push the button towards the inside and close the contact. It is only when we place



WATCH ILLUMINATOR

the hand on the top of the battery that the button is pushed in and the lamp will be lighted. The upper part can be taken out if desired and used as an ordinary pocket electric lamp.

With this outfit we need not search in the darkness for a button or contact lever, but simply place the palm of the hand upon the whole apparatus and the lamp will instantly glow. The form illustrated is used for the table, others have been devised for the wall. The shield in front serves as a reflector to throw the light upon the dial of the watch and to protect the eye from direct light.

A wireless plant will be installed on the top of the tower of the city hall of Philadelphia, 500 feet above the street.

BOOK REVIEWS

ELECTRIC RAILWAY POWER STATIONS. By Calvin F. Swingle. Chicago: Frederick J. Drake & Co. 1909. 701 pages with 368 illustrations. Price, $2.00.

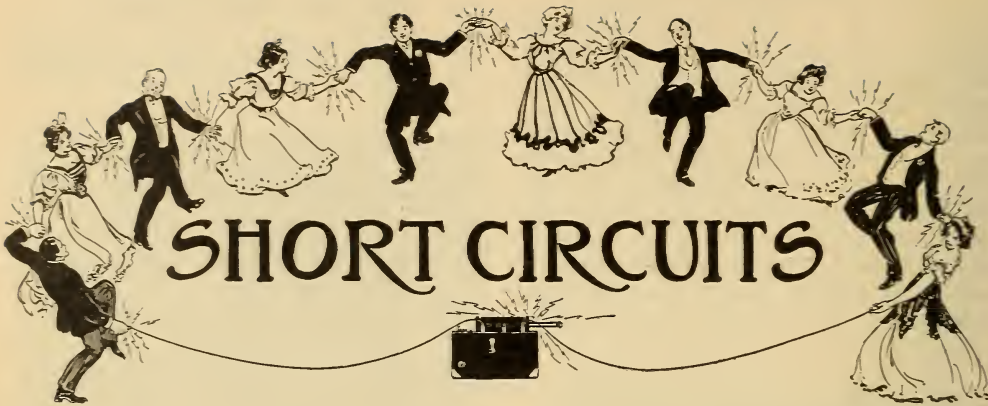
The electric railway power station is treated in a plain practical manner from the standpoint of the operating engineer rather than the designer. The complete power station equipment is treated in logical sequence beginning with the entrance of the coal into the boiler room and ending with the exit of its contained energy in the form of electricity from the station switchboard. It teaches the engineer what he ought to know regarding different kinds of coal handling apparatus, stokers, boilers and steam engines, including the steam turbine. Then the electric generators are taken up, and their various parts described. Finally station switchboards are discussed, switching devices, instruments, etc. An educational feature of the book is a collection of questions and answers following each chapter which bring out the features discussed.

WIRELESS TELEGRAPHY AND TELEPHONY. By Walter W. Massie and Charles R. Underhill. New York: D. Van Nostrand Co. 1908. 75 pages with 28 illustrations. Price, $1.00.

This is an explanation, in simple language, of the theories leading up to the present development in the art of wireless telegraphy and telephony, also descriptions of the leading systems in use today. Some interesting historical data is also appended concerning the early attempts to make wireless telegraphy practical.

APPLICATION OF ELECTRIC MOTORS TO MACHINE DRIVING. (Third Edition.) By Andrew Stewart. London: S. Rentell & Co., Ltd. 1905. 131 pages with 92 illustrations.

After first describing in a general way the construction, operation and characteristics of the electric motor, examples are given of the various applications of the motor to machine drive. There are described applications of the motor in the shop, on the farm, in the home, in the railroad yard, the printing establishment, etc. With the extension of motor applications has come an increasing appreciation of their advantages. It has been the author's aim, therefore, not only to illustrate the various applications of electric drive, but to further increase this appreciation by indicating the economic advantages gained.



SHORT CIRCUITS

"Jackie," said the boy's mother, "your face is fairly clean, but how did you get such dirty hands?"

"Washin' me face," said the boy.

* * *

Canvasser—"Madam, I would like to show you the beautiful silver forks that we are giving away with every half dozen bars of Skinflint soap."

Lady of the House—"We don't never eat with no forks in this house. They leak."

* * *

"You say you were in the bar at the time of the assault referred to?" asked the lawyer.

"I was, sir."

"Did you take cognizance of the landlord at the time?"

"I don't know what he called it, but I took what the rest did."

* * *

An old lady appeared in church one Sunday with an ear trumpet. Her presence seemed to worry one of the ushers who had never seen one of these instruments before. Being a devout Scotchman he apparently came to the conclusion, at last, that something might happen unbecoming to the sanctuary, so he tiptoed up to the old lady and in a loud whisper announced: "One toot and you're oot."

* * *

It was in the hotel of a Western mining town that the New England guest, registering in the office, heard a succession of loud yells. "What in the world is that —a murder going on upstairs?" he demanded.

"No," said the clerk, as he slammed the book and lounged toward the stairs. "It's the spring bed up in No. 5. That tenderfoot up there don't get the hang of it, and every few days he gets one o' the spiral springs screwed into him like a shirt stud. I guess I'll have to go up; there ain't anything more I can do for you for a few minutes."

* * *

"In Chicago one evening," related the college son back home, "as I was passing beneath a gas lamp I beheld the form of my old college room-mate silhouetted on the snow!"

"I ain't surprised," exclaimed Aunt Martha shuddering. "In that awful city they even murder people on the street in broad daylight!"

* * *

The father frowned.

"What is that boy watching all the clocks for?" he demanded.

The mother smiled.

"He's got them running in a six-day Marathon race," she replied, "and the one that runs the longest gets oiled."

"Judge, did you ever try an absinthe frappé?"

"No; but I've tried a lot of fellows who have."

* * *

Drink to me only with thine eyes
And I will pledge with mine;
For I see six germs within the cup
So I do not care for the wine!

* * *

"I suppose," said the casual acquaintance, the day after the wedding, "it was hard to lose your daughter."

"No," replied the bride's father. "It did seem as if it was going to be hard at one time, but she landed this fellow just as we were beginning to lose all hope."

* * *

This story would seem to show that colored people have tough heads:

Dinah, crying bitterly, was coming down the street with her feet bandaged.

"Why, what on earth's the matter?" she was asked. "How did you hurt your feet, Dinah?"

"Dat good fo' nothin' nigger (sniffle) done hit me on de haid wif a club while I was standin' on de hard stone pavement."

* * *

The Poet—Is there a literary club in this vicinity?

The Editor (reaching behind the desk)—There is. Are you literary?

* * *

"But why should we grant a pension to this California state senator for throat affection?" inquired the minority leader of the committee on pensions.

"Because it's the result of ponderous platitudes uttered during the war between California and Japan!" replied the chairman.

* * *

"Doin' any good?" asked the curious individual on the bridge.

"Any good?" answered the fisherman, in the creek below. "Why, I caught forty bass out o' here yesterday."

"Say, do you know who I am?" asked the man on the bridge.

The fisherman replied that he did not.

"Well, I am the county fish and game warden."

The angler, after a moment's thought, exclaimed, "Say, do you know who I am?"

"No," the officer replied.

"Well, I'm the biggest liar in eastern Indiana," said the crafty angler, with a grin.

* * *

Mrs. Jenner Lee Ondego—"Did you feel that earthquake shock this morning?"

Mrs. Seldom Holme—"Very distinctly; but I thought it was my husband getting out of bed."

WHAT IS ELECTRICITY?

ELECTRICAL DEFINITIONS

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

Accumulator.—See secondary battery.

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

Ammeter.—An instrument for measuring electric current.

Ampere.—Unit of current. It is the quantity of electricity which will flow through a resistance of one ohm under a potential of one volt. The international ampere is the current which, under specified conditions, will deposit .001118 gram of silver per second when passed through a solution of nitrate of silver in water.

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

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

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

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

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

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

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

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

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

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

Circuit.—Conducting path for electric current.

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

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

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

Condenser.—Apparatus for storing up electrostatic charges.

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

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

Dielectric.—A non-conductor.

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

Direct Current.—Current flowing continuously in one direction.

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

Electrode.—Terminal of an open electric circuit.

Electromotive Force.—Potential difference causing current to flow.

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

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

Farad.—Unit of electric capacity.

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

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

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

Generator.—A dynamo.

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

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

Kilowatt.—1,000 watts. (See watt.)

Kilowatt-hour.—One thousand watt hours.

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

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

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

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

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

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

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

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

Potential.—Voltage.

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

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

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

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

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

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

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

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

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

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

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

Storage Battery.—See secondary Battery

Thermostat.—Instrument which, when heated, closes an electric circuit.

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

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

Volt Meter.—Instrument for measuring voltage.

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

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

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Entered at the Chicago Post Office as second class matter Feb. 18, 1901. Listed with every responsible Advertising Agency in the United States.

To Savings Bank Depositors

Trustees of Estates, Investors depending upon interest or dividends for income, and others desirous of securing at least 10% a year for an investment of from $100 to $5000, under conditions guaranteeing the redemption of principal and payment of dividends.

Subscription Books have been opened at the office of the Balch Publishing Co. for the receipt of applications for the unsold balance of its

10% Guaranteed Preferred Shares

(total issue 10,000 shares) redeemable for cash with a premium of 5% at the holders' option at the end of 3 years, carrying a guaranteed annual dividend of 10%, payable semi-annually, (Sept. 1 and March 1) and participating in all excess profits.

The next and following pages contain:

Price, Terms and Conditions
Personal Statements by Frank O. Balch
Opinion of the "American Banker"
A few Names of Chicago Stockholders
Fourteen Reasons
Application Blank and

Complete Information, consisting of

Profits in Magazine Publishing	Outline of Improvements
A Brief Story of Home Life	Guaranty
Balch Publishing Company	References
Present Condition of the Company	Supervision of Business
The Purpose	Conclusion

This offering is sufficiently unusual to require immediate attention.

Turn to next page

The price is $10 per share for the first 5,000 shares and $12.50 per share for the remainder. The book value is $16.28.

Terms: Plan A—Payment in full with application.
Plan B—25% with application, balance in 3 equal monthly payments.

No application for less than 10 or more than 500 shares will be accepted from any one subscriber.

Dividends will commence from the date certificate is issued.

Applications for these shares may be made in person or by mail. If mailed, they should be accompanied by check or money order for the required amount, payable to the order of the Balch Publishing Co., Chicago.

Applicants residing at a distance from Chicago are advised to telegraph their orders, which will be accepted, providing application and remittance are mailed on the same day.

Applications will be filled in the order received, and money refunded if oversubscribed.

To secure the shares at $10 prompt application is recommended.

Two months' dividends at the rate of 10% will be credited on all payments with accepted applications personally made, mailed or telegraphed before July 15. This is equal to 3% savings bank interest for six months.

The American Banker

May 9, 1909, editorially analyzing this investment, says:

"———to the American Banker it seems a most unusually fair and clean opportunity to earn at least 10%, and most likely more, on an investment now showing at a conservative valuation a book value of 62% in excess of the price asked for the shares, and bound to increase in market value as the improvements in the magazine and plant are consummated. Bankers can safely take advantage of and recommend the Balch Publishing Company's shares as an investment."

$40,000 Has Already Been Subscribed

and among the Chicago subscribers personally acquainted with Frank O. Balch and the Home Life Magazine are the following:

T. C. FREDERICK,
Treasurer Bedford Quarries Co.

GEO. GILLETTE,
Attorney

H. A. BINGHAM,
Pilcher-Hamilton Paper Co.

H. A. BOWMAN,
President Bowman Auto. Addressing Co.

JOHN ARTHUR DIXON,
Chicago Record-Herald.

ALFRED BERSBACH,
Treasurer Manz Engraving Co.

JOHN HINDMAN,
President Colonial Mercantile Co.

ARTHUR E. SWETT,
Swett Advertising Agency.

E. C. BODE,
Advertising Manager Chicago Examiner.

H. E. GROTH,
Treasurer Mahin Advertising Co.

E. L. KUNZE,
Insurance.

R. C. HARRELL,
President Steamfitters' Supply Co.

W. A. C. SMITH,
Manager The Ohio Quarries Co.

WM. A. WADSWORTH,
Manager Popular Electricity Magazine.

Frank O. Balch

President of the Balch Publishing Company, submits the following personal statements:

Bearing upon the 10 per cent preferred stock of the Balch Publishing Company, I submit the following:

No one is as competent to know your character as the man who comes into daily contact, does business with you and extends you credit. I started in the publishing business in Chicago nine years ago and am dealing with the same firms today as at the start. I have built up the business from practically nothing under the standard that carries no regrets in its trail, and permits of traveling the same paths certain of encountering the same uniform welcome.

My own good faith is amply evidenced by the fact that I have turned over the entire property to the company for only $50,000 in stock (or one-third of the entire capital stock of $150,000, thereby surrendering control to the public), although it is considered to be worth a good deal more. In doing so I was prompted by a realization that with additional capital of $100,000 the profits can be increased sufficiently to make my third interest pay me and be worth more than the entire ownership as heretofore.

A bank is a stock company with the privilege of receiving deposits. A business corporation is a stock company without the privilege of receiving deposits. Both have the privilege of selling their stock, and both can be either sound or unsound. A bank having resources of $290,000, liabilities of $200,000, and a surplus of $90,000, is considered sound and prosperous. A business corporation making a similar showing is considered equally prosperous and sound. The figures are taken from the last trial balance of the Balch Publishing Company (May 1, 1909).

Money deposited in a bank may be withdrawn at any time, but it draws only 3 per cent a year. Money invested in the Balch Publishing Company cannot be withdrawn for three years, but it pays at least 10 per cent a year.

While banks are always ready to receive deposits and investments of various character always available, the information submitted herewith will convey to the intelligent investor the rarely encountered advantages and qualities of this offering.

The ground is thoroughly covered in this announcement, and I can only reiterate the facts which in assembly serve to make the investment unusual and desirable:

The business has been in successful operation for years. The value of the stock is real and ample. The profits are actually earned now. The dividends are payable, the same as bank or bond interest, every six months from the date of the certificate, and at least 10 per cent a year is guaranteed. The future is not discounted, imagination not drawn upon, success accomplished by others not considered a criterion, only what we ourselves *have done and are doing*, forms the basis of the entire proposition.

Respectfully submitted, FRANK O. BALCH.

Fourteen Reasons Why

the Home Life Shares constitute the strongest industrial investment at present available to the public:

1—The principal is guaranteed.

2—Annual dividends of at least 10 per cent are guaranteed.

3—The earnings are several times as large as the amount required to pay 10 per cent on the entire 10,000 shares. The discounts alone should be sufficient to meet the dividend requirements.

4—While the business shows earnings at the rate of 6 per cent on $1,000,000, and is estimated to be worth $450,000, it is capitalized only for $150,000.

5—The Company is incorporated under the laws of the State in which it is doing business.

6—The business is well established, successful and paying.

7—There is no promotion stock.

8—The entire amount of money realized from the sale of stock, less the actual expense of selling it, goes into the business.

9—With the additional investment of the money realized from the sale of the shares the earnings are expected to be considerably greater than at present.

10—The books of the Company are at all times open to interested parties.

11—The business is known practically throughout the United States, and every claim can be substantiated.

12—Every phase of the proposition is exactly as represented, and every facility for corroboration will be afforded. Whatever point of view it may be judged from, the investment is of a character rarely, if ever, offered to the public. The business is conducted with the same care and economy as any successful business man would conduct his individual affairs.

13—On a 10 per cent basis with earnings of about 40 per cent the shares may be considered to be worth $40.00 each. Their value will increase proportionately with the earnings.

14—Each $10 share is guaranteed $1 a year in dividends and may be expected to earn considerably more as the expense incidental to improvement and maintenance diminishes.

Complete Information

is submitted below. The Balch Publishing Co. is an Illinois corporation, located in Chicago, at the corner of Kinzie St. and Dearborn Ave., directly opposite the Dearborn St. bridge. Receipts from the Chicago Post Office are cited. References are published from a few of the largest and oldest firms in their respective lines in Chicago. Figures are given and the books are in Chicago. The business has been under the same management for nine years. It is favorably known to every one prominently connected with the advertising and publishing business.

Profits in Magazine Publishing

Frank A. Munsey started in the magazine business with a capital of $40; his business now pays a profit of $1,000,000 a year. The stock of the S. S. McClure Company is worth $1,000 a share. The income of the Curtis Company from the Ladies' Home Journal and the Saturday Evening Post is nearly $6,000,000 a year. The annual income from the Cosmopolitan Magazine is about $1,500,000. The property is now owned by William Randolph Hearst, who bought it from John Brisben Walker. Mr. Walker had made several fortunes from the magazine. The profits of Everybody's Magazine are estimated as being as high as $800,000 a year. Other American magazines are all large profit earners. A well-known English author about ten years ago accepted $2,000 worth of McClure's stock in payment for a story; recently he sold the stock for $20,000. During the time when he held the stock it paid him dividends of $14,000, making a total of $34,000 cash for $2,000 worth of fiction manuscript. If you had been able to secure an investment of only $100 in Munsey's Magazine that investment would now be paying an income of $1,000 every year and would be worth at least $10,000 in cash. Those who had the opportunity to become interested with magazines when they first offered their stock to the public have become wealthy. I

A Brief Story of "Home Life"

Home Life was established 19 years ago at Caro, Michigan. Mr. Balch became connected with it in 1900 and moved the magazine to Chicago. In September, 1900, it had a circulation of 20,000, at the end of five years 500,000, and now the circulation of Home Life is 900,000 copies each issue, mailed direct every month into the homes of 900,000 laboring and farming American families residing in the rural districts, and read by more than four million people. It is not sold on news stands and has no waste circulation. The advertising rate of Home Life is $3.60 per single column line, or $1,764 per page, which is higher than Collier's, Munsey's, McClure's, Everybody's, etc., and exceeded only by five magazines in the United States. It makes no claim to beauty in appearance and is not in the class of ornamental magazines—just a substantial 25-cents-a-year, "2-cents-a-copy" mail order publication for the masses, and a dependable source of profit to its advertisers and publishers.

Among the contributors are: Rev. Dr. Frank W. Gunsaulus, President of the Armour Institute of Technology, who furnishes editorials and special monthly articles; Robert W. Chambers, Bishop Samuel Fallows, Opie Read, Cyrus Townsend Brady, Robert B. Armstrong, Elia W. Peattie, Charles Noel Douglas, S. E. Kiser, Richard Henry Little, Carolyn Wells, etc. Among the numerous advertising patrons are: Lyon & Healy, Sears, Roebuck & Co., Chicago, Milwaukee & St. Paul R. R., National Biscuit Co., Kimball Pianos, John M. Smyth & Co., Mead Cycle Co., Hartman Furniture Co., Crofts-Reid Co., etc., etc. All advertising orders are received through and bills paid by advertising agencies with established credit.

Balch Publishing Company

Home Life is owned and published by the Balch Publishing Company, incorporated under the laws of the State of Illinois. The authorized capital stock is $150,000, divided into 15,000 shares of $10 each. $50,000, or 5,000 shares, are common stock, and $100,000, or 10,000 shares, are preferred stock to the extent of 10 per cent. The $50,000 of common stock constitutes the consideration for which Mr. Frank O. Balch transferred the entire property to the Company, and the $100,000 of preferred stock is offered for investment. While the preferred stock is guaranteed only 10 per cent of the profits it participates in and is entitled to receive its full share of the additional profits, the same as the common shares.

Present Condition of the Company

The following figures are taken from the trial balance for the four months of the present fiscal year:

The income during the said period of four months was $109,735.46, the expenses for the same period $88,138.25, and the earnings $21,597.12, which is at the rate of $5,399.30 per month, equal to 43 per cent on the entire capital of $150,000, and six times as large as the guaranteed annual dividend.

As per trial balance of May 1, 1909, the resources of the Company are $291,545.54, the liabilities (inclusive of the capital stock) $199,781.51, and the surplus $91,764.03.

The receipts from the Chicago Post Office on file at the office of the Company show that over 900,000 copies of Home Life are mailed monthly.

The value of a magazine is figured on a basis of $2.00 per circulation unit, which would make Home Life, with its 900,000 circulation, worth $1,800,000, or twelve times the amount of the Company's capitalization. Even on the basis of 50 cents per unit the magazine would be worth $450,000; on the books of the Company, however, circulation is valued at only about 16 cents per unit.

The Purpose

The purpose for which the stock is offered is to secure funds to improve Home Life to the extent of making it the leading rural publication in this country. The population of the United States is eighty-four millions, of which seven millions are classes and seventy-seven millions are masses—the field of Home Life is with the masses. The stock is offered to the public because the security, while ample, is not of the class on which banks are permitted to make loans, and large or short term loans from individuals are not advisable. It should be understood, however, that while additional capital is desirable and will enable the Company to make immediate improvements, the business is sufficiently well established to continue profitable regardless of the sale of stock.

Outline of Improvements

The first improvement will consist of discounting all bills, which discounts are expected to be sufficient to pay the guaranteed 10 per cent interest on the entire issue of $100,000 worth of preferred stock.

The next improvement will consist of using a higher grade of paper for the magazine, better cover designs and superior reading matter.

The third improvement will consist of eliminating all objectionable advertising. To secure higher grade advertising, such as is carried by the Ladies' Home Journal and other standard publications, the objectionable advertising has to be eliminated for about two months, as the higher grade advertisers are particular of the company in which they appear. New, substantial advertisers can easily be secured, owing to the fact that Home Life is known to be very near the top as a paying publication for advertisers. The proceeds from the sale of the preferred stock will provide the necessary strength to effect the above improvements with safety.

After the mentioned three improvements are accomplished and the magazine made the best and strongest publication for the masses in the country, the fourth improvement will be introduced, consisting of raising the price of Home Life from 25 cents to 50 cents per year, which, on the basis of the present circulation, will increase the income from that source alone by $225,000 a year, equal to 150 per cent on the entire capital of the Company.

Guarantee

An indorsement upon each certificate guarantees the payment of at least 10 per cent dividends, payable semi-annually, and the redemption of the principal with a premium of 5 per cent on demand at the end of three years. The entire assets of the Company and Mr. Balch's personal estate are back of the guarantee, which is as effective as a first mortgage, there being no bonds, mortgages or prior liens of any kind. In addition to the security represented by the business, Mr. Balch's life is insured in the Penn Mutual Life Insurance Company for the benefit of the preferred shareholders to guard against the value of the business being impaired temporarily or permanently through his unexpected decease. The surrender of the shares, however, is not obligatory, being left at the option of the shareholders.

References

The magazine is known to every one prominently connected with the publishing or advertising business. It is known to 900,000 homes in the United States. It is listed as one of the leading mail-order monthlies in every newspaper and magazine directory, and the Company receives business from nearly every advertising agency in the country. A few specific Chicago references are submitted herewith and many others can be furnished on request.

March 5, 1909.

We have had business dealings with the Balch Publishing Co. for several years, and our relations have been very satisfactory.

We regard them as a reliable and progressive concern and any statements that they make are worthy of consideration.

THE PILCHER-HAMILTON CO.,
1824 Dearborn Ave.

We desire to advise you that we are greatly pleased with the results our customers are getting from Home Life.

The best evidence of our appreciation of the merits of your publication is the fact that during 1908, which was a panicky year, our business, with you increased 262 per cent over 1907. Yours very truly,

MAHIN ADVERTISING CO
125 Monroe St.

March 5, 1909.

TO WHOM IT MAY CONCERN:

We have known Mr. F. O. Balch, publisher of the Home Life and Ladies' Magazine, since the year 1900. We have been doing business with him continuously since then, and we believe that to him alone is due the credit for building up the business to its present large proportions. BRADNER SMITH & CO.,
134 Monroe St.

March 4, 1909.

Balch Publishing Co., 205 Kinzie St.

Gentlemen—We are glad to say to you and all who are interested, that we greatly admire the manner in which you conducted your business and the sincerity with which you have met your obligations during the present financial stringency. We highly regard your Mr. Frank O. Balch and believe him to be an exceptionally honorable and hard-working young business man. Very truly yours,

MANZ ENGRAVING COMPANY.
Majestic Building.

March 5, 1909.

Referring to your investment proposition in the stock of Balch Publishing Co.

It is a well-known fact that the larger the scale any business proposition is conducted on, the less expensive it is pro rata. For this reason it does appear to me that the stock proposition you offer the public should be a most excellent one. Nelson Chesman & Co. are already spending with you for our clients in the neighborhood of from $50,000 to $75,000 per year, and the fact that the character of business which applies to your publication is constantly increasing, there is no reason why we should not in the next year or two be able to spend with you double the amount. Other agencies will undoubtedly be in the same position as ourselves, and altogether we think your investment proposition a good one. Yours very truly,

NELSON CHESMAN & CO.,
Owners of Publicity Bldg., St. Louis. Chicago Office: Trude Bldg.

March 12, 1909.

At your request we are submitting you herewith a statement showing the value of paper you have purchased from us since October, 1908, for your publication, Home Life.

October, 1908	$ 4,994.01
November, 1908	4,522.83
December, 1908	5,032.58
January, 1909	5,826.98
February, 1909	5,882.84
Total	$26,259.24

We desire to assure you that your account is fully appreciated and that we are at all times ready to cooperate with you in maintaining the success of your magazine. Yours very truly.

BERMINGHAM & SEAMAN CO.,
Tribune Building.

Supervision of Business

The Company, being a home enterprise, more or less public, located right here in Chicago, within five minutes' walk from the loop, it would be easy for any one interested to keep posted on progress and conditions, and as the magazine would be mailed each month to every shareholder, knowing the advertising rate to be $3.60 per line, it can always be figured out how much income is derived every month. Complete statements will be sent to all shareholders semi-annually with the dividend checks.

Conclusion

The investment is presented and will appeal only to the man who realizes that he has no money to lose in purely speculative enterprises; to the deliberate man, who in making his investments requires a clean record of success and indisputable reference upon the integrity and ability of the institution to which he entrusts his money; to the man desirous of realizing more profit on his money than savings banks or first mortgages pay, and yet not grasping enough to sacrifice safety to a mere "prospect" of big profits.

In presenting this investment to the public no inducements other than merit are offered. The investment is advantageous as it stands, and its advantages are due to the fact that the Company is capitalized for only as much as it needs, which in turn is due to a desire on Mr. Balch's part to continue the business as heretofore, producing profits from its legitimate sources and not from the sale of securities to the public. The Company is a comparatively uncomplicated affair, and all there is to the proposition is told in this announcement. The entire issue consists of 10,000 shares only, over 4,000 have already been sold, and it is anticipated that the remainder will be promptly subscribed. It is therefore recommended that applications be sent in promptly to secure the shares at $10. The attached blank can be used in applying for shares, and the application with payment should be made or mailed before July 15 to be entitled to a credit of two months' dividends.

The entire information presented in this announcement constitutes the basis upon which these shares are offered for subscription, and it is made a part of the application as if embodied therein.

BALCH PUBLISHING CO.

Use This Application Blank

Balch Publishing Company,
51 Dearborn Avenue, Chicago, Ill.

Subject to your guarantee, I herewith apply for............Shares of your 10 per cent Guaranteed Preferred Stock at $10 per share on Plan......and enclose herewith $........ as required under the said plan, agreeing to pay the balance, if any, according to your terms.

Issue and mail me certificate or receipt, as I am entitled to by my payment. In the event of my application reaching you too late to secure the shares at $10, you will advise me and be governed by my instructions. Mail me a current copy of Home Life and a copy of each issue thereafter.

Name ....

Address ....

N. B. If application is accompanied by full payment certificate will be issued immediately. If part payment is sent, regular receipt will be mailed and certificate issued when payments are completed.

CLASSIFIED ADVERTISING
(CONTINUED)

AGENTS WANTED

STOP, women and men; hurry; seven new, useful fast sellers; 30 others to select from; big profits; write for $2 free offer and particulars. Fair Mfg. Co., Box 208, Racine, Wis.

DON'T ACCEPT an agency until you get my samples and particulars. Chance of a life time to get into a money-making business. T. M. Sayman, 2390 Franklin Ave., St. Louis, Mo.

AGENTS WANTED in every shop to sell our "Midget" knurled handle pocket screw-driver; sample, 10c. Sterling Novelty Co., Plainfield, N. J., Dept. E.

AGENTS—It's so easy to make $200 monthly with our Dash Board Line Holder. We are shipping them in 10 gross lots. Sample, prepaid, 30c. silver. Wholesale Supply Co., D 17, Valdosta, Ga.

THE LIGHTNING MULTIPLIER POST CARD will solve problems in multiplication quick as a flash, with absolute accuracy. Indispensable to every person who uses figures. Cannot get out of order. Send for one, and you will wonder how you ever got along without it. Agents wanted. Sample, 10 cents in stamps. The Simplicity Co., Chicago.

FOR SALE

FOR SALE—Complete set of castings, with blue prints of $\frac{3}{8}$ h. p. gasoline stationary engine; includes governor and timer, screws, etc., $10. Comet Motor Works, 17 W. Madison St., Chicago, Ill.

FOR SALE—Complete 3-rail electric railway. Cost $20.00. Will sell for $9.00. Further particulars for red stamp. E. A. Gordner, Box 547, Rochester, N. Y.

FOR SALE—Amateurs, make your coils with a slide wire bridge. Drawings and instructions, 50 cents. No toy. Cost, $3.00. Advance Bridge Co., 125 E. Jefferson St., So. Bend, Ind.

FOR SALE—A large quantity of No. 34 single silk magnet wire at $1.50 per pound; any address prepaid; nothing less than one-half pound. Geo. E. Glasser, Charlotte, N. Y.

EXCHANGE OR SELL your motors, generators, steam and gasoline engines, cameras, magic lanterns, phonographs, printing press, musical instruments, real estate or anything of value, new or second-hand. Send 4c stamp for best trading plan known. National Exchange Co., 929 Olive, St. Louis, Mo.

THREE THOUSAND FORMULAS—My 368-page volume of recipes and trade secrets, cloth bound, only 40c prepaid. Worth dollars. Satisfaction guaranteed. Wiley Sanderson, Dept. E, Ypsilanti, Mich.

SNOW SCENES—Views from one of Maine's most picturesque places. 5 ft. snow. 6 actual photo-cards, highly polished, 50c. Suitable for framing. C. Stanley, L. B. No. 5, Dixfield, Me.

FOR SALE

LUBRICANTS, asbestos, graphite and mica candles for loose pulleys and shaftings; no drip; no dirt; economical. Swain Lubricator Co., 252 E. Lake St., Chicago.

BUSINESS OPPORTUNITIES

CONCRETE—Learn how to handle this material, by reading "Concrete," a monthly magazine devoted to the uses of Portland cement. Practical, instructive articles, written in plain English. Sample copy, 10c. Yearly subscription, one dollar. Concrete Pub. Co., 299 Owen Bldg., Detroit Mich.

500 PER CENT PROFIT seems incredible, don't it? Send us 10c silver for copy of our folder, "How to Make Money Making Mirrors." Money returned if not satisfied. Economy Chemical Co., Box P-805, Ludington, Mich.

I HAVE listed with me to sell all subjects, I. C. S. and A. S. C. bound volumes. Do not buy until you get my prices. M. C. Suttle, McLeansboro, Ill.

SEND A DIME—coin or stamps—for a sample of "Just-Pull," the greatest electric light attachment on the market. A child can operate it. Easy money. No labor attached to the selling. Takes one minute to show it; can't get out of order; sells on sight for 25c. 100 percent profit. 2,000 sold to consumers at Chicago Electrical Show. Send ten cents for sample and full descriptive matter by return mail. Premier Novelty Company, Dept. C, 42 River St., Chicago.

MAKE MONEY AT HOME faster and easier than you ever dreamed possible. Russell's New Confection, Dairy Cream Crisp, sells like wildfire, from stores, on the street, or on trains. The more they eat the more they want. Profits, $5 to $10 a day, sure. Proceeds from a single batch pays for the formula, all raw material, and then some. A child can make it. Formula with full instructions, $1, postpaid to any address. Special: Until further notice, all orders will receive, free, my up-to-date method for making Stale-Proof Salted Peanuts; also my book, Straight Talk on Candy. Address Chas. E. Russell, 716 Clybourn St., Milwaukee, Wis. P. S.—Over 30 years a candy-maker.

1000 WAYS TO MAKE MONEY—This 125-page book, worth dollars, only 20c. prepaid. Satisfaction guaranteed. Landin & Co., Dept. 22, 97 E. Chicago Ave., Chicago, Ill.

WIRELESS

WIRELESS SUPPLIES—Norway iron core wire No. 22, straightened and cut to length, 20c. per pound. Core, 1x10 inch, weighs $1\frac{1}{2}$ pounds. Wire for electrolytic detectors, 5c. per inch. No. 34 S. C. C. magnet wire, $1.23 per pound. All sizes and insulations at proportionate prices. Tin foil, 35c. per pound; 2000 square inch per pound. Leyden jars, $3\frac{1}{4}$x7, 60c. each; $1\frac{3}{4}$x4 for adj. cond., 40c. Catalogue ready in a few days. O. S. Dawson, 156 Wabash Ave., Chicago, Ill.

CARBON WIRELESS DETECTOR sent prepaid upon receipt of 50c. Simple, sensitive and strong. Dept. Q, 357 E. 46th St., Chicago.

CLASSIFIED ADVERTISING

(CONTINUED)

WIRELESS

LEARN WIRELESS TELEGRAPHY. Operators make big salaries. Why? Because they are scarce. Big field; easy to learn; cost small. Instructions free. H. B. Steele, 229 Greene Ave., Brooklyn, N. Y.

THE NEW SILICON DETECTOR will increase your receiving radius 500 per cent. Only type sold to experimenters authorized by owners of Silicon patents. Infringers prosecuted! Send for special price list. W. C. Getz, 345 N. Charles St. Baltimore, Md.

WIRELESS TELEGRAPHY—Send twenty-five cents, coin, today and receive by return mail complete instructions, with diagrams, for making a complete sending and receiving station. Among instruments described are 1-inch coil and two different types of receivers. Box 519, Lima, Ohio.

WIRELESS EXPERIMENTERS, 1200 OHM receivers, each $3.00. Wound with copper wire and very sensitive. First 25 sold will be fitted with nickel plated headband. W. C. Getz, 345 N. Charles St., Baltimore, Md.

WONDER MEDICAL COIL, 35 CENTS. No man can take full strength of it with one dry cell. Stamp for catalogue. Hertzian Elec. Co., 1924 Flatbush Ave., Brooklyn, N. Y.

1,000 OHM Wireless Receivers $1.75. Very sensitive and absolutely reliable. New Wireless Detector. You want to know about both. Send stamp for descriptive circulars. Alden Wireless Co., Campello, Mass.

WE HAVE THE HANDSOMEST, and clearest receiving ELECTROLYTIC DETECTOR in the United States. Price $1.50. Everything in Wireless. Stamp for catalogue. Hertzian Elec. Co., 1924 Flatbush Ave., Brooklyn, N. Y.

WIRELESS. One-inch spark coils, specially made for wireless. Fat hot spark. Regular $6.00. Special this month $4.50. Also larger coils. A B C Wireless Specialty Co., 111 Broadway, New York.

WIRELESS EXPERIMENTERS—The Wireless Equipment Co. has taken over the business of W. C. Getz and will continue the same high efficient apparatus. Address all communications to Wireless Equipment Co., West Arlington, Md.

STATIC MACHINES, $3.75, Wimshurst, 2-8-inch plates. 3-inch spark. Work in wet weather. Stamp for catalogue. The Hertzian Elec. Co., 1924 Flatbush Ave., Brooklyn, N. Y.

WIRELESS TELEGRAPHY. Complete instructions, with diagrams, for making 1 inch coil, two types of receiver, and all other instruments necessary for a complete wireless sending and receiving station. Price, 25 cts. (coin). Box 519, Lima, Ohio.

WIRELESS

SPECIAL PRICES: 1000 ohm wireless receiver, double pole, special thin diaphragm, $1.75. Wireless telephone for amateurs, blueprint showing connections, 20c. Morse, Continental and Navy Codes, 10c. "National" receiving condenser, 30c. Waterhouse Bros., 5 Main St., Bourne, Mass.

WIRELESS TELEPHONE OUTFIT—Inductive type. Transmitting and receiving coil for both ends (communication can be held each way). Two special wireless transmitters, switches, receivers; all mounted for immediate use. Will talk up to 30 feet through walls, etc. Distance can be increased by use of more batteries. Complete, ready for shipment, $30. Victor H. Laughter, No. 9, University Bldg., Detroit, Mich.

FLASHERS

FIREFLY FLASHER—Automatically flashes any lamp on and off 30 times a minute. Flashing socket or standard flasher. Price $1.50. Send for booklet. C. O. Schneider & Co., 103 S. State St., Chicago, Ill.

MISCELLANEOUS

MEDICAL AND SPARK COILS repaired. Send stamp for full detail drawings on a medical or spark coil. Price 50c. Address J. Lockie, R. 1718, Marquette Bldg., Chicago.

SELL your surplus couplings and fittings. We buy. Write us. A. & J. Mfg. Co., 24 W. Randolph St., Chicago, Ill.

FREE—Our latest illustrated catalogue of tricks, novelties, puzzles, books, etc. Peerless Trick & Novelty Co., 3146-3148 State St., Chicago, Ill., Dept. O.

MAGIC POCKET TRICK FREE. Catalogue included, send 4c in stamps. Magic, Dept. 17, 270 W. 39th St., New York.

SNOW SCENES. Views from one of Maine's most picturesque places. 5 ft. snow. 6 actual photo-cards, highly polished, 50c. Suitable for framing. C. Stanley, L. B. No. 5, Dixfield, Me.

THREE THOUSAND FORMULAS—My 368-page volume of recipes and trade secrets, cloth bound, only 40 cents, prepaid. Worth dollars. Satisfaction guaranteed. Wiley Sanderson, Dept. E, Ypsilanti, Mich.

HOW TO GET a Hektograph that will make 150 copies in 10 minutes. Costs $2.00, for letter size. Write for circular. Heyer Duplicator Co., 86 LaSalle St., Chicago.

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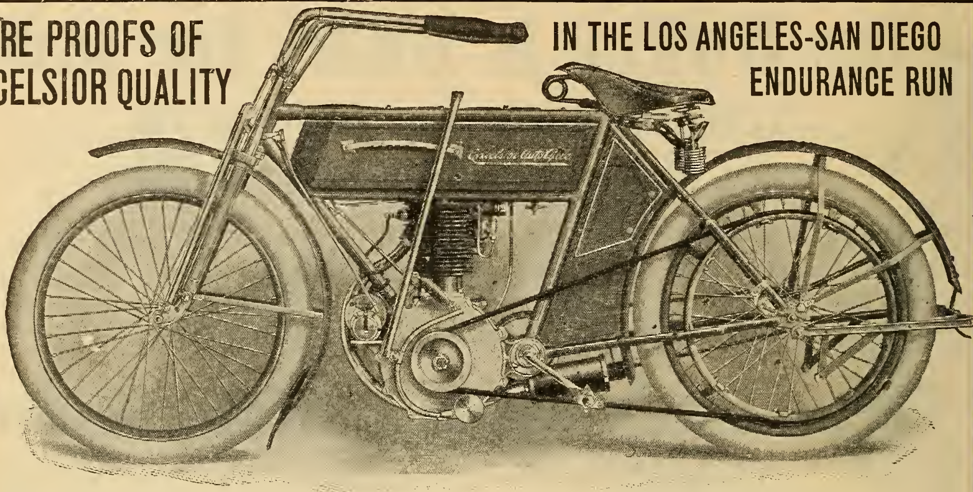

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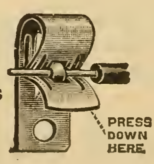

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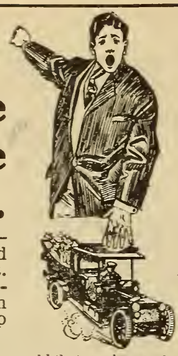

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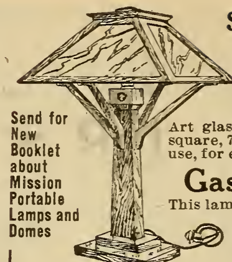

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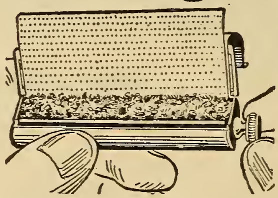

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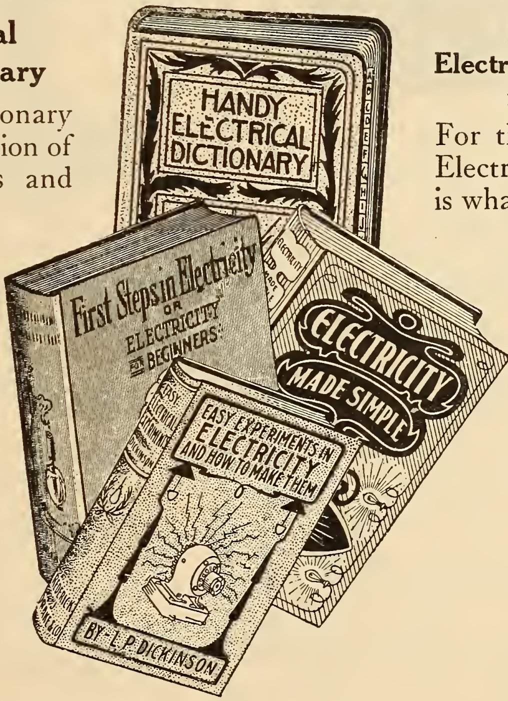

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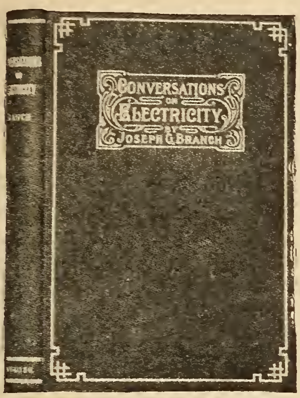

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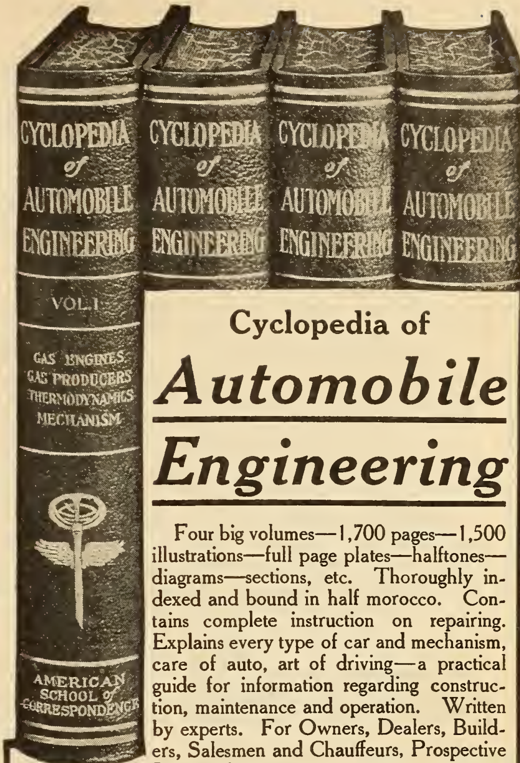

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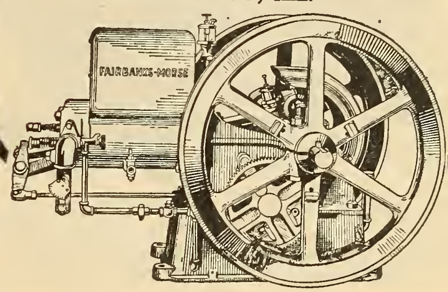

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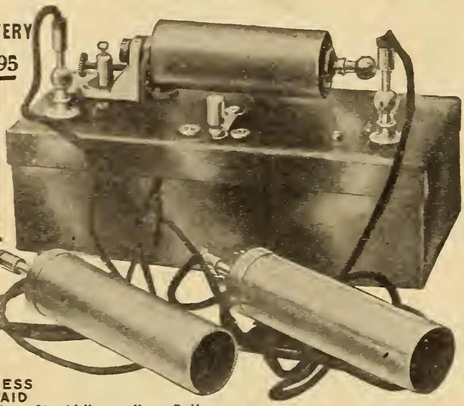

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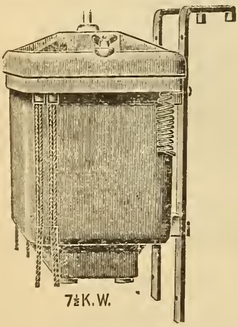

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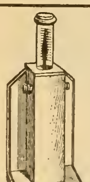

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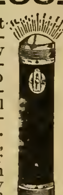

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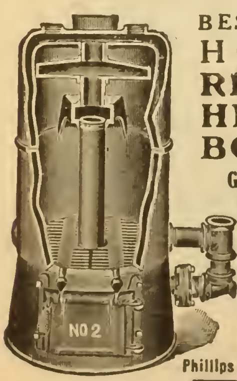

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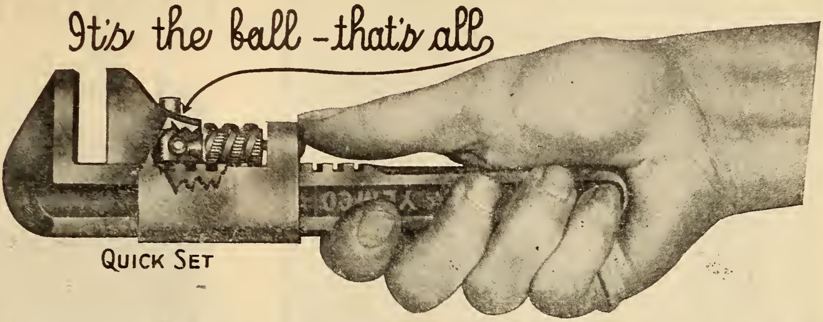

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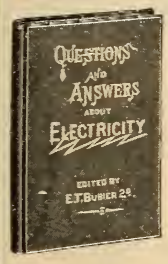

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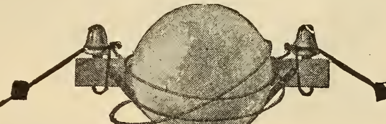

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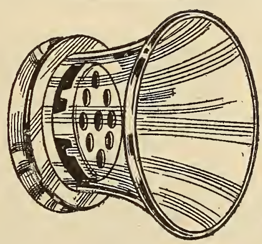

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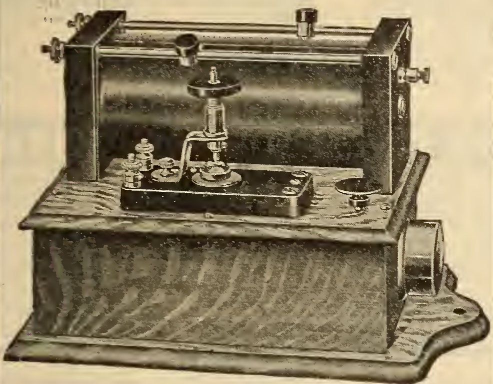

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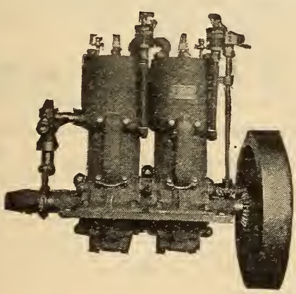

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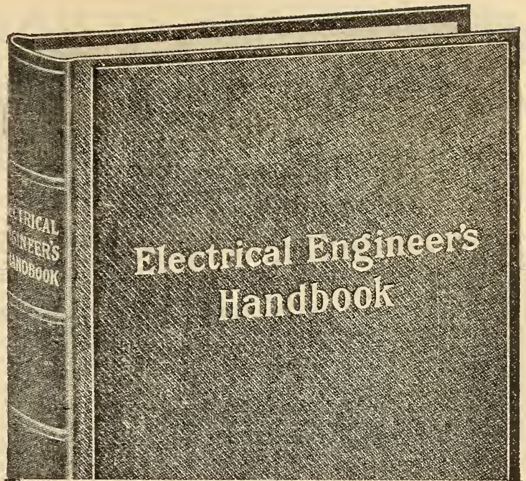

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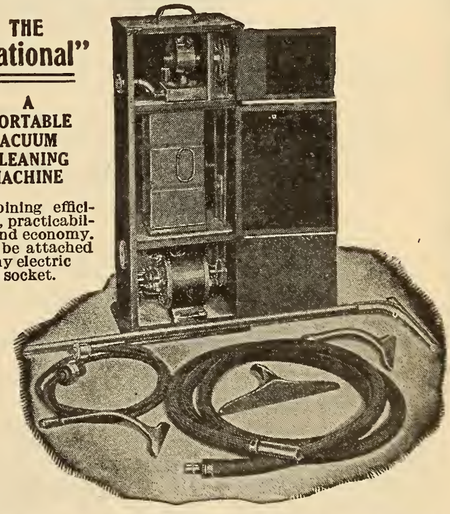

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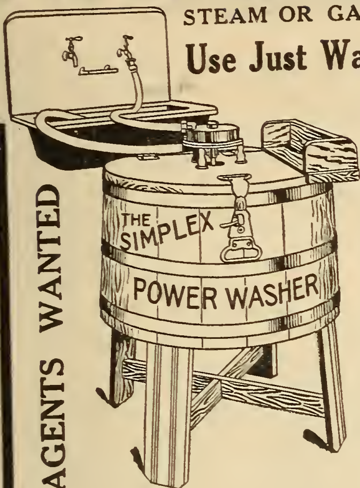

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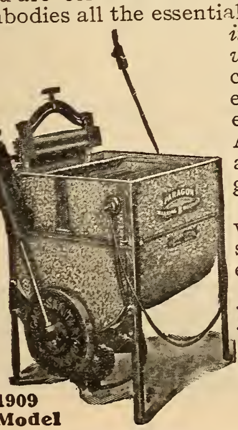

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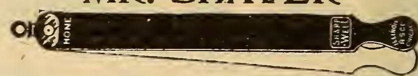

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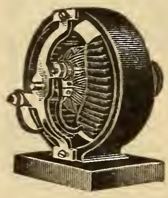

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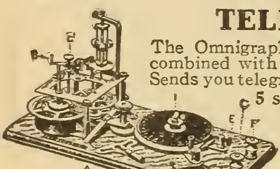

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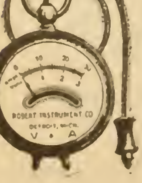

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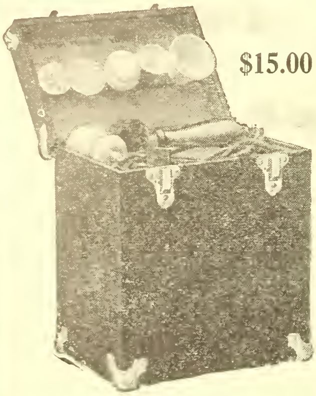


$15.00

Swedish Electric Vibrator No. 6

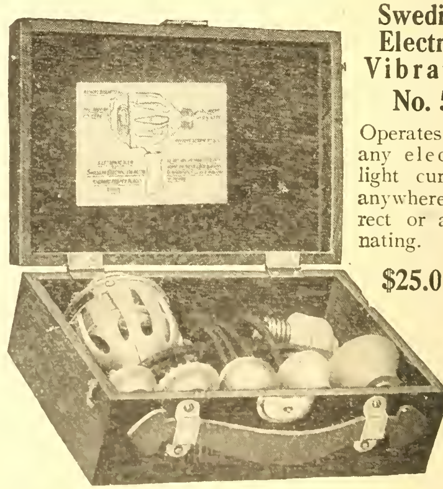
Operated by its own powerful electric batteries, equally as effective as the No. 5, but for the use of those not having access to the electric light current.

A man said the average person would rather pay $200.00 per year doctor and drug bills and REMAIN SICK than to buy a health giving Vibrator for $15.00 and GET WELL and save $185.00 the first year that they would otherwise pay the doctor and druggist.

Vibration is positive in its effects and in using it you are not experimenting, but KNOW what the result will be. All human beings are created on one plan, "In God's Image," consequently the NATURAL laws apply with equal force to ALL.

Vibration, in the treatment of disease, is the application of one of Nature's most potent remedies, and is the ONLY treatment that is invariably beneficial and NEVER harmful. There is no guess work, no chance, no luck, and no uncertainty. Nature's laws are one and immutable. Certain causes ALWAYS produce certain effects.

Two 2 cent stamps bring our handsomely illustrated booklet, containing 22 half-tone pictures of well-known, prominent people and copies of letters they have written us together with charts, diagrams and instructions in PLAIN ENGLISH, showing WHY and telling HOW you can obtain new life, vitality and health without drugs, dope or diet.



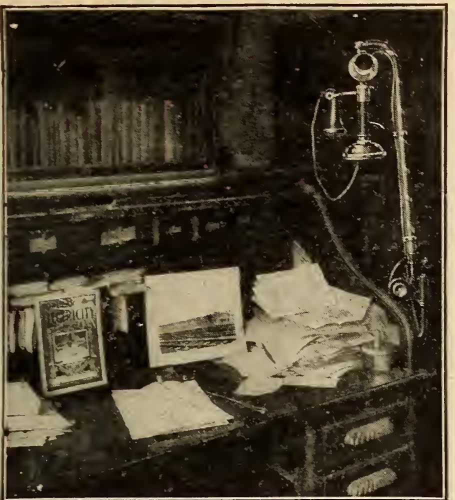
Swedish Electric Vibrator No. 5

Operates on any electric light current, anywhere, direct or alternating.

$25.00

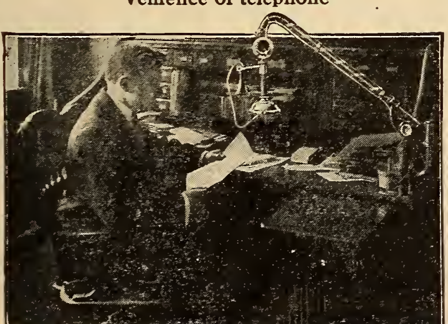
SWEDISH ELECTRIC VIBRATOR CO.

611 BERWIN AVE., - - - - - CHICAGO, ILL.



Up and off the desk and out of the way when not in use

Permits one to adjust telephone to their position, not adjust self to position and convenience of telephone



Never in the way but always ready for instant service, sitting or standing

Your caller on the opposite side of desk can use the telephone without either of you getting up

If anyone wishes to use telephone while standing, you do not have to get up but simply push it up and over

Perfectly balanced; can be moved up or down, sideways or in a circle with the slightest touch and will remain in any position you put it

The Radio Arm Ideal Telephone Holder

Price $3.50

Can be used in connection with any make of desk Telephone, roll or flat top desk

The Radio is simplicity and perfection, has fewer parts than any other Telephone Holder, is better made and finished, meets with instant approval of all who see it. Fine enamel and oxidized copper finish. Agents wanted. Write for terms.

Swedish-American Telephone Co.

CHICAGO

BRANCH KANSAS CITY, MO. 113-115 West 6th Street

PROMOTED!

¶ Don't worry about the boss not having his eye on you and noticing the improvement in your work. Remember he is human—he is on the lookout for good men. His success and the firm's depends on his ability to select the right man.

¶ If you are a little better than the other man—if you know more about your work than he does, do you suppose the boss will pass you by and boost the other fellow?

¶ You wish you had a better job. You wish you knew more, then you could do more and earn more. Fill in the blank form below and let us tell you how these wishes can be realized.

¶ Our advice, based upon the experience of our successful students and graduates will cost you nothing. It may start you right and change your whole future.

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...STRUCTURAL ENGINEER	...TEXTILE BOSS
...MUNICIPAL ENGINEER	...SHEET METAL PATTERN DRAFTSMAN
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