Practical Electrics

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Oct. 1924

EDITED BY H. GERNSBACK

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Page 682

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Practical Electrics

VOL. 3 **CONTENTS** NO. 12

FOR OCTOBER

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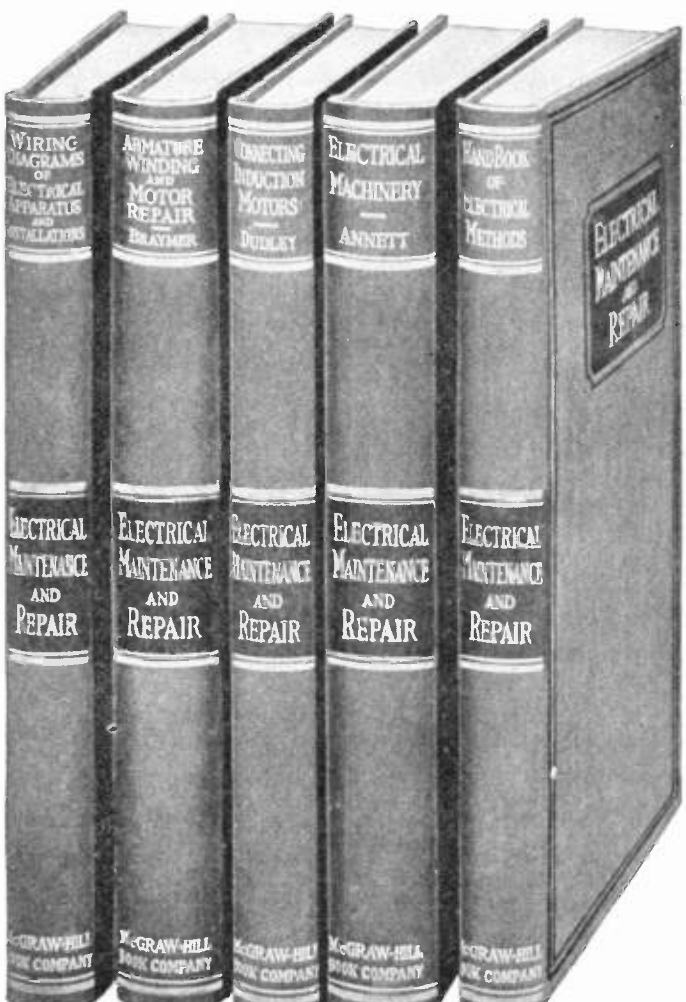

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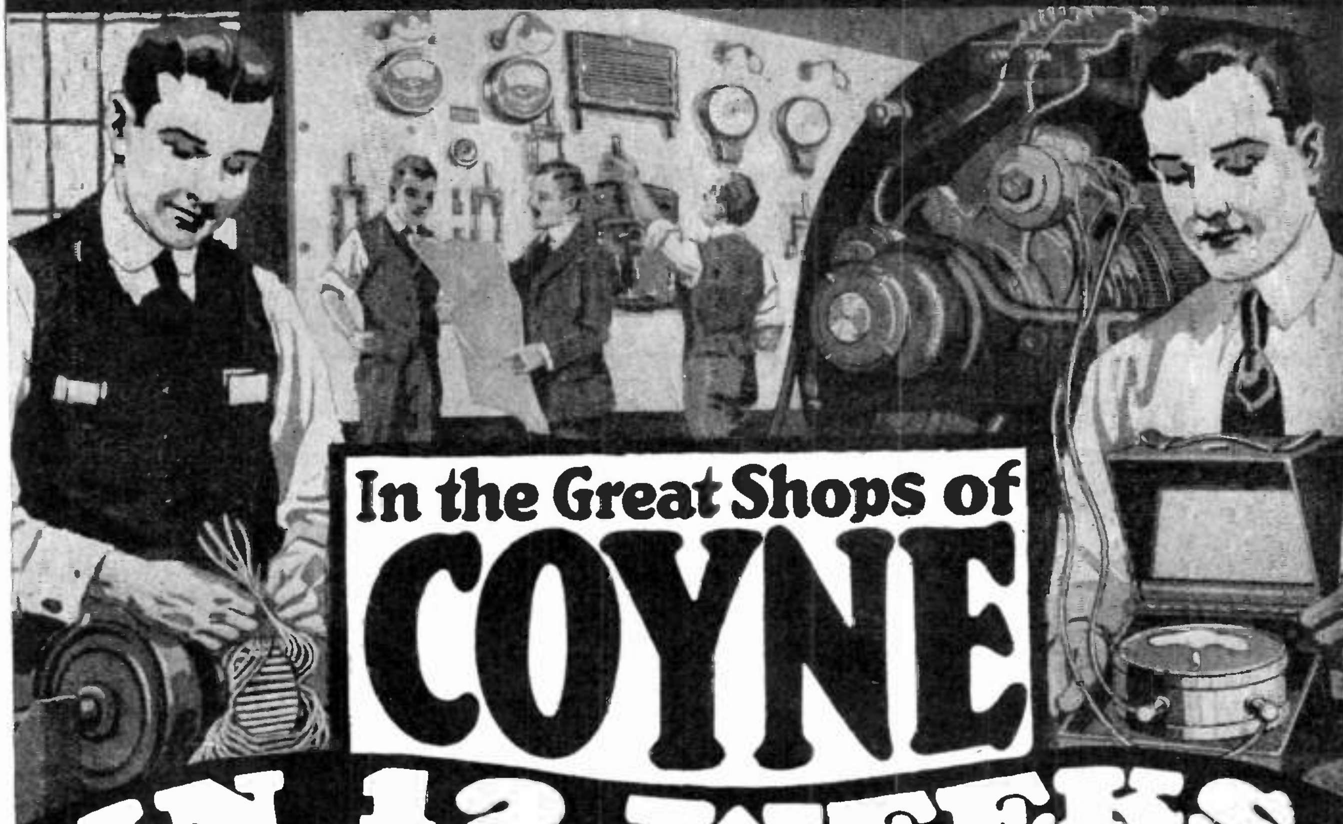

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The drawings of connections for electrical apparatus include Motor Starters and Starting Boxes, Overload and Underload Release Boxes, Reversible Types, Elevator Controllers, Tank Controllers, Starters for Printing Press Motors, Automatic Controllers, Variable Field Type, Controllers for Mine Locomotives, Street Car Controllers, Connections for reversing Switches, Motor and Dynamo Rules and Rules for Speed Regulation. Also, Connections for Induction Motors and Starters, Delta and Star Connections and Connections for Auto Transformers, and Transformers for Lighting and Power Purposes. The drawings also show all kinds of lighting circuits, including special controls where Three and Four Way Switches are used.

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Practical Electrics

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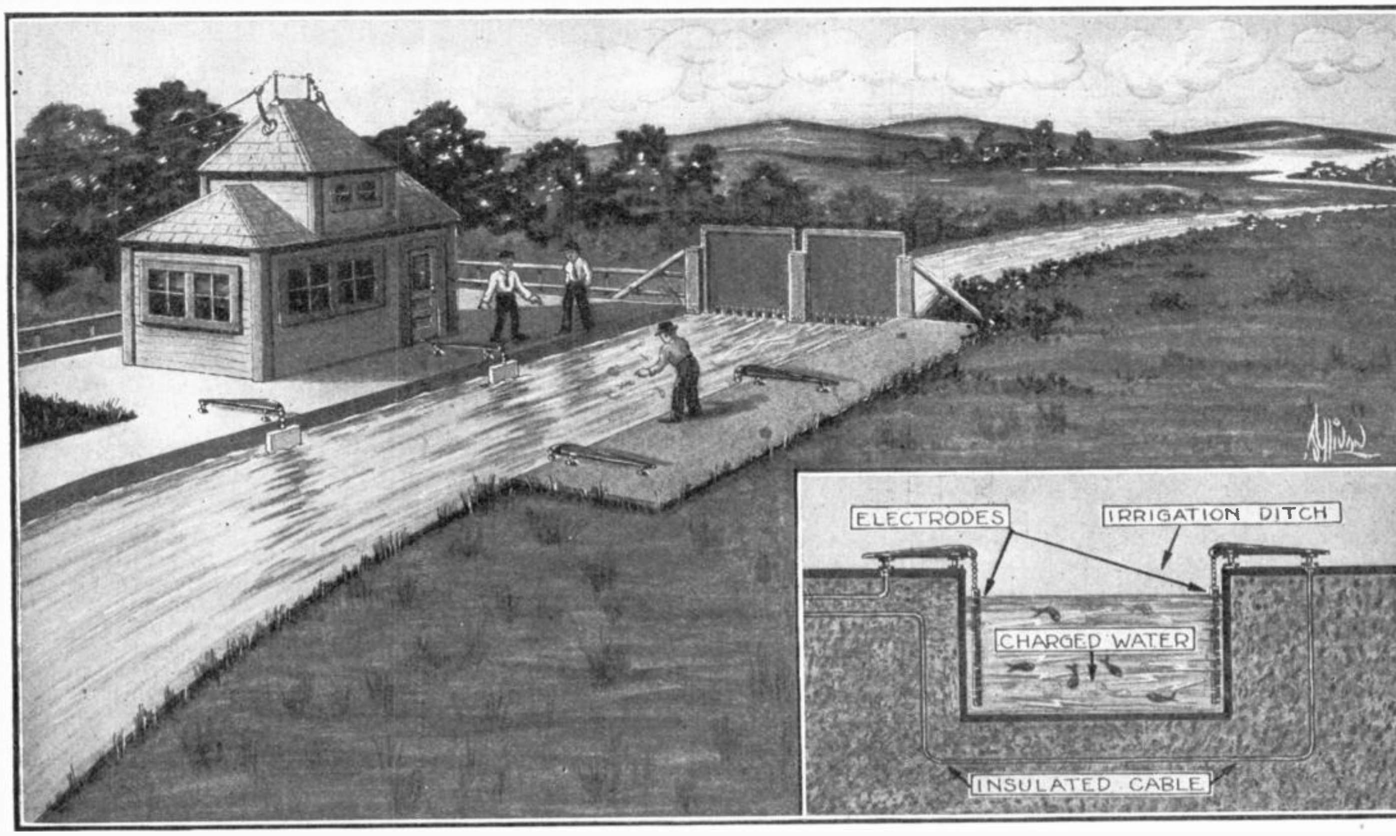
H. Gernsback, Editor and Publisher T. O'Conor Sloane, Ph.D., Associate Editor

"Electric Barrier" for Fishes

By Ernest Brennecke



How electricity prevents fish from entering irrigation canals. A "phantom wall," as the author picturesquely terms it, is built up by a high voltage alternating current circuit across the opening of the canal; the fish will not pass by it. (Insert)—The details of the connections are shown; note the underground cable leading to the right-hand electrodes.

WITH almost magic precision electricity has solved a curious and intricate problem. This solution puzzles thousands of fish; then it saves their lives. It also preserves the fertility of many acres of fine soil; and it will save Western farmers many dollars, as well as much irritation every year.

In those sections of the country where land has been reclaimed by irrigation, it has been found that large numbers of fish find their way from natural lakes and streams into the irrigation canals. When the water in these canals dries out, the fish are left high and dry, caked in the mud. They are then unfit to eat and must be cleared away, at a great expenditure of labor and money.

Efforts of various kinds have been made to remedy this unfortunate condition. Network has been placed across the entrances to the canals. But when the meshes of such network were too small they not only kept out the fish, but became clogged up with the debris and obstructed the passage of the thick, muddy water. If larger meshes were used, not only the water but also the small fish found a way into the canals.

This hopeless situation was neatly remedied recently by an electrical engineer. He placed two metal electrodes in vertical positions on opposite sides of the canals. The electrodes were connected to the output terminals of a high-frequency alternator of high voltage and relatively low amperage. Thus the current which passed through the water between the two electrodes formed an invisible but highly effective barrier. For the body of a fish is a much better conductor than water; consequently, whenever a fish ventured into the region between the electrodes the current passed in extra proportion through his body, that being the path of least resistance.

The fish, then, approaching the "phantom wall" of electricity, receives a stinging electric shock—enough to surprise, but not enough to stun or kill. Bewildered, the fish recoils, then perhaps tries again to get through, and is again shocked. He turns around and swims back to his familiar stream or lake. There he tries his luck with old-fashioned anglers, armed with the usual hook, line, sinker and enticing bait or artificial fly.

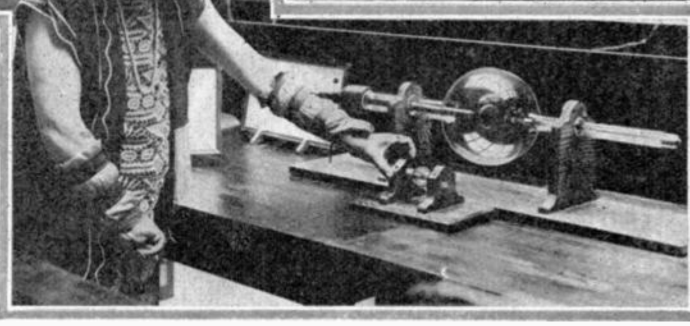
Thus the irrigation canals are kept free from unwelcome visits of members of the finny tribe. Agriculture is boosted, and places where fishing is carried on regularly are not depleted of their subaqueous inhabitants.

The annoyance of getting rid of interference with the water-supply exceeds by far in importance the preserving of the fish for anglers.

By modifying the electric current so that it will stun or actually electrocute the fish the device can also be used to capture the fish. Perhaps the trout fisherman of the future will sally forth with a storage battery, induction coil and a pair of copper plates instead of his rod and reel.

In a previous issue of PRACTICAL ELECTRICS we described an electric fish net, quite on the lines of this unseen barrier. The editor of this paper has conducted some interesting experiments on the effects of an electric current upon fish. They are definitely affected by it, and it is interesting to see a second application of the effect put into practical use. The fishy tribe have their own members who can give powerful shocks, so here we find mankind returning the compliments and making what is called a "return in kind."

Exhibits at the National Academy of Sciences Meeting



Above (left). An apparatus for producing a curve or graph on a sheet of paper for the study of the vibrations in the human voice. A telephone circuit is used to give the electric currents. (Right.) The large and the small in electric lamps, one using some 40 horsepower and the other 1/50th of a horsepower, certainly the two extremes.

Below. Another example of the large and the small. The large X-ray tube is 15 times the power of the ordinary one, while the small one hardly visible is for dentists' use in securing radiographs of the dental process.

I.

AT the National Academy of Sciences, Washington, D. C., there has been exhibited an apparatus for recording the vibrations produced by the human voice.

The voice with its almost infinite variety of intonations is very rich in overtones, and when it comes to conversation, simple reading or speaking the sound waves produced are of extreme irregularity and complexity. The apparatus shown receives the sound by telephone and reproduces it on a chart, so that it may be studied at leisure.

II.

THE Coolidge X-ray tubes were a distinct departure in X-ray work. The heated cathode reminds one of the heated filament in audion bulbs. The results obtained by the Coolidge innovation were very striking and the tubes have had a great success.

The picture shows what is supposed to be the largest and smallest of the Coolidge tubes that have yet been made, and which were exhibited there.

The large tube is designed for therapeutic work and is credited with some fifteen times the output of the ordinary tube used by physicians and surgeons.

Dentistry has had its regime greatly modified by the X-ray tubes. So many bodily ills are now traced to the teeth that it has become almost a fashion to attribute to unfortunate teeth, the ills that flesh is heir to and sometimes they are extracted remorselessly. The X-ray tube has done wonders in the giving of a basis for intelligent treatment of the detail process, and the smaller tube shown in the illustration is a dental tube for radiographs of the teeth.

III.

THE photograph is another example of the largest and smallest. The largest and smallest incandescent lamps are shown here. They were exhibited before the National Academy of Sciences of Washington, D. C. The large lamp consumes 30 kilowatts of power, in the neighborhood of 40 horsepower at 110 volts potential, passing some 300 amperes. Its light is about 2,000 times that of the ordinary lamp now popular for household use. It was designed for motion picture work to which the mercury vapor lamp has long been applied. The small lamp is a surgical one and is used for lighting the interior cavities of the body. This consumes three-tenths of a watt, something like the 20/1000th of a horsepower. Its current consumption is one-fifth ampere.

The First Telegraph Office

By S. R. WINTERS

AN inconspicuous iron tablet, only eight by ten inches in dimensions, marks a memorable date in American history. This is a modest recognition of the first telegraph office established in the United States.

The tablet is placed on the Land Office Building, almost level with the street. It reads:

"Samuel F. B. Morse, artist and inventor, opened and operated on this site under the direction of the post office department the first public telegraph office in the United States, April 1, 1845.

"What Hath God Wrought."

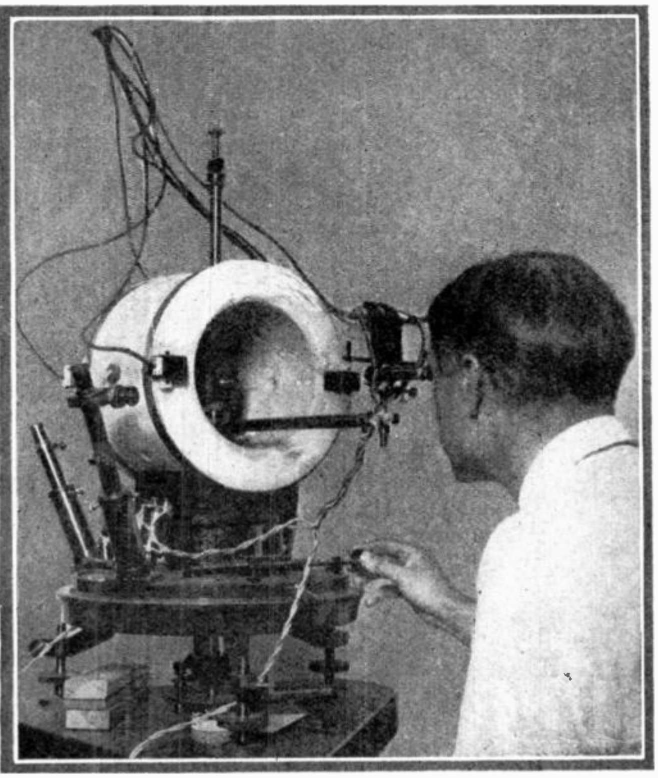
The latter classical phrase, although imbedded in this tablet, was telegraphed by Professor Morse nearly a year before this date. It was on May 24, 1844—a little over 80 years ago this month—that the first message by wires was sent between Washington and Baltimore, in the famous words, "What hath God wrought."

A tablet from the Land Office building in Washington, D. C., to commemorate the location of the first public telegraph office in the United States, going back some 80 years.

Growing Plants by Electric Light

By S. R. Winters

Carnegie Institute Sine Compass or Galvanometer



Above is shown a view of interesting experiments in the propagation and growing of plants by artificial light. Electricity takes the place of the sun. On the right is a photo of a very elegant sine compass, a near relative of the well-known tangent galvanometer. It uses the natural field of force of the earth for its action.

EXPERIMENTS recently concluded by W. W. Garner, H. A. Allard and R. A. Steinberg of the Bureau of Plant Industry, United States Department of Agriculture, afford proof that artificial or electric light will foster the normal growth of plants and their production of seed with quite the facility which is now possible through the influence of sunlight. These observations with respect to the use of artificial and colored lights in the propagation of plant life also confirm a discovery, made about three years ago, that the seasonal blossoming and fruiting of plants are caused by the length of day.

The artificial control of conditions governing the normal development of plants from germination to the maturing of seed has been accomplished in these experiments by specially designed apparatus which does not admit daylight. The equipment, designed by R. A. Steinberg of the Bureau of Plant Industry, has been installed in the National Academy of Sciences in Washington, and is shown in the photograph.

Light rays from a gas-filled tungsten lamp are filtered through a layer of running water which absorbs a large part of the heat without interfering with the passage of the light. By the use of colored glass or colored chemicals in the water, sunlight is simulated or light of widely different colors may be obtained for experiments. Lights of intensities equal to, or even greater than, that radiated from the sun are thus artificially created. The length of exposure to the light is governed by means of electric time switches which turn the lights on and off as set by the experimenter. Thus daily and seasonal changes may be at variance with the length of the days and seasons as we know them.

The different kinds of plants subjected to artificial propagation outnumber the proverbial "57" varieties—in fact, more than 60 species of plants have been grown under such conditions. These include lettuce, celery, spinach, morning glory, cypress vines, soy bean, didens, chenopodium, godetia and poinsettia. These plants have responded to the glow of the electric light with the same result as if they had been exposed to the sunlight. The so-called "short day" plants, the characteristic autumn and winter flowering plants, blossom when exposed to the short artificial day. The summer plants blossom when given a long day under electric light.

"Practical conditions," say plant physiologists of the Bureau of Plant Industry, "preclude the use of artificial light in place of daylight, but it will be possible in growing some greenhouse plants to extend the natural day by use of the electric lights to speed up blooming. Obviously, this practice will be useful in case of 'long day' and 'interminate day' plants. A relatively low power illumination can be used, extending the length of day from sixteen to eighteen hours for many plants. Intense lights have been found unnecessary and wasteful. For commercial use engineers and greenhouse men must work out the particular requirements of special crops.

These pioneer experiments have exploded the widely accepted belief, prevailing especially in Europe, that certain wave lengths of visible light are essential to normal development of growing plants. According to the result of the Bureau of Plant Industry, healthy normal seeds have been produced with wide variation in the composition of the light employed.

THERE are two forms of galvanometer depending on circular functions for their readings.

The tangent galvanometer from the simplicity of its theory and also that of its construction always appeals to one as a very attractive instrument. It consists of a short compass needle or magnetic needle supported in the center of a relatively large circle of wire or other conductor. Thus, even a heavy bar may be bent around to give the circle carrying the current.

In use the circular conductor is turned until the plane of the circle coincides exactly with the axis of the needle. If a current is passed through the coil, the tangent of the angle of deflection of the needle will be proportional to the current. This gives a direct reading.

The sine compass, a beautiful example of which we illustrate, is named from the circular function its action depends on, the sine of an angle. Here we have a coil of wire or its circular conductor, which need not be of large diameter, and supported at its center there is a magnetic needle, which may be quite long compared to the diameter of the coil.

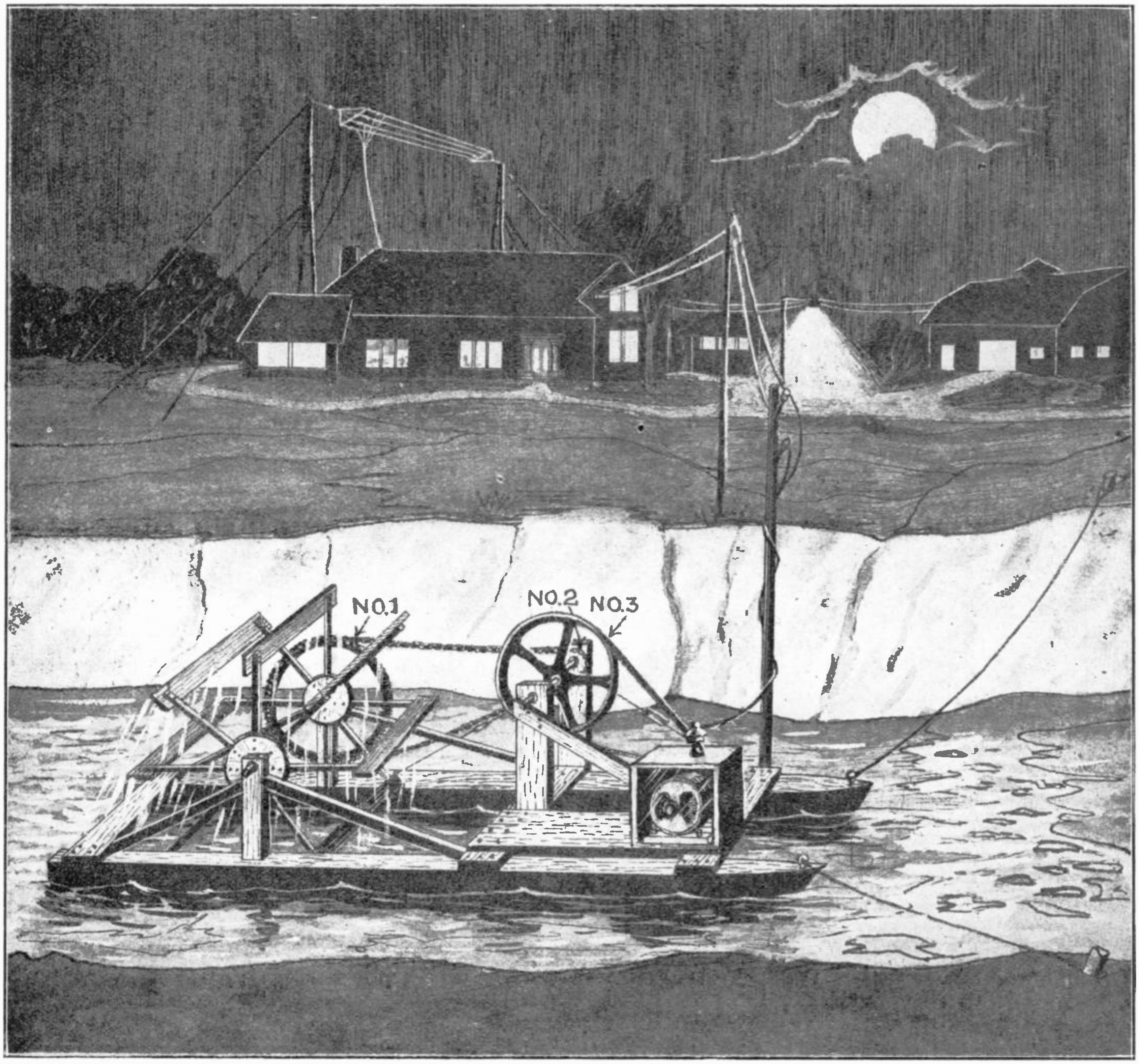
Here, as before, the field of the earth affects the needle. The law involving the sine is that the current will vary in proportion to the sine of the angle of deflection which is produced when the core and needle lie in the same vertical plane. When the current is first passed through the coil, the needle swings to one side, exactly as in the tangent compass. The coil is then turned in the direction of the needle, pushing it still further by the effect of its field. If this is kept up the plane of the coil and the axis of the needle eventually coincide to the extent that the axis of the needle lies in the plane of the circular conductor.

In the beautiful instrument which we illustrate, the powerful magnifying instruments for reading the verniers, the long tangent screw for moving the coil, and the three leveling screws are features brought out very clearly. The instrument is in use at the Carnegie Institute, and in the illustration is supposed to be employed for measuring the horizontal force of the earth's magnetic field.

An observer at the Carnegie Institute, Dr. J. P. Ault, is shown above, working with the sine galvanometer. The three tangent screws for bringing the instrument to a level, the two long telescopes on the left for reading the verniers, and the long tangent screw, indicate the great accuracy of construction.

Small Stream Power Plant

By T. Garver



A suggestion for a floating water power plant. Some work in this line on an industrial scale has been done in England, and here is a suggestion for the country dweller.

TWENTY years ago electrical supply was confined to expensive plants for power and illumination. Today the taxpayer is taking on much verbosity and highly technical language. His superiodine hook-up is full of electrons shooting back and forth at so many miles per shoot and the problem of providing the necessary "juice" to bring in PWX, and incidentally home illumination and power, is being solved in various ingenious and surprising ways.

The fellow who harnessed his generator to the swift-flowing current of a nearby stream, as shown above, would not trade places with Thomas A. Edison himself.

The paddle-wheel, 10 feet in diameter and 8 feet wide, is built of oak planking and "2 by 4's," and with gears, pulleys, countershaft and generator, is mounted on two floats made of well-seasoned, hewn and pitched logs, 20 feet long and 18 inches in diameter.

The generator and countershaft are housed from the weather and spray and the whole securely anchored to the banks with two cables. To run the 40-volt generator at a speed of 1,800 revolutions per minute the diameters of the pulleys and cogwheels required for an 8-mile current are as follows:

Cogwheel No. 1, 4 feet; cogwheel No. 2, 1 foot; pulley No. 3, 32 inches; pulley No. 4, 4 inches.

The shafting, bearings, cogwheels, pulleys and chain belting were requisitioned from discarded mill machinery, and the completed plant, exclusive of the light power motors, was installed for less than $150.

No storage battery is used. Variations of water level do not affect the continuous operation, as the whole thing rises and falls with the stream, keeping the vanes at a constant depth in the water.

Besides illuminating the premises and charging storage batteries sufficient current is supplied to run light motors which operate the lathe, pump-jack, separator, buffer, grindstone, washing machine, etc. Substantially built, an occasional turn of the grease cups is the only attention required.

The possibilities of a large electrical plant constructed along these lines are interesting to contemplate. Who has not wept to see the energy going to waste, the thousands of horsepower running by in the many rapid streams throughout our country?

A battery of these floating generators, one behind the other, with their aggregate electrical energy wired to the nearest town, would be an entirely feasible undertaking. There would be no unsightly and expensive dam, chutes, tail-race, gates or backwater to deface or alter the natural beauties of the stream and surroundings and the time and material spent in the construction of such an apparatus would be well invested. The stream must be adequate in summer flow.

Announcement

WITH this issue PRACTICAL ELECTRICS concludes its third year. When this magazine was first established, the writer promised his readers it would contain nothing but electrical subjects. This promise was kept to the letter for three years.

Unfortunately, however, the magazine has never been able to expand, due to this editorial policy. At the end of the third year the circulation of PRACTICAL ELECTRICS has not increased to the extent that it should in three years' time. We have not been able to increase the size of the magazine as much as we would have liked because the circulation did not pass 50,000 at any time, and with such a circulation it is practically impossible to obtain extended advertising patronage. And, as every one knows, it is the advertising that "pays the freight." If PRACTICAL ELECTRICS carried a large advertising section we could afford to give our readers twice as much reading matter.

DURING the past year the writer has been in receipt of many letters from readers throughout the country, many of whom have been clamoring for radio and chemistry articles. The demand has recently become so insistent, that in order to meet it, the publishers decided to add other departments to the magazine beginning with the November issue.

This also logically necessitates a change of name too. So, with the next issue PRACTICAL ELECTRICS will be known as "THE EXPERIMENTER." The keynote of the new magazine will be experimenting: electrical—radio—chemical. Most of our readers show a decided preference for experimental articles. It is therefore up to us to furnish the articles and we assure you that you will not be disappointed with the quality and quantity of the experimental articles.

Of course, we will retain the departments we have always had, but we will add a number of pages to care for the new departments.

THERE will be some 12 pages of articles on experimental RADIO, *a brand new treatment of radio.* Other magazines give you circuits and show you how to put a set together. THE EXPERIMENTER in the future *will show you how to experiment in radio.*

In the November issue, for instance, Mr. Clyde Fitch, who has been writing many articles for RADIO NEWS will show us how to experiment with a one-tube reflex set. There will be other experimental radio articles by other eminent radio authorities.

In the new section of experimental chemistry we will show how to make the latest chemical experiments and the procedure used in making them.

The writer is certain that if you liked PRACTICAL ELECTRICS you will like THE EXPERIMENTER very much better. It will be bigger and better than its predecessor and, more important, it will be known better from one end of the country to the other.

The first issue of THE EXPERIMENTER will have a circulation of over 100,000 copies. The new cover of the magazine is reproduced herewith, so you will have no difficulty in identifying it on the newsstands next month, if you are not a subscriber.

H. GERNSBACK,
Editor.

The Radio Vision

By H. P. Clay

MILES OWEN is, of course, known all over the civilized world as the inventor of the first practical television device which enables us to view interesting occurrences by having the moving scene radio-casted and received by his remarkable apparatus. His genius has made it possible for us to remain at home and yet see baseball games being played; automobile and airplane races with all of their thrills; the inauguration of the President of the United States; the ruins of the old-time scenic beauties of Niagara Falls and other natural wonders; and now we are coming to the point of witnessing various daily events where formerly it was necessary to imagine them from the inaccurate and incomplete descriptions given by the newspapers.

Owen is reticent about relating his efforts to achieve his present success, with the result that some of his early experiences are unknown to the public. The writer has had the good fortune to be associated with him from the time he perfected his first television apparatus which is now universally used in a modified form, and for this reason I am in a position to write this small portion of biography.

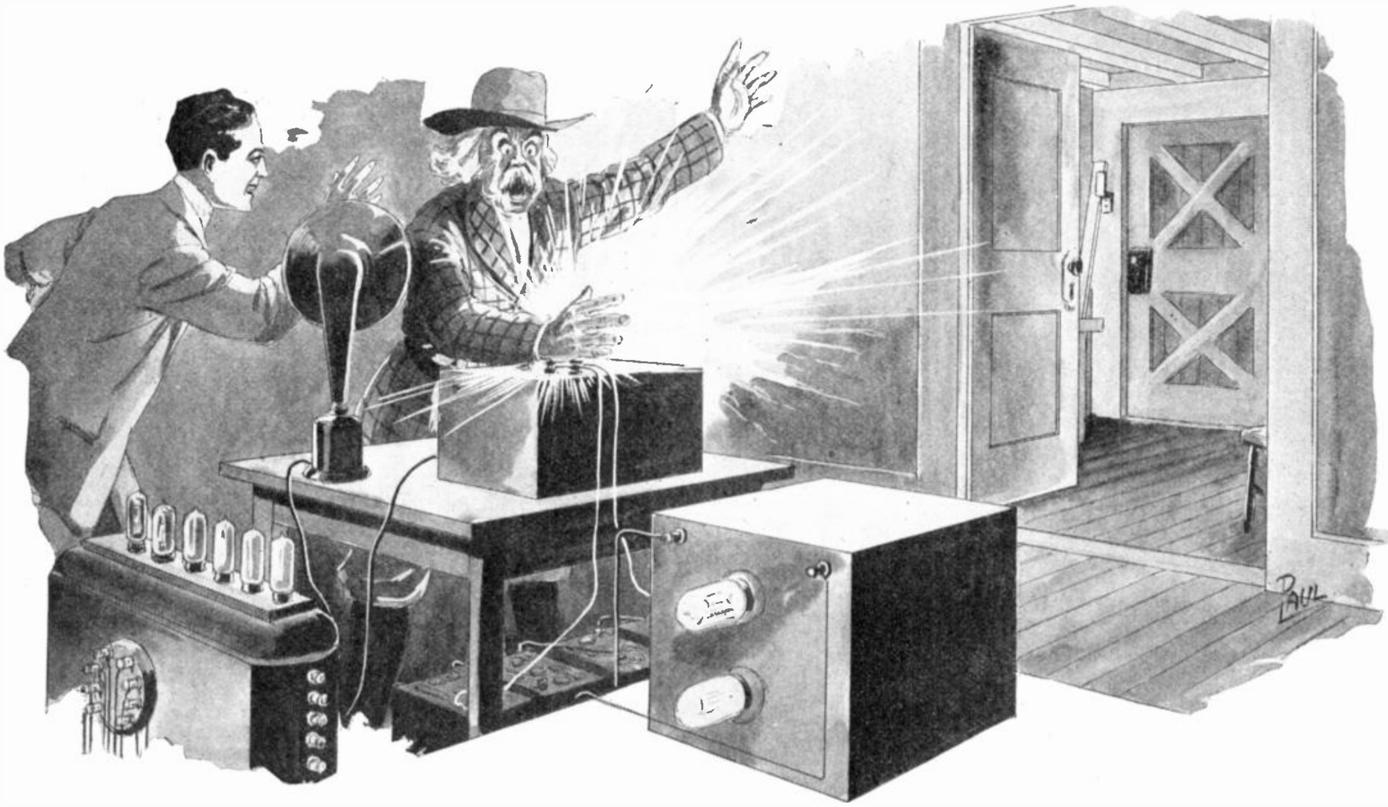
An Advertisement

Several years ago, in 1930 to be exact, I answered an advertisement, which stated that a chemist desired an assistant to help him in his laboratory. Owen was the author of the ad, and after a few questions gave me the position.

His laboratory was situated in the basement of the boarding house where he was staying, and considering the fact that his finances were very low the completeness of his equipment was remarkable. He seemed to have almost every device and apparatus used in scientific work, a good proportion of which had been constructed by himself.

He had gained the privilege of uninterrupted experimenting by becoming the janitor of the building. The money made in this way was a welcome addition to his daily wages as a store-clerk, and it was this that made it possible for him to employ the services of an assistant. Since Owen's two occupations required the full day and part of the evening it was necessary that his experiments be carried on at night from about ten o'clock until three or four in the morning.

"Your duties will be simple," Owen said to me, "But in case you may become dissatisfied with what you receive, remember that you will share reasonably whatever profit I obtain from the invention I am now perfecting.



Two hundred and seventy volts and a heavy battery current burned its way into his hand and the resultant short-circuit caused a brilliant blaze of sparks.

The Great Invention

"Doubtless you have heard of the television apparatus that certain inventors are endeavoring to exploit. I have also invented one that utilizes what I believe to be the correct principle, and which is likely to be superior to any other."

"Yes," I replied, "I have read various accounts of the television device but yet I don't quite grasp the purpose of the device or how it operates. I am a chemist only, so it is difficult for me to understand the things that belong to electricity and physics." Owen began to explain his invention.

"A telephone, as you know, is an instrument for transmitting sounds to a point distant from the place of origin. Likewise, a televiser is an instrument that performs the same function with light. On a white screen at the receiving station it reproduces the images or *vision* present at the transmitting station, this effect being similar to the telephone receiver that repeats the voice, music or other sounds made before the transmitting microphone.

"Since the two instruments serve two distinct portions of the scale of vibration it is logical that they should be built on relatively the same principle. The present telephone is very nearly correct as it has but two simple moving parts; the metal disk on the microphone and the receiver. Both disks are moved to a slight degree by the direct vibrations of the sounds and the corresponding pulsations of the electric current, but the movements are too small to be important. The improved telephones are as yet too expensive for commercial use."

He paused for a moment and stepped over to one of the tables covered with apparatus.

The Usual Design for Transmitting Vision

"The most favored design of televiser that most of the inventors are attempting to improve is one employing a slender beam of light which is controlled by arrangements of prisms and mirrors and caused to impinge upon a screen; when stationary it appears as a small point of light. But when the spot of light is set in motion it completely covers the screen 16 times in one second and thus creates the illusion of an illuminated screen. The beam of light is varied in brilliancy in synchronism with the lights and shades of the picture at the transmitter, and in this way recreates the same picture.

"A few of the largest newspapers in the United States are making use of a televiser made as I have described, for the purpose of receiving pictures of important news events immediately after the photographic negative has been developed. It has been used also to send and receive pictures of moving objects with success, but the practical application of the device is limited because of the great expense of construction.

"Later the objection of expense may be largely overcome by improved methods of manufacture, but the defect that prevents the device from being as simple and practical as it should be is the incorrect principle upon which it is based. It is operated with a complicated arrangement of moving parts when really there should be no movement of any part of a perfect instrument.

An Instrument Without Moving Parts

"When I first began to work on a new televiser I determined to use the principle of the telephone. I had the idea that a perfected telephone diaphragm capable of responding to tremendously high frequencies of current might solve the problem; but when one of the greatest scientists invented a telephone built completely immovable in every part using a peculiar minute arc microphone and a practical minute arc receiver, I realized that the most difficult portion of my contemplated experiments had been done for me. I knew then that my theory as a correct one, could be practically applied.

"The arc telephone really gave me the clue as to how my television, especially the receiving part, should be made. There is in fact a close similarity between the receiver of the arc telephone and the receiver of my televiser.

Selenium and the Transmitter

"I will not tell of the experiments I have made or how I crystallized the selenium element so that each minute crystal acts as an individual photo electric cell.

"The selenium cell is made in a peculiar way. The selenium is melted and flowed over a thin copper plate two feet square; and before the selenium has time to cool a metal screen of copper wire thinner than human hair with a mesh consisting of 200 openings per linear inch is embedded in the element.

"The copper plate and copper screen are connected in circuit with the new type of radio vacuum tubes. The current used is direct and in the course of its flow it passes from the copper screen to the copper plate through the film-like layer of selenium. The selenium varies its resistance to the flow of current in comparative proportion to the strength of the light falling upon it. The selenium is nearly transparent, so that the light is allowed to affect the minute crystals that happen to be directly back of the wires of the screen; for it is the screen that the light falls upon.

Frequencies of Light Rays

"Each color of light has a different rate of vibration, but the whole of the visible light may be roughly grouped under the forty-ninth octave or over 562 trillion vibrations per second. Usual electric frequency runs from the twenty-fifth to the thirty-fifth octave or from 33 million to 34 billion vibrations per second.

"The selenium cell attempts to reproduce the exact vibrations of the light falling upon it, but because of its great inertia or lag it responds only after a certain number of vibrations have 'piled' up on it. The selenium I use is so nearly perfect that I can almost calculate the ratio mathematically. The result is that the light is transformed into high frequency electricity of the same comparative ratios and this electricity is amplified by the radio vacuum tubes and sent out through an antenna like ordinary radio waves. Or the different values of high frequency current may travel over the same wire without interference from each other.

"As you have noticed there is attached to the selenium screen a plate of quartz glass of constantly varying thickness which serves to allow only certain vibrations of light to pass through at certain points. This is the heart of the device, for it controls the light. The back of the glass plate is flat but the front is cut prismatically, having the superficial appearance of an opened fan.

"I have described the transmitting part of the device.

The Receiving Apparatus

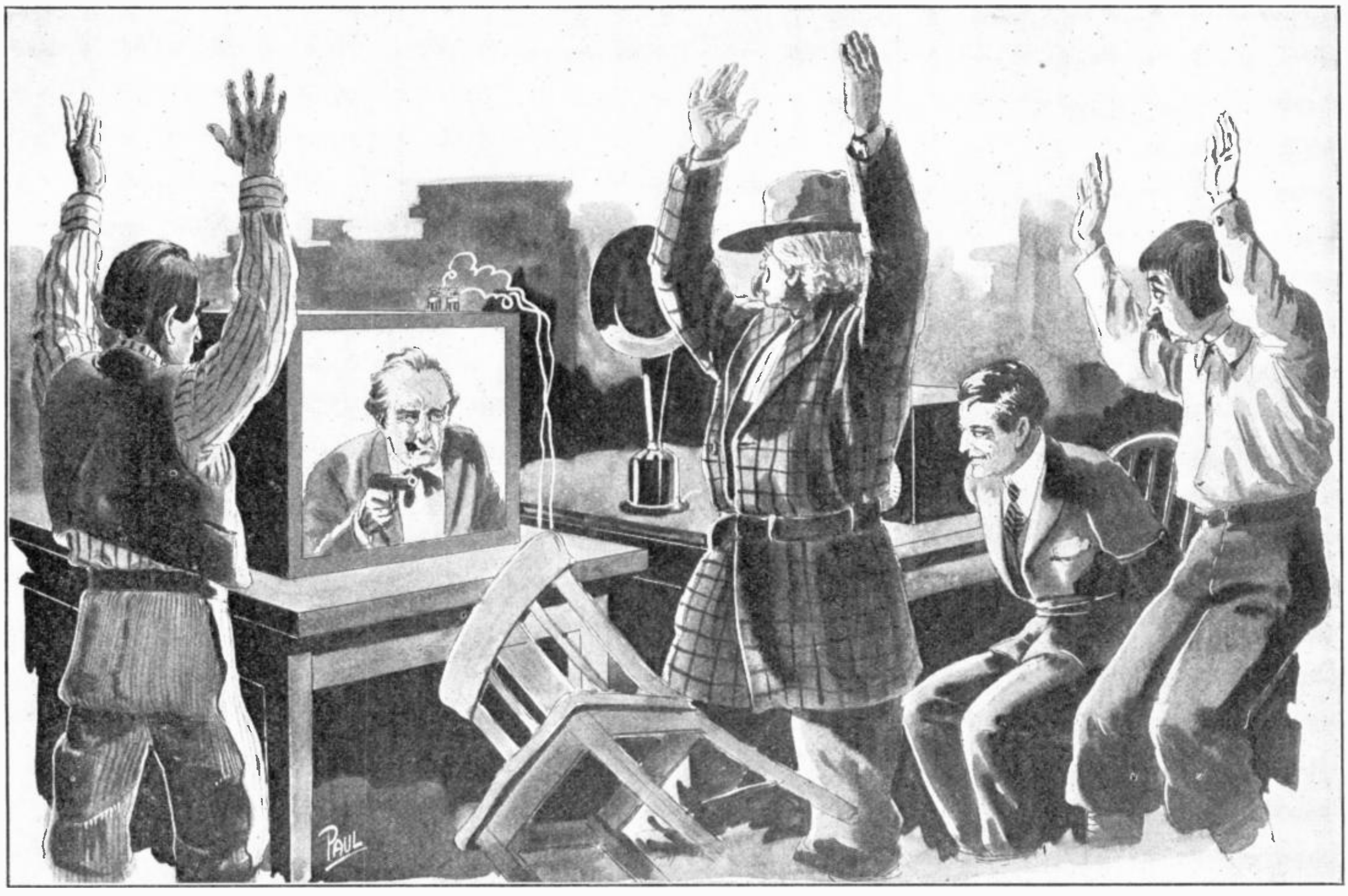
"The receiver of the device is much less complicated than the transmitter. The high frequency currents from the transmitter are amplified at the receiver by the audion tubes and are then passed through a small glass bulb partly evacuated and containing a mixture of rare gases. It is really an adaptation of the ordinary Geissler tube. Each vibration of high frequency current produces in the bulb a strong light that has the comparative characteristics of the current causing it. Due to imperfections the light is not of the same vibrations as the light impinging on the selenium screen, but it is similar enough to be practical.

"The light from the bulb falls on a translucent screen two feet square after first passing through a prismatic glass plate attached to the screen. The glass plate is similar to the one used on the selenium cell of the transmitter.

"The glass plate arranges the thousands of varying vibrations of light from the bulb, so that the rays of light are allowed to pass through to the translucent screen only in a definite pattern. This light pattern is the same for both transmitter and receiver and the translucent screen reproduces the light image affecting the selenium cell.

"I have not yet solved the problem of transmitting colors so I use a special arc

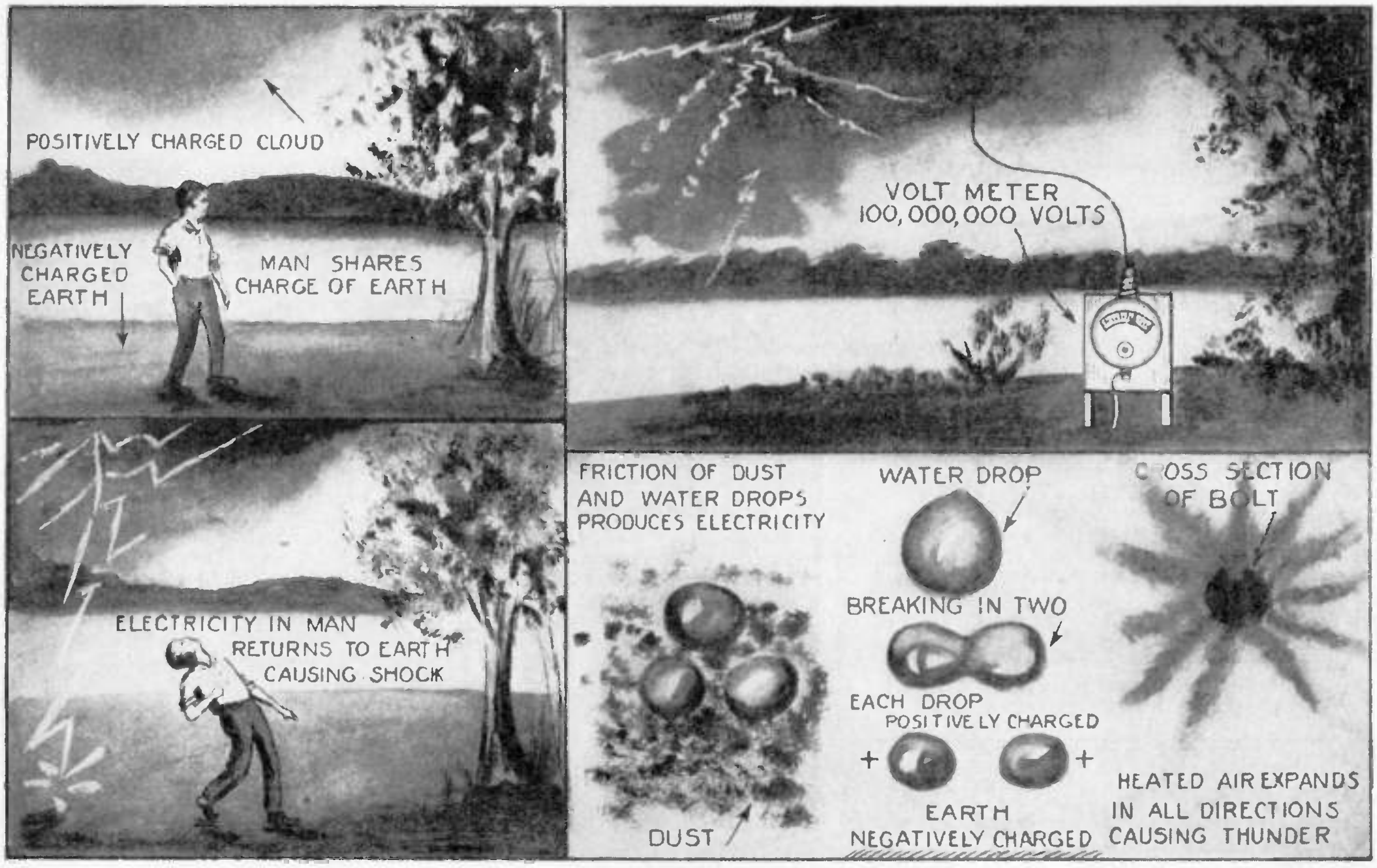
(Continued on page 724)



On the translucent screen of the Television appeared Owen's face, tinted a bluish green but perfectly recognizable. . . "The three of you raise your hands to the ceiling and keep 'em there," came over the wire in synchronism with the picture.

What Is Lightning?

By Joseph M. Howard



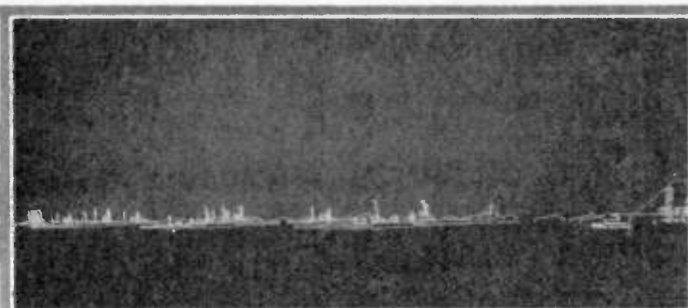
Left—The effect of a thunder cloud on a human being without the lightning directly striking him.
Right—The voltage of a thunder cloud, how it is produced, and the cause of thunder graphically presented.

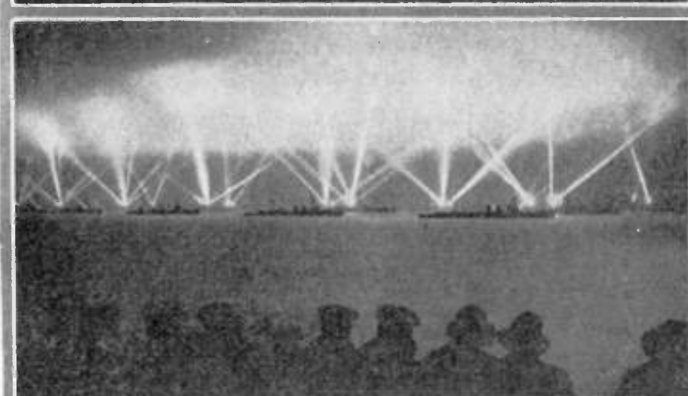
CONTRARY to popular opinion, it is not always necessary for a bolt of lightning actually to strike the individual in order to produce death. A man walking on the ground shares the negative charge of the ground. When lightning strikes nearby, the accumulated electricity on the body returns to the earth. If the bolt is heavy, sufficient current may arise to produce a shock severe enough to cause immediate death.

Lightning is a very common phenomenon yet its origin has been a mystery almost since ancient times. Benjamin

(Continued on page 726)

The Spithead Review





A great review of the British navy for the benefit of King George V at the great naval station of Spithead on the south coast. In one view the fleet is shown outlined by its innumerable lamps; in the other the searchlights are playing. In one view a haze in the air develops a great mass of white illumination. In perfectly clear air the effect would be minimized.

CERTAIN localities on the English coast have familiar associations with the people of this country. Scarborough Cliffs, whence the combat of Paul Jones with his decrepit yet victorious "Bonhomme Richard," the Nore at Thames mouth, where the great mutiny of the Nore occurred, the Hoe of Plymouth, where Drake finished his game of bowls before sailing out to meet the Spanish Armada, are old acquaintances.

Spithead in Portsmouth Harbor is to be added to the list. It is a great naval place for assembling the British fleets,

(Continued on page 727)

Photographing the Invisible

By Dr. Alfred Gradenwitz

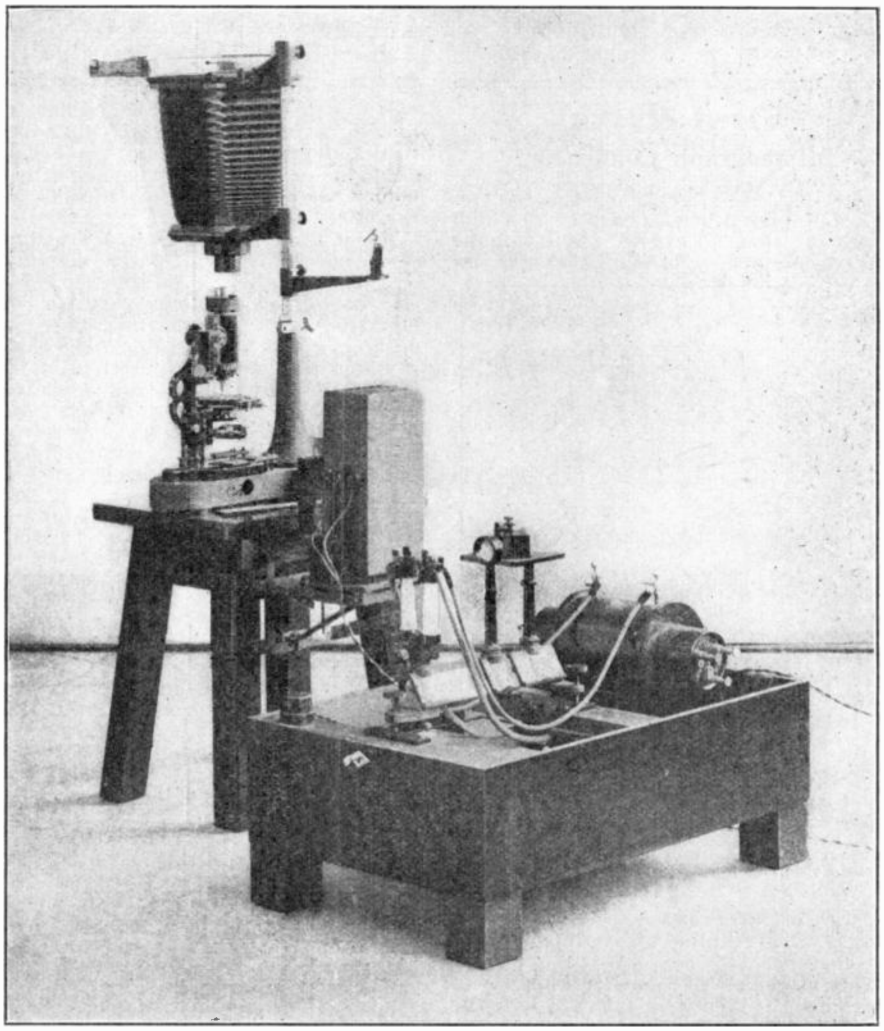
Berlin Correspondent, PRACTICAL ELECTRICS

A REMARKABLE biological discovery which is likely at no distant day to lead to the invention of an effective cure for the terrible cattle scourge, the foot-and-mouth disease, has lately been made, when Professors Paul Frosch and H. Dahmen isolated and identified the causative agent of that disease.

This achievement, which with an ordinary microscope, be its magnifying power ever so high, would have been impossible, was made by the application of a wonderful experimental outfit enabling the normally invisible to be photographed by means of ultra-violet rays, *i.e.*, those rays which in the spectrum are situated beyond the short-wave, or visible violet rays.

Practical experience as well as theoretical speculation had shown that the microscope with a given magnification will bring out a wealth of details all the greater as the wave length used for illumination is shorter. In opposition to the relative ease with which an up-to-date microscope is operated in visible light of any wave length, there are, of course, special difficulties to be overcome in connection with ultra-violet rays which not directly visible to the human eye, exclude the usual methods of observation.

Inasmuch as ultra-violet beams, on the other hand, exert an intense action on the photographic plate, the magnified image in the microscope can readily be photographed. It would be too long here to discuss the various methods by which the invisible picture can be focused distinctly on the photographic plate. A glass plate or lens at first sight appears equally bright and transparent as one of rock crystal. However, inspection in ultraviolet light shows only the rock crystal to be as transparent as in daylight, while glass then becomes quite opaque, behaving like very dark smoked glass. In fact, no microscope intended for use in ultraviolet light should contain any glass, all lenses, etc., being made of rock crystal or a product derived therefrom known as quartz glass.



The apparatus shown above takes photographs of microscopic objects using ultra-violet rays, which are of great effect upon the photographic film. By their use remarkable results in the photographing of extremely small objects are obtained.

Substances seemingly of equal transparence, such as glass and rock crystal, are readily distinguished from one another in ultra-violet light by their essentially different transparencies. The various components of those tissues, constituting animal and vegetable bodies, are frequently distinguished by a variable transparence to ultra-violet light, and are readily detected in a micro-photograph made in ultra-violet light.

In the outfit devised and used by Professor Koehler of the Zeiss Works the ultra-violet light is provided by an electric spark passing between two metal rods distant a few millimeters from one another. The most suitable ultra-violet rays, the wave length of which is about half that of the brightest green light, are separated by means of rock crystal prisms from the remaining light, especially the visible beams, and are exclusively transmitted to the microscope.

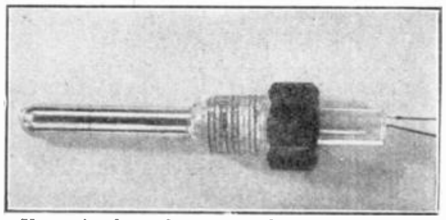
The illustration shows in the foreground on the right the induction coil generating the ultra-violet light. Ultra-violet beams invisible to the human eye are projected into the opening below the microscope, thence to be reflected upward by a prism, and thus to serve as source of light for illuminating the microscope. After penetrating through the microscopic preparation on the slide they will pass through the latter into the camera, which will reproduce the picture on the photographic plate. The camera can be turned to the side and the actual adjustment can be obtained by means of the "searcher" above the eye glass of the microscope.

Electric Water Vapor Detector

By S. R. WINTERS

THE presence of a tiny amount of water vapor in a gaseous substance cannot be ignored in conducting certain manufacturing processes. Notably in the production of liquid air the presence of an infinitesimally small quantity of water vapor will clog the manufacturing machinery as it freezes. Similarly the successful operation of the synthetic ammonia process may be thwarted by the presence of a seemingly negligible amount of water.

Obviously, then, the detection and indication of water in a presumably dry gas is of consequence. E. R. Weaver of the Bureau of Standards, United States Department of Commerce, has invented a device for doing it electrically. This new instrument consists of a glass tube that is coated with platinum, this coating being divided by etching into two electrodes. Platinum wires sealed through this glass tube connect the electrodes to an electrical-measuring circuit. The resistance to the alternating current of a thin film of a hygroscopic electrolyte bridging the gap between the electrodes is employed as a measure of the water vapor present in the atmosphere with which this film is in contact.



Very simple and compact device for determining the presence of water vapor in air or gas, depending on the conductivity of a water film.

Laboratory experiments covering a period of three years indicate that the sensitivity of this water-detecting device may be adjusted by the use of sulphuric and phosphoric acids, and various hygroscopic salts, in forming the conductor.

Awards in Odd Electrical Experience Contest

First Prize, $20.	Second Prize, $10.	Third Prize, $5.
Harry A. Sorensen, 371 Franklin Ave., Hartford, Conn.	Ray S. Nowitzky, U. S. N. R. F., 939 Main St., Norfolk, Va.	S. B. Williams, Marysville, Missouri.

Fourth Prize, $2.50—T. V. Voorhees, Ripley, N. Y.
Honorable Mention—Palmer T. Ramey, 221 Hammond Place, South Bend, Ind.

First Prize

Mimeograph Condenser

By Harry A. Sorensen

I AM employed after hours at the high school which I attend. Most of the work consists of printing laboratory exercises for the various science departments. The copies are printed by a mimeograph.

Very interesting description of an electric shock given by a pile of papers from a mimeograph. As sheet after sheet was added to the pile, the potential increased until a severe shock was received.

This machine has a hand rotated drum on which the stencil is fastened and the paper is hand fed.

One afternoon I had about 100 copies to print. The paper was quickly run through. I was surprised and startled when, touching the pile of printed copies, I received a severe shock. Touching the copies a second time nothing was felt. Evidently the charge had escaped at the first touch.

The next day I told one of the physics instructors of my experience. He said it was likely that the charge was static electricity produced by friction between the paper and the inked drum. This is apparently the cause as the drum had more ink on than usual, and the paper when being run through made a crackling sound.

The paper printed on this time was thinner but stronger and of a better grade than is used most of the time. It seemed to have the appearance of being a better insulator of electricity. The pile of paper must have acted as a condenser storing up the charge.

I generally print between 200 and 300 copies and now I touch the pile a few times during the printing, in case the experience should be repeated, in order not to receive the full charge.

Second Prize

Running Lights in the War Zone

By Ray S. Nowitzky

DURING the recent war, I was chief electrician on the U. S. S. "Antigone."

A general order was issued to the effect that naval vessels would navigate the ocean from sunset to sunrise without running-lights; in other words all exposed illumination extinguished. Through this order the electrical department put on an hourly watch reporting to the officer of the deck on the hour.

About three o'clock one morning in the war zone the officer of the deck sent for me. Upon my arrival on the bridge I discovered what was wrong. The yard arm blinkers were working and they were flashing a signal; I immediately ran up the ladder to the fire control bridge, unlocked the blinker key box and found both switches open; I then went to the forward lighting panel box and removed the fuses on that circuit, and returned to the bridge only to find the blinkers still flashing.

I was at a loss to understand this situation and after gazing at the blinkers I noticed for the first time that they were not lighting at full brilliancy, so as a last resort I sent two electricians up the battle stays to remove the bulbs from the blinkers. I walked over toward the radio room while the globes were being removed, and overheard the motor generator in the wireless room vibrating in unison with the flashing blinkers. This gave me a new clue and I opened the door of the radio room and saw the operator transmitting a message. I then decided to go to the yard arm and further investigate the trouble. I discovered that the hanger securing the antenna's insulator passed over the yard arm and around the steel mast and that the main antenna insulator was cracked; this gave an uninterrupted course of induction from the antenna to the steel mast, and the induced current followed the conductors across the yard arm and into the blinkers, there heating the filaments in the blinker bulbs, which was responsible for the phantom signals.

A wireless plant on a ship by accidental contact gave night signals when all lights were supposed to be extinguished, as it was in war time.

Third Prize

Lightning Exhibition

By S. B. Williams

I WAS working for a carpenter at the time of this odd experience. The carpenter shop was just southeast of the house; the house had a door in the east. There was a barbed wire fence running north and south of the shop and the wires were fastened to the ground wire of the lightning rods. About 20 feet north of the shop was a cross fence running east and west; the wires of this cross fence were fastened to the wires of the fence running north and south. About 50 feet east of this north and south fence, on the cross fence line, was a high post.

It came on to rain one evening, and we went to the house for shelter. I was sitting in the doorway of the house facing the east when the lightning struck the high post on the cross fence running east and west.

A very interesting and unusually impressive exhibition of ball lightning described at length.

It followed the wire until it reached the fence running north and south, where it melted the wires in two. It then turned south and followed the wire until it reached the ground wire of the lightning rod on the work shop. It looked like a large ball of fire, about the size of a foot-ball, and traveled slowly, until it struck the ground wire of the lightning rod; then it seemed to shoot back north like a shot fired from a gun until it reached the end of the fence, when it came back on the lower wire slowly, until it reached the ground wire of the lightning rod again, when it again shot back north to the end of the fence.

It repeated this circuit perhaps a hundred times or more, each time growing smaller, until we couldn't see it any longer, and during all the time this strange electrical phenomenon was playing on the wires, there was what seemed to be a blaze of fire about as wide as your hand flowing off of the three lightning rod points.

Since witnessing this electrical performance, I have been a firm believer in the protection of lightning rods.

Fourth Prize

Hot Dots and Dashes

By T. V. Voorhees

IN the Indiana village where I was born, the town was supplied with electricity from a one-horse dynamo and steam engine combination, which was owned by a very wealthy lady of the neighborhood. who was not fond of children. The operator of the plant was a tall raw-boned individual who, like his employer, had a dislike for kids. This fact caused us youngsters to be very cautious about anything which concerned the electric system of the village. However, when our home was wired, the lineman for some reason put the main switch in my chamber, an upstairs front room. Here I had great opportunity to experiment to my heart's content and soon had my room lighted with fixtures of my own design and attaching.

A short time later, I became interested in electricity in another line. A young man of the neighborhood had at one time been a telegrapher and had a dandy practice set which he gave me for "keeps." With this new possession I at once decided to become a telegrapher, but money was scarce and therefore I could not buy the necessary dry batteries. Well, someone has said that a little learning is a dangerous thing, and this I found the case to

Trying to send code with the lighting current. The result was disastrous. The Morse key resented such treatment.

be with electricity. Boldly I hitched two wires to the big switch in my room and then to the telegraph key. After making sure that the wires were all tight, I pressed the key. Every dot and dash made a crackling blue spark and I enjoyed it. Then I made an extra long dash, there was a burning snap and I knew that I was in for trouble. The practice set was smoking and had suddenly become very odoriferous. I quickly detached the wires and went outside to interest myself in affairs entirely foreign to electricity.

That night the lights in our house and in the homes of two or three of our neighbors, refused to be lighted, and a call was sent to the boss at the light plant. He discovered a pole transformer near our home in very bad condition, and because I was the only boy in any of the three homes, he seemed to think that I might have been the cause of the trouble. He never was able to confirm his belief, however, and this is my first public confession. Perhaps if he reads this he may settle one mystery of his long electrical experience which has never to this time been fully solved.

Honorable Mention

Charging Batteries with A. C.

By P. T. Ramey

WHILE attending high school in Morehead, Ky., I was only a youngster, but I had helped an electrician wire some houses, therefore I knew more about electricity than anyone—just a smart fellow that knew it all.

One day the president of the school called me into his office and told me that his doorbell wouldn't ring. He thought the battery was run down and needed replacing, for the bell had been ringing weakly for the last few days.

I made a long-distance diagnosis telling him that there was no need to go to the expense of buying a new battery, for I could take the dry cells and recharge them; sending an alternating current through would restore their power to the cells. As I would use 110 volt alternating current it wouldn't make any difference which poles I connected to the positive or negative, for an alternating current reverses its direction at a very rapid rate, and the effect would be the same either way that I should connect them. As it takes six volts 24 hours to charge a cell, I could use 110 volts and charge a dry cell in one-eighteenth of that time, therefore it would only take 1 hour and 18 minutes to charge a dry cell with 110 volts alternating current (according to figures I put before him).

After I got through telling him how I figured all this out, by the use of the well known electrical laws of Ohm, Kirchhoff's, Vector's, Phase Relations, Induced Forces and all other electrical terms that I could think of, he told me that he didn't care so much about the technical part of it, so he would leave that to me.

Happy as could be because I had a chance to show the President of the school what I knew about electricity, I rushed to the basement and got the dry cells, took them to my work-shop, which was located in an outside building, and had a large sign across the outside door: PALMER T. RAMEY. SCHOOL ELECTRICIAN and CHIEF ENGINEER.

I connected the cells in parallel and ran the wires to a switch which, when closed, would send 110 volts alternating current through the cells. After completing my connections, I took out my watch to get the exact time that the current would be turned on, for according to my calculating it would require 1 hour and 18 minutes to completely recharge the dry cells with 110 volts alternating current. And as I was working for the President I wanted to be as accurate as possible.

When I closed the switch? ? ? ? ! ! ! Well! I don't know what happened first. A flame of fire shot from the cells, a loud report came from the switch, the wires carrying the electricity to the cells was heated to a red hot glow. I pulled the switch quickly enough, but it was no use. The insulation had caught fire on the wires that had carried the current to the cells, and this fire was not on one end either,

An embryonic electrician tried to "charge" a dry battery on alternating current. The battery apparently was not used to such treatment and things began to happen.

the whole length of the wire was on fire; I stood dazed for a moment, and didn't know what to do first. After I realized what had happened I made a grab for the wires, jerked them down and threw them on the floor; the fire was extinguished in about two minutes.

My work shop now looked like a wire department of a local junk dealer, with two dry cells standing on a work bench in the center of the room.

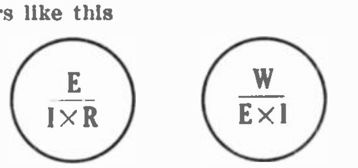
Just then the telephone rang, the President told me all the lights were out. Of course I knew what was the matter. I picked up a couple of fuses and went to the fuse box, replaced the fuses and the lights came on.

I didn't return to my shop, but rushed down town and bought two cells, and installed them; the bell worked fine. I told the President that I was not in position at present to recharge dry cells.

Ohm's Law and the Watt Law

TWO suggestions that are interesting and useful are shown here.

One is an easy way to remember the Ohm's and Watt's laws. Let us now have the letter (E) stand for voltage, (I) stand for current and (R) stand for resistance. Now let us make a circle and insert the letters like this



The above are two simple formulas which will be of considerable use and which could be well drawn out and kept posted in the electrician's laboratory, substantially as shown here.

and we have Ohm's law, and to use it, all you have to do when any two of the three factors are known is to cover the third and the answer will be before you.

Example: (E) and (R) are known find (I), cover up (I) and you have the answer which is $\frac{E}{R} = I$. The watt law is the same, but instead of using (E) the letter (W) is used, thus:

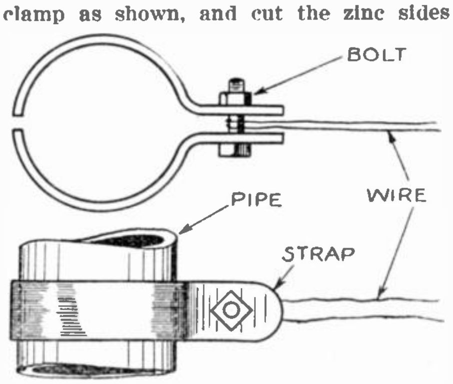
If you want to know the watts corresponding to given voltage and current, cover up the (W) and you have $E \times I$, which is the value of (W) or of watts. Cover up (I) and its value is given by what is left: $\frac{W}{E} = I$.

There are three changes for each circle.

Ground Clamps from Dry Cells

MOST electrical workers are familiar with the clamp shown, for attaching to an iron pipe for a ground.

Such clamps can be made from material which 99 times out of 100, is thrown away. Remove the inside material from old dry cells, use the nuts and bolts on the clamp as shown, and cut the zinc sides



A ground connection from dry battery parts

into pieces to make strips to fit around large pipes.

Contributed by James E. Noble.

Applications of Photo-Electric Cells

By H. Vigneron

THE discovery of photo-electric phenomena is due to Hertz in 1887, when he observed that the ultra-violet light emitted by an electric discharge between two terminals, facilitated the discharge of electricity between another pair of terminals on another circuit.

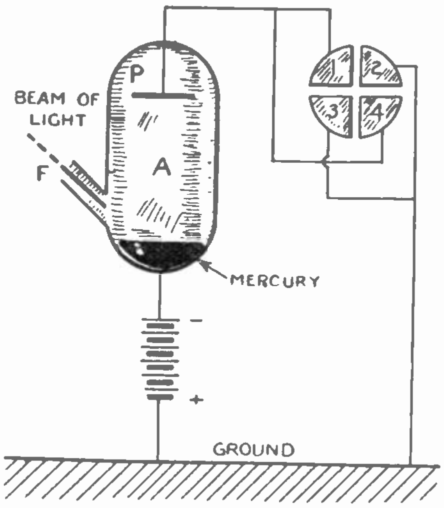


FIG. I

The beam of light received by a mercurial photo-electric cell operating a quadrant electrometer for measuring infinitesimal heat changes.

Hallwachs, a year later, showed that certain substances charged negatively lost their charge, when ultra-violet light fell upon them, and neutral substances, under the same circumstances acquired a positive charge. Although the phenomena seem to belong to the realm of electrons and quanta, they have found a practical application, limited today to astronomy, but whose field of utility may increase at any time, for example in telegraphic transmission of pictures and in television.

The Hertz and Hallwachs phenomena are due to electrons expelled by the impinging light, in other words, to the emission of cathode rays.

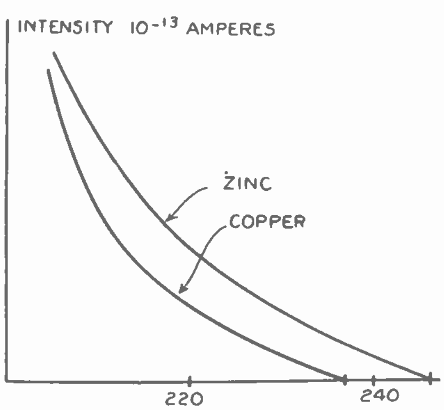


FIG. 2

The graphs of zinc and copper, when acted on by light, giving the photo-electric character for each.

In one system of investigation, a metallic surface is illuminated in vacuo and its positive charge is measured by an electrometer, Fig. 1. In the second method a metallic plate faces at a little distance a second plate connected to the ground through a galvanometer, which measures the current strength resulting from the transfer of electrons.

Photo-electric effect can be shown by directing the light of an electric arc concentrated by a quartz lens upon a freshly polished zinc plate, which is connected to the plate of an electroscope. If the plate has been charged negatively the leaves of the electroscope fall as soon as the light strikes it. If on the contrary it has been charged positively, the light has no effect.

The apparatus shown in Fig. 1 is used for studying the laws which govern the effect. In a bulb (A) which has been pumped out, there is some mercury or other metal to be studied resting upon the lower part of the bulb, forming a cathode. It receives light through an aperture (F) closed by quartz in certain experiments. A plate (P) acts as anode and catches the electrons emitted by the cathode. It is connected to one pair of quadrants (1 and 3) of an electrometer, whose other quadrants (2 and 4) are grounded.

The cathode is connected with the positive pole of a storage battery whose negative pole is grounded. The potential difference thus established between the two electrodes is termed the "accelerating potential." The following laws have been established:

1. The number of electrons emitted is proportional to the quantity of energy received, whatever the wave length of the incident light, which enables us to apply the photo-electric phenomenon for measuring the intensity of light.
2. The velocity of electrons emitted under the influence of light increases with its wave frequency.

Fig. 2 gives two photo-electric current curves of copper and zinc. As the wave length of the light increases, the current falls and reaches zero value for a definite length of wave characteristic for each particular metal.

In a certain range of wave lengths, almost confined to the visible spectrum, there is a considerable increase of the photo-electric current. A maximum current is reached, and the wave length of the light producing it is characteristic of the particular metal, as was the other wave length just referred to.

We now come to the practical part. A photo-electric cell is composed of a bulb of glass or of melted quartz, whose interior walls are covered with a deposit of potassium or other metal, one of the alkali metals preferably. This film is connected to a platinum wire melted into the glass, so as to give an outside connection. This is the cathode

For anode a ring or a grid is used. To prevent a short-circuit between the two electrodes, there are guard rings connected to the ground. The bulb is either completely exhausted or is charged with a minute amount of gas whose pressure is of the order of a millimeter of mercury (1/25th inch). It is enclosed in a metallic case, with one opening through which a beam of light may be passed.

The photo-electric current is measured by a zero method by producing an opposing current. Loading a piezo-electric quartz crystal of the Curie type gives the latter.

The illustration, Fig. 4, shows a quadrant electrometer whose readings are to

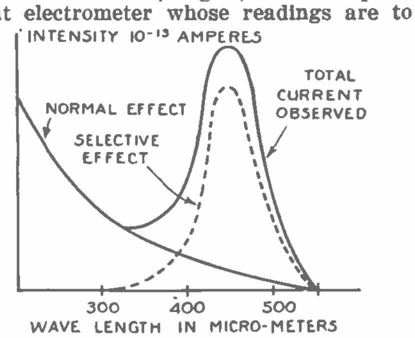


FIG. 3

Other graphs showing relation of wave lengths to currents and the selective effect.

be brought to zero. The piezo-electric current is calculated by a formula based on the weight and time of its application. Other electrometers can be used according to the intensity of the photo-electric current. The metal inside the bulb is made to give an electric discharge for a few seconds in hydrogen, which increases its sensitivity. If potassium is used a fine violet color is produced in the interior of the bulb.

In spite of every precaution, the photo-electric current is too slight to be measured with any degree of precision, unless the source of light is very intense. Accordingly, means have been sought to amplify it considerably by utilizing what is called ionization by shock.

A minute amount of neutral gas, argon, helium or neon, is contained in the highly exhausted bulb. Electrons emitted from the cathode are supposed to collide with the molecules of the gas and set free other electrons. Fig. 5 gives the characteristic curve of such a tube. As the voltage rises the current increases in higher and higher

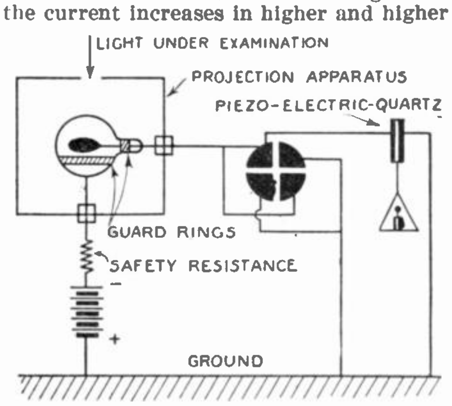


FIG. 4

Highly sensitive connection using the piezo electric current in its operation; it is of extreme sensitiveness.

proportion. Care has even to be taken lest the apparatus be injured.

Slight as the current is, it is even three hundred times greater than if it were due to pure thermo-electric effect and not electric transmission of photographs, such as that of Professor Korn. The difference between telephotography and distant vision, although only quantitative, is really enormous as regards practical difficulties. In telephotography we have a photograph ready for transmission, which can be given as intense illumination as desired, and for transmitting the picture five to twenty minutes or even more can be used if necessary. For distant vision, however, the strength of light of the subject to be transmitted cannot be increased unduly if it can be changed at all, and the time for the transmission of the subject is excessively short, as already noted. All the image-elements must go within the persistence of vision period, one-tenth of a second about. If it therefore was a great feat, when Professor Korn succeeded in sending photographs in from five to twenty minutes to considerable distances, the technical difficulties rise to an enormous degree when this period must be reduced to 1/3000 down to 1/12,000 second.

Another difficult feature is the conversion of the elements of the picture of different brightnesses into an electric current varying in the same ratio of intensity. We use for this purpose an instrument which we can designate as the electric eye. Such instruments have been long known to us. They are the so-called photo-electric cell; such as the selenium cell and others. Some by the operation of light change their resistance, as in the case of selenium; some develop a potential as in true photo-electric cells.

The selenium cell is all that concerns us here. The English electric cable engineer, May, was the first to discover that the resistance of selenium which he wished to use for cable messages, diminished as it was exposed to light. This resistance we can use as the basis for an electric eye. Considering its very great specific resistance, we must give the selenium as large a cross-section as possible and keep it very short in length, which can be done in the following way:

On a flat or curved plate two wires of platinum or brass 600 to 800 meters long and very thin are wound, with an interval of about one-half millimeter or one-fiftieth of an inch between them. A thin layer of amorphous selenium is spread over this surface and this by a heating process is converted into the gray crystalline modification, which unlike the amorphous is a conductor of electricity and is highly sensitive to light—exactly what we require. Such a selenium cell has in the darkness an electric resistance of 60,000 to 100,000 ohms. It is diminished by the light from a 16 candle-power incandescent lamp at one meter distance to one-half the above resistance. But the peculiarities of the selenium cell are many. They are referred to the most involved phenomena with which modern physics has to do. A disadvantage of the selenium cell above all is that on account of its high resistance it can only pass a very slight current, of the order of one milliampere, so that its usefulness from this side is very limited.

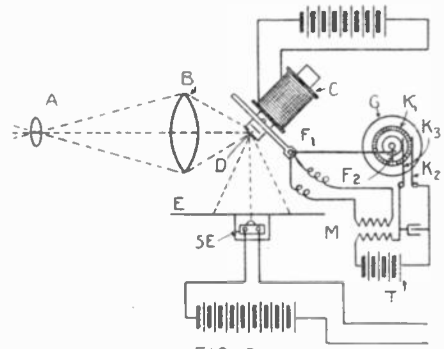


FIG. 3

Fig. 3. Diagram of the transmitting apparatus. (A B) optical lenses; (D) mirror of the oscillograph (C); (E) Diaphragm; (SE) selenium cell; (F_1) connecting rod pivoted between two screws; (F_2) eccentric of the synchronous motor (G); (K_1, K_2) rotary circuit breaker.

A still worse feature which makes its use for the registration of quick changes of light unavailable is that it possesses definite lag, requiring time to be affected by light changes. Many methods have been worked out to overcome this lag or to restrict it within definite limits. But the high resistance already mentioned is one of the greatest difficulties in the way of solving our problem of distant vision. The exceedingly slight current whose variable intensity represents the variations in light of the different elements of the picture, can be hardly carried to a great distance for reproduction of the object.

Until recently it was hardly possible to transmit these currents preserving the wave relations. Since the development of the audion, we are now prepared to strengthen varying currents of any frequency whatever, and the development, especially in radio, of these tubes which are well designated as the modern Aladdin lamp, has given a practical development to our subject. It was a young Hungarian engineer, Dionys von Mihaly, who succeeded in overcoming the practical difficulties of our subject. The characteristic feature of the distant vision apparatus of Mihaly or as the inventor terms his apparatus very properly, the Telehor, is the use of a very small oscillating mirror, both for the analyses of the picture as well as for the changing back of what we may term the image-current into the image-element of varying brightness and disposition for projection on a screen.

This mirror of about one-square millimeter area (1/625-square inch) must have a very short period of oscillation. The mirror (p) Fig. 2 is riveted to an excessively thin loop of platinum wire which is stretched between the two poles (N, S) of a strong electromagnet. The wire is about one-hundredth of a millimeter thick (1/2500 inch). If a current is passed through the platinum wire both the leads exercise a force whose direction is perpendicular to the axis of the wire and to the magnetic lines of force of the field. As in both leads of the loop the currents flow in opposite directions, one of the wires will bend towards us perpendicular to the plane of the picture, as we may express it, and the other in the opposite direction. This brings about a slight turning of the mirror (p), that up to a certain limit varies with the strength of current. If the current passing through the wires is an alternating current, these oscillations are in opposite directions for each phase, and the frequency of the oscillations corresponds to the period of the alternating current. This is the well known Siemens oscillograph. If the wires are thin enough, the mass of the mirror small enough, the mirror can give from 15,000 to 20,000 swings per second. Fig. 3 and 4 shows the transmission apparatus.

The two optical lenses (a) and (b)

(Continued on page 728)

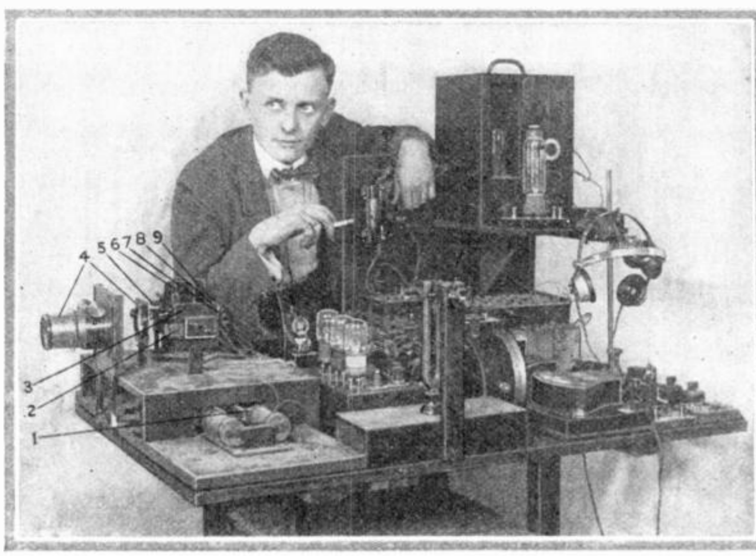
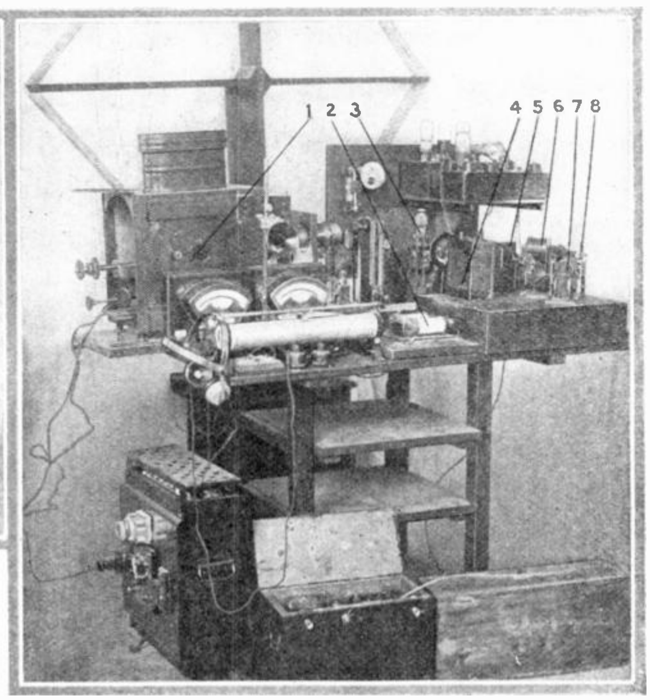


Fig. 4. Dyonys von Mihaly at the transmitter of his Telehor for wireless distant vision.
On the left of the picture is seen the high vacuum amplifying audion in the middle, the apparatus for producing electric oscillations on the right. The Telehor works in a camera obscura; the wooden case, which covers the actual transmission apparatus, is removed to show the apparatus. 1. Electromagnet; 2, blende; 3, oscillograph and mirror; 4, lenses; 5, phonic wheel; 6, selenium cell; 7, 8, 9, other details. In the center is seen the tuning fork to govern the synchronous motor phonic wheel.

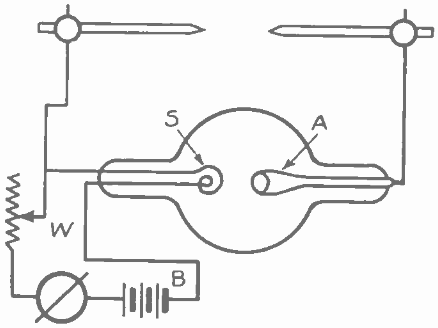


Receiving apparatus of the Telehor. The antenna is seen in the background. 1, electric arc lamp; 2, light relay; 3, ditto oscillograph; 4, screen; 5, blende; 6, oscillograph mirror; 7, oscillograph; 8, phonic wheel.

Testing Metals with "X" Rays—II

By Dr. Franz Fuchs, Munich

IN the Lilienfeld and Coolidge electron tubes the vacuum is pushed to the lowest possible degree .000,000,4 inch of mercury, so that the ordinary high potential cannot discharge through the tube. The number of air molecules is too slight to give an ionization. The electrons therefore have to be brought into the tube



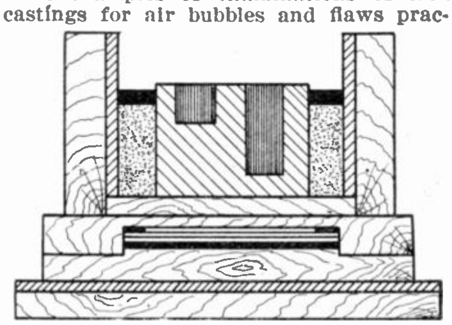
The general principle of construction of a Coolidge tube, using an incandescent cathode.

by a so-called incandescent cathode. This cathode in the Coolidge tube Fig. 8 consists of a spiral of the almost infusable tungsten wire (S) and by an auxiliary circuit as for instance from a storage battery (B) is heated to a white heat. Such an incandescent wire sends out electrons into the highest vacuum, which under the influence of the electric field within the tube impinge again with great velocity on the anti-cathode placed about 1¼ inch distant (A) and thence evolve Roentgen rays.

The high potential which can be delivered to the tube without injury depends upon its vacuum. In ion tubes for the production of hard rays a very high vacuum must be used, but on the other hand in electron tubes the potential can be used independently of the current intensity and according to the hardness of rays desired. This circumstance as well as their constancy of working indicates the adaptability of electron tubes for examination of solids.

3. *Results*

As examples of examinations of iron castings for air bubbles and flaws prac-

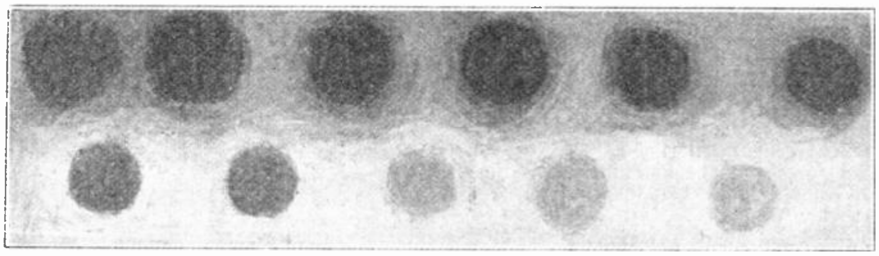


The mounting of a piece of metal for securing a radiograph; it was set in wax covered with mercury.

tically carried out some specimens are reproduced here obtained by Engineer Zacher in the years 1918 to 1923.

Zacher has investigated very closely the high importance of proper selection of intensity and hardness of rays as well as the time of exposure. For the successful radiography of metals, especially when the transparency of the object in different direction varies, he uses as a source of high potential a transformer with broken magnetic circuit, whose primary current goes through a gas circuit breaker. The spark gap of the apparatus is 20 inches. For production of Roentgen rays a gas filled 100 degrees C. tube was first used. Later a high vacuum Coolidge tube, that could take a current of 1.6 to 2 milliamperes, connected in parallel with a spark gap from 11 to 12 inches, was employed.

In order to get rid of the irregularities in the radiograph due to variations in transparency of different parts of the object, the weaker parts of the material to be proved are screened off progressively from the rays. This action of the screen

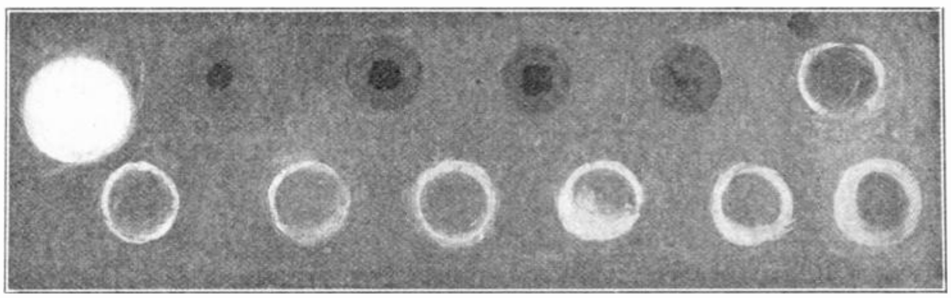


A radiograph from the mounting shown in preceding illustration after 30 minutes exposure

was tested with a piece of copper 1¼ inches thick and with holes drilled into it varying from ⅛ inch to 1¼ inches in diameter. As shown in Fig. 9 it was imbedded in a wooden box lined with iron. The sample was set in wax with a layer of quicksilver over its surface. Beneath the box the plate holder with its sensitized plate and the fluorescent screen was placed upon a lead plate.

Fig. 10, Plate 11, shows the radiograph as it came out with the arrangements just described under a thirty minute exposure. While the white portions of the gaps in the pictures show that the greatest thickness of metal was not penetrated, the smaller thicknesses of material as the washed out dark spots on the upper left show, were also much overexposed. But now if the special manipulation is employed so that during the photographing of the individual holes beginning with the deepest one, they are covered one by one, after definite intervals with lead, one obtains thereby a radiograph of the holes, completely free from the effect of secondary rays and over-exposure (Fig. 11, Plate 11).

The white circle at the right end is due



By successively covering the holes with a disk of lead overexposure and secondary ray effects are avoided. The white spot is due to the disc of lead.

to a one-eighth inch piece of lead through which the rays could not pass.

The distance of the plate from the anti-cathode of the tube was 20 inches so that in consequence of the central projection an image of the drill holes could not be avoided.

Another interesting radiograph is shown in Fig. 12, Plate 11, namely a thick walled copper tube of 1⅛ inch external and ⅛ inch internal diameter. Very characteristic flaws appear which can be seen neither from outside nor inside. A similar radiograph by Dr. Jena of Dresden is shown in Fig. 13, Plate 11, which is the radiograph of an aluminum wire which by too strong wire drawing has suffered changes in inner structure. The tensile strength and toleration of bending the wire is thereby considerably reduced.

Fig. 14, Plate 12, shows various characteristic views of a piece of bronze alloy. A disc was cut out of a shallow dish; the inner granular structure of the ⅛ inch proof piece showed various irregularities; alloys of uniform structure give uniform pictures.

Figs. 15 and 16, Plate 12, show how pieces inserted in a machined piece of the same material, can be detected by the Roentgen ray. A copper bar 1.4 inches in diameter had four different holes bored into it which were filled up very carefully with copper, so that the polished piece showed absolutely no signs of these inserted pieces. The two exposures were turned 90 degrees from each other for the successive radiographs. The two exposures of the bar show clearly in the dark portions the portions of the holes which were not filled in by the plugs. We must remark in the side view the clear transparency of the interval between the plugs and the sides of the hole that were due to a small unfilled space.

Forty minutes exposure was given and a fluorescent screen was used. For the Coolidge tube there were two milliamperes of tube current and a 11 to 12 inch gap; the tube was at a distance of 20 inches from the focal plate.

Of great interest moreover is the examination of weldings of which an example is also given here. Fig. 17, Plate 12, shows an externally good sample of welding, where two pieces of square steel of a little over 1½ inches on the side are united. The proof piece, to avoid surface rays, was carefully bedded in wax and was covered with quicksilver. The line of welding shows as a dark streak which has at one end a characteristic bend. The exposure time with a 1.5 milliampere current and a fluorescent screen lasted for ten minutes. The dark line showed that in the interior there is a zone within which the surfaces are not welded together.

As Roentgen technique stands today, iron and steel samples up to 2 inches thick can be penetrated by an adequate plant, so that flaws of 1/250 inch can be detected. The required time of exposure for the maximum current strength of 1½ to 2 milliamperes tube-current may extend from 13 minutes to an hour and a half. A long time of exposure makes the investigation, otherwise so simple, quite expensive.

In the endeavor to shorten up the period of exposure by increasing the intensity and hardness of the rays, a limit is soon reached. Nevertheless we may hope that in the future photographic plates for the extremely hard ray which penetrates the metallic samples can be made especially sensitive thereto and thereby will shorten the time exposure of radiographs.

Meanwhile, the examples we have described show that with the plates and apparatus of the day and careful manipulation, we can get results with Roentgen technique of all samples brought to us, which for the testing of materials in metallurgy gives most valuable service.

We may return to the third point, the strengthening of the action of the rays on the photographic plate. The action of the fluorescent screen in spite of its simple manipulation gives no help in the investigation of metals, because for penetrating iron of a thickness of one-quarter inch or over, very considerable intensity of rays must be used, in order to give upon the fluorescent screen a quite sufficiently bright image. The photographic plate presents a very great advantage as by longer time of exposure it increases the effect of the Roentgen rays. One can therefore by prolonging the exposure increase the effect on the plate of even the weakest illumination, so that on development a clear image results.

As already stated, too long an exposure to the rays brings about a failing of the image by the action of secondary rays. For this reason we try to abbreviate the period of exposure by using an intensifying screen. It consists of a fluorescing layer of calcium tungstate which gives a blue light under the influence of Roentgen rays and which is spread over a piece of cardboard or celluloid. The screen is placed against the film side of the photographic plate and the operation of the Roentgen rays is strengthened by those emitted by the fluorescent screen. By using this system the time of exposure is brought down to one-sixth and under some circumstances to one twenty-fifth of the normal time.

A practical and very much used measure for the hardness of the rays is given by the so-called half value layer. This is that thickness of a material, water or aluminum, which only permits the passage of one-half the rays falling upon it. Hard and soft rays are distinguished physically by their wave lengths. Since the discovery by Laue and Friedrich (1912) of the interference of Roentgen rays we know that Roentgen rays are ether waves, whose wave length is about ten thousand times shorter than that of visible light. The shortest Roentgen ray wave varies from 1/100th to 3/100ths of a millionth of a millimeter in length and is the hard ray. The longest waves of 1/20th to 1/30th of a millionth of a millimeter are the soft rays. Fig. 4 shows the determination of the hardness of the rays with the spark gap of an induction coil. The spark lengths are given on the horizontal axis and the half penetration for aluminum is given on the vertical axis.

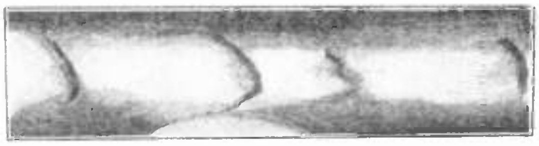


Fig. 12. Radiograph of a copper tube showing imperfections absolutely invisible otherwise.

To penetrate metals we must use rays whose hardness is measured by one-half to two millimeters of the half value of aluminum, in other words, due to a spark gap of 30 to 60 centimeters.

By increasing the intensity and hardness of the rays the effect on the photographic plate can take a considerable increase, so that we can get pictures of the interior and thicker portions of metal. But here we have to be careful, as the rays with increasing intensity and hardness and especially by longer exposure, have a bad effect on the photographic plates, because the finer distinctions in light effect disappear more and more.

The cause of this impairment of the radiograph lies in the action of the so-called secondary rays, which results in the penetration of every object, and in especial strength in the penetration of metal. We can picture to ourselves that the passage of Roentgen rays through a body is a winding and bending of the minute waves of Roentgen light between the atoms of the body. It is understandable then that the short wave of the hard rays has the greater power of finding its way through.

Therefore, only one part of the primary rays falling on the body get through among the atoms without any change, these going in a straight path; another part are bent back and forth as they go through the gaps between the atoms as if through a grating and are scattered about in all directions. The so-called scattered rays are produced also by the action on the Roentgen rays of the glass of the original tube, also by the impinging of the rays on the photographic plate and even in going through the air.

Moreover, a part of the impinging primary rays are completely absorbed in the atom, and this portion the atom converts into rays which for each element have one or more characteristic wave lengths. One calls this kind of secondary rays, the characteristic ray. The indirect and secondary impair greatly the photograph.

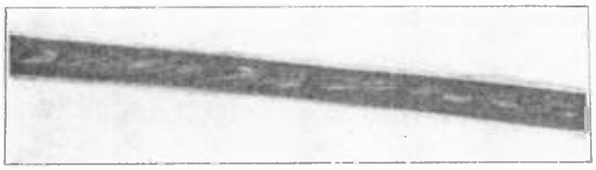


Fig. 13. An aluminum wire showing the effects of the stress of drawing.

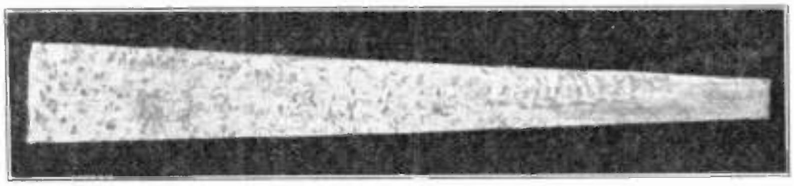


Fig. 14. A strip of copper in which the granular structure is brought out by the camera and X-rays.

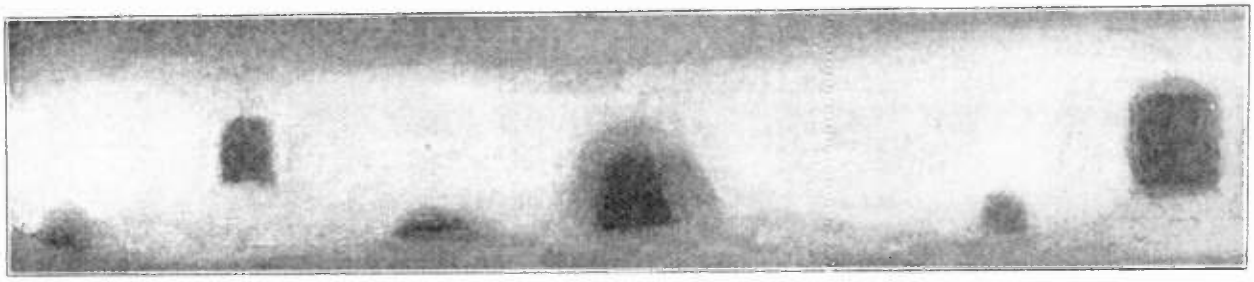


Fig. 15. One view of a copper bar with perfectly fitting plugs. This is the side view, below is the——

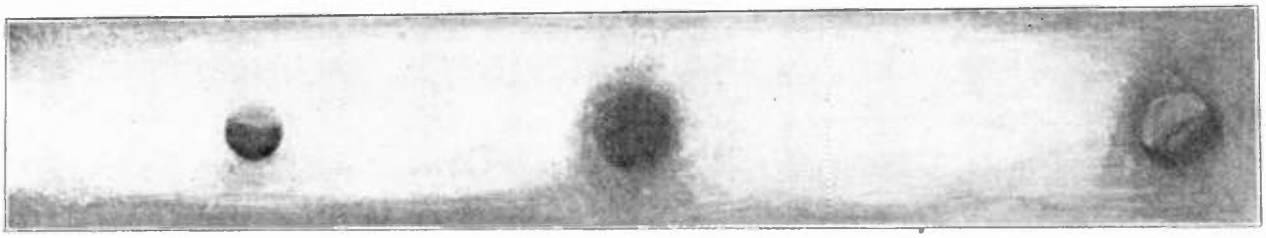


Fig. 16. Top view of the same bar. These plugs fit so well that they were indiscernible except by X-rays.

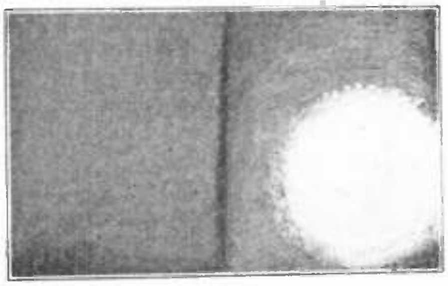


Fig. 17. A weld supposed to be perfect has its defects brought out by radiography, the dark line indicates imperfect joining.

Magnetism

By Harold Jackson

MAGNETISM is one of the most useful and important effects produced by the electric current. Many of the electrical devices and apparatus in use depend entirely up-

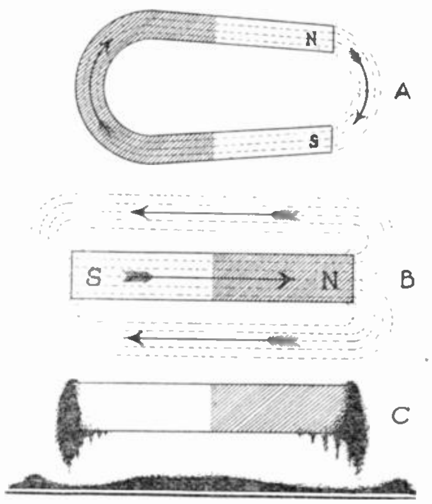


FIG. 1
Lines of force in a horseshoe and bar magnet and the experiment with iron filings show the location of polarity.

on it for their operation. Magnetism and electricity are the same in essence, in many respects are much alike, while in others they are quite different.

There are two kinds of magnets in common use, namely, the electromagnet and the permanent magnet. A permanent magnet has the power to retain its magnetism for a very long period of time after it has been magnetized, while an electromagnet possesses most of its magnetism only while an electric current is passed through its winding.

Permanent magnets are made of steel and are magnetized by placing them in a solenoid through which a heavy current is passed. Once a piece of metal is magnetized it is difficult to remove all traces

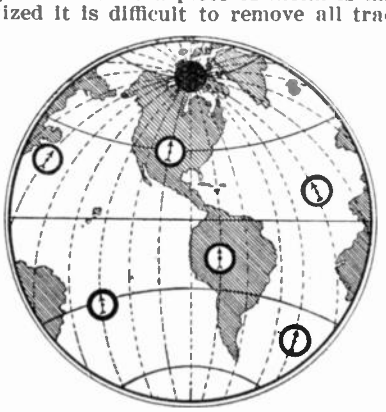


FIG. 2
How compass needles in all parts of the world point to the magnetic pole as the traction is exerted between unlighted poles, the north pole of the earth is of opposite polarity to the north seeking pole of the magnet.

of its polarity. This persistent magnetic force is known as residual magnetism, and it is due to such property that a permanent magnet retains its polarity after the magnetizing agent has been removed. Annealed wrought iron retains very little magnetism, and for that reason is used in the core of electromagnets, so that the polarity will practically disappear when the current is opened.

The magnetism of a magnet is represented by dotted lines which are drawn in the position which the magnetic lines of force are believed to occupy. The total number of lines of force is called the magnetic flux. In Fig. 1 at (A) is shown the magnetic circuit of a horseshoe magnet. The magnetic lines of force leave the magnet at the north pole and re-enter at the south pole, flowing in the direction indicated by the arrows. At (B) is shown the magnetic circuit of a bar magnet. Here the magnetic lines of force which emerge from the north pole flow around to the south pole through the surrounding space. If a compass is placed in the positions indicated by the arrows, the magnetic needle will arrange itself so as to conform with the magnetic lines of force and will point in the directions indicated.

A horseshoe magnet is simply a bar magnet bent so that its magnetic power will be increased by the two ends working together. At (C) in the same figure is shown a bar magnet which has been dipped into iron filings. This illustrates the fact that the magnetism of a magnet resides at the ends or poles of a magnet. If two like poles are brought close together they will repel each other, while if unlike poles of two magnets are placed near each other they will be strongly attracted. It is due to this attraction and repulsion of the two different kinds of magnetic poles that the operation of the electric motor depends.

The earth itself is a magnet; that is, it has two magnetic poles between which flow magnetic lines of force similar to those of a bar magnet. In Fig. 2 the northern magnetic pole is shown. The southern magnetic pole occupies a similiar position on the other side. The dotted lines represent the lines of force flowing from the north to the south pole. It has already been stated that a magnetic needle will turn so as to conform with the magnetic lines of force. It is this quality which renders the compass valuable in locating of direction. We illustrate a number of small compasses to show why a compass will always point toward the north magnetic pole regardless of its location on the surface of the earth.

When a current of electricity passes through a wire there is a magnetic field set up around the wire. This field consists of circular magnetic lines of force which surround the conductor in planes at right angles thereto. Therefore, if the wire is placed directly above a compass needle the needle will be deflected as shown in Fig. 3. With the current flowing through the wire as shown, from left to right, the needle will be deflected in the direction indicated by the shaded needle. The reason for this deflection is that the lines of force set up around the wire are at right angles to the wire; and the tendency of the needle to conform with the lines of force will cause it to turn until equilibrium has been reached between the magnetic field surrounding the wire and the magnetic meridian of the earth.

If the direction of the current in the wire be reversed the needle will be oppositely deflected. This is because the direction of the whirls around the wire is reversed by the change in the current direction. Placing the compass needle under the wire also causes an opposite deflection. If the current in the wire is increased the needle will show a greater deflection. Galvanometers operate upon this principle.

In Fig. 3 is shown the end view of a wire in which the current is flowing away from the observer, as indicated by the cross which represents the tail of an arrow. Here the magnetic lines of force or magnetic whirls are in a clockwise direction. If this wire be bent into a ring

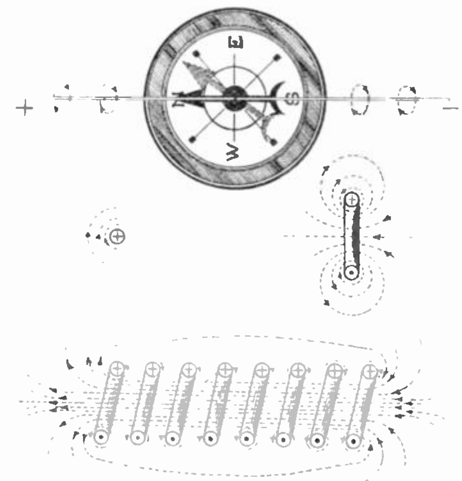


FIG. 3
Lines of force surrounding a wire carrying the current. In one case a straight wire and the other case a coiled one. The effect of the lines on the compass.

as shown at the right the magnetic field will be greatly increased in the center of the ring, for the lines of force from all parts of the ring will unite in the center and all pass through in the same direction as indicated by the arrows.

This effect can be still further increased in the manner shown at the bottom of Fig. 3. Here we have several turns of wire through which a current is passing. The magnetic field is greatly increased and will become stronger as the number of turns is increased. This is called a solenoid and has wide application in many electrical devices.

Its special feature is that if a soft iron core is placed close to one end of the

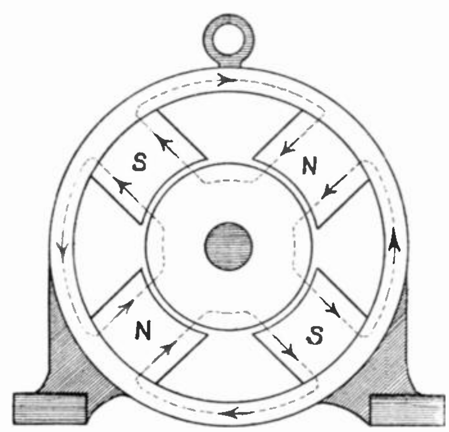
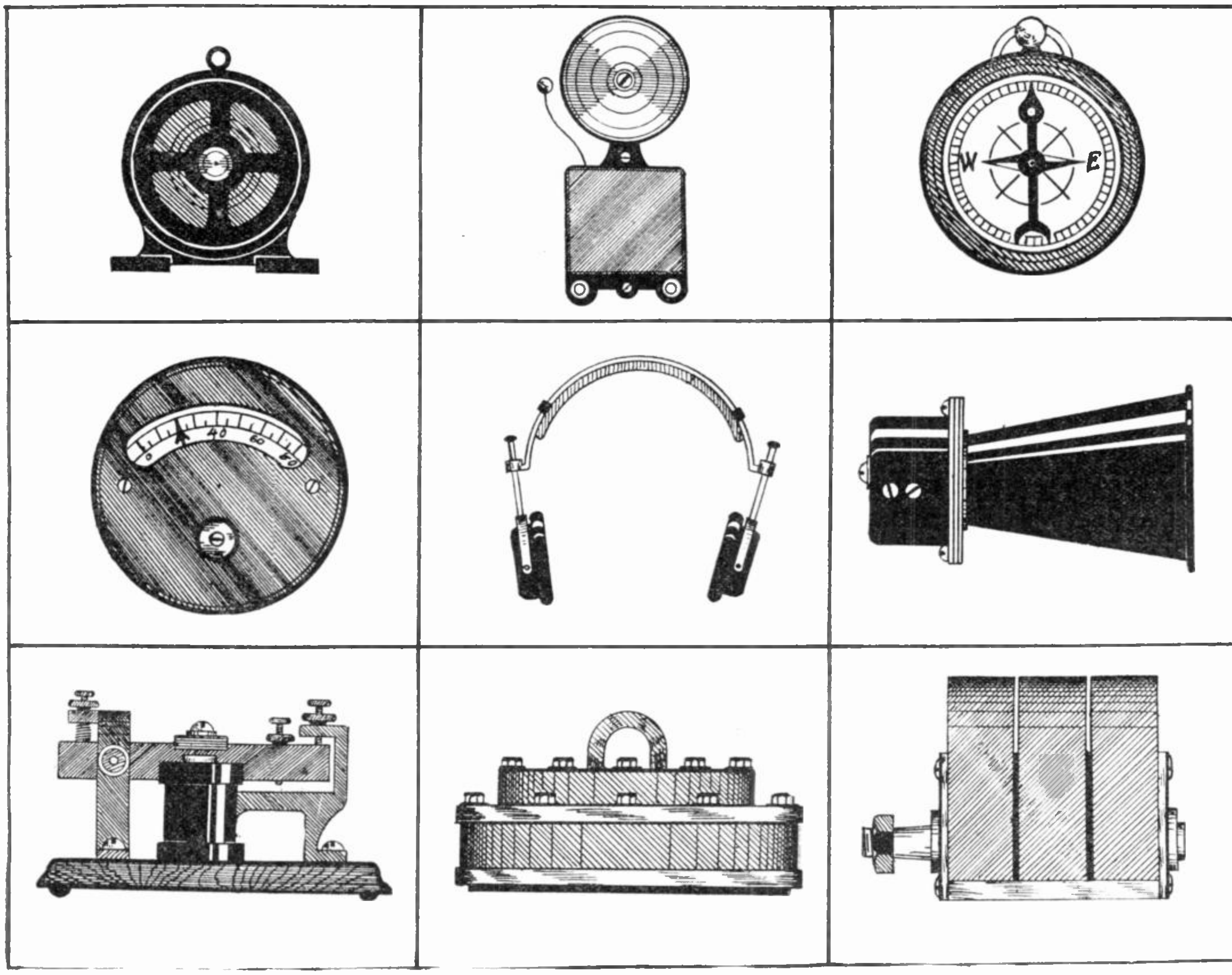


FIG. 4
Lines of force indicated by the arrows and dotted lines as they exist in the four poles.

solenoid it will be quickly attracted into the center of the coil. In this way considerably more range of movement is obtained than is possible with an ordinary electromagnet; for the attracting power of a magnet, while very strong a short distance from the pole, decreases very rapidly as the distance increases. Solenoids are used in the application of brakes, in arc lamps, etc.

An iron core placed in the center of a solenoid becomes a powerful electromagnet. The presence of the iron core greatly



Nine examples of the practical application of the electromagnet. The motor or generator, electric bell, compass, voltmeter or ammeter, telephone, electric horn, sounder, lifting magnet, and the magneto generator.

increases the number of lines of force produced by the solenoid, the extent of the increase being determined by the permeability of the iron core. The permeability of good quality soft wrought iron is sometimes three thousand times that of air. The iron offers less reluctance to the flow of the magnetic flux than does air, and consequently more lines of force will pass through the solenoid when the iron is present.

The mechanical production or generation of the electric current depends entirely upon magnetism. It is a well-known fact that current is produced, or rather induced, in a wire when it is passed through a magnetic field so that lines of force are cut by the wire. This is known as electromagnetic induction. Fig. 4 shows the magnetic circuit of a four-pole dynamo. As indicated by the dotted lines, the magnetic flux leaves the north poles, crosses the short air gap and enters the armature core. The flux leaves the armature core under the south poles, through which it passes, then goes through the yoke and back to the north poles. It can be seen that if a number of inductors are placed on the surface of the armature and the armature is rotated at a high speed the inductors will cut a great many lines of force per second and a strong current will be induced in the inductors.

Fig. 5 illustrates a number of common electrical devices which depend upon magnetism for their operation. They are: (1) motor; (2) bell; (3) compass; (4) measuring instruments; (5) radio head set; (6) auto horn; (7) telegraph sounder; (8) lifting magnet; (9) magneto. These are only a few of the many devices in which magnetism is the vital factor, and have been cited only to exhibit the importance and usefulness of magnetism.

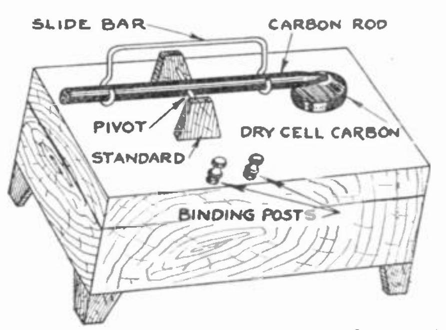
Sensitive Microphone

THE base of the instrument is made from a cigar box cut down to 5 inches by 4 inches by 1 inch and should be put together by glue, for nails or brads decrease its sensitiveness.

The top should be planed down until it is three-thirty-seconds of an inch thick. The bottom of the box is to be left open. Small feet, one-quarter of an inch square, are glued to the bottom and cushioned with felt to counteract jars.

The carbon rod may be made from an ordinary flashlight-cell carbon cut down to 2¾ inches length; it is one-quarter inch thick. A small hole is drilled 1⅝ inches from one end and a brass pin is pushed through it tightly. It is cut off to project one-half inch on each side, and is filed to a point on both ends.

The standard is made out of sheet brass and bent in the shape shown in the illustration. It is mounted on the box by a small brass screw securing it firmly.



A delicate microphone, interesting because it has a counterweight by which its operations can be regulated and brought to the highest degree of sensitiveness.

The top end of a dry cell carbon is sawed off one-half inch from the end, the binding post being used to hold it on the box.

It is mounted under the end of the carbon rod, which rests on it lightly.

A slide-bar is made from a piece of one-eighth-inch copper wire, bent as shown in the illustration. By moving this towards one or the other end the balance of the carbon is adjusted and regulated.

A fine wire runs from the standard to a binding post, and another wire from the dry cell carbon to the other binding post. One post connects with the brass standard, the other with the carbon block. The carbon rod should rest very lightly on this block.

Contributed by S. A. MYERS.

Construction of Electrolytic Rectifiers

By Leon Magron

RECTIFYING the alternating current is a proposition encountered by many radio amateurs. There are several solutions of this important problem; rotary converters of a prohibitive price, tungar lamps in general use but of deplorable inefficiency; mechanical rectifiers, of which several models give excellent results from every point of view, and finally electrolytic rectifiers.

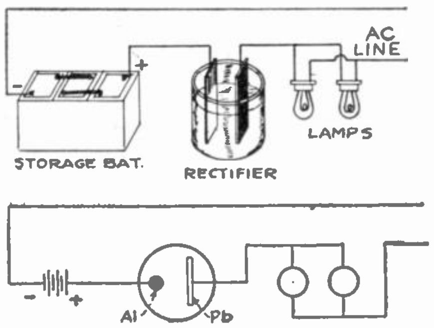


Fig. 1. Connection of a single cell electrolytic rectifier for charging a storage battery.

Here we must state that the latter are only available for recharging small accumulators, those of small dimension requiring low intensity, as, for example, B batteries. But by adopting certain precautions it is possible to charge heavy batteries successfully. Electrolytic rectifiers enable us also to supply directly the plate circuits of audions of minor transmitting stations and of amateur reception sets.

Action of the Electrolytic Rectifier

It is based on the following property: If two electrodes, one of lead and the other of aluminum are immersed in a saturated solution of sodium phosphate, and they are connected to a single-phase alternating current line, the current will not pass through the liquid except from lead to aluminum, thus suppressing one-half cycle of each alternation. This phenomenon is explained by the almost instantaneous formation and decomposition, at every alternation, of a pellicle of alumina on the surface of the aluminum. As this oxide is an insulator, it cuts off the current during the half period of its existence. Practice has always shown that the action of the

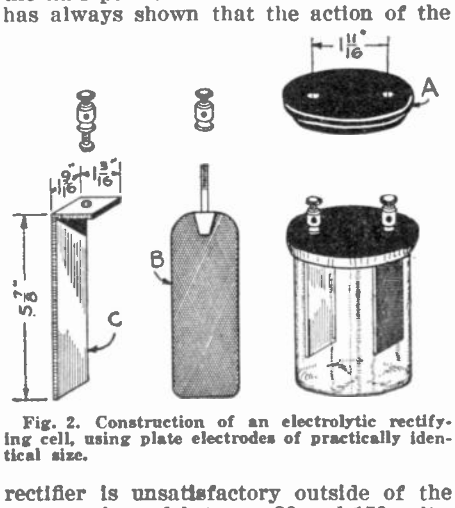


Fig. 2. Construction of an electrolytic rectifying cell, using plate electrodes of practically identical size.

rectifier is unsatisfactory outside of the range embraced between 20 and 150 volts. Below this potential it passes a very small current and above the higher potential the rectification is no longer complete.

This is why, if we want to utilize electrolytic rectifiers for rectifying a current whose actuating voltage has previously been stepped up, as for supplying the plate currents of the audions of a transmitting station directly, we will be obliged to connect a sufficient number in series so that each one will carry not over 150 volts maximum.

The Electrodes

The positive electrode is made of aluminum which should be of a high degree of purity if we want it to last long. If uncertain of its quality, the aluminum with which an electrode is to be made can be immersed for four hours in a 1 per cent solution of caustic soda (sodium hydroxide). As fast as they form, any slight incrustations must be removed. If these incrustations are too many and too thick, the aluminum plate must be rejected.

Electrodes cast in the form of pencils or plates with a terminal binding post are sold in commerce and generally give satisfaction.

The negative electrode may be of lead, tin, sheet iron, or of gray cast iron. If lead is used it should also be perfectly pure. That which is employed for the plates of accumulators should be specially rejected as it is alloyed with other metal. The quality of sheet iron or cast iron, if such are used, seems to be immaterial. Pure tin is excellent.

The Electrolyte

The electrolyte normally used is basic sodium phosphate in a 15 per cent solu-

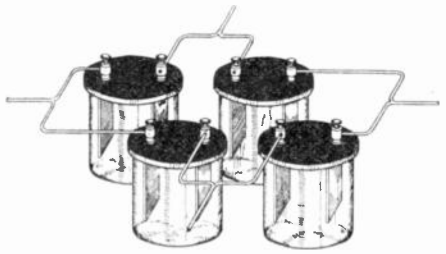


Fig. 3. Connection for four electrolytic cells. The alternating current lines enter at right angles to the charging lines. The idea is to utilize both positive and negative phases.

tion. As this salt dissolves with difficulty in the cold, the solution can be better effected at a higher temperature in rain water or distilled water. Commercial sodium phosphate is rarely neutral to test paper. If a drop of the solution proposed to be used leaves a spot of discoloration on blue litmus paper, a solution of pure sodium carbonate should be added drop by drop, until the same test produces no change.

Instead of sodium phosphate a saturated solution of ammonium phosphate may be used which must be neutralized in the same way, if there is need of it, with ammonium carbonate or sodium carbonate, the latter in a 5 per cent solution. Ammonium phosphate dissolves very readily in the cold.

The use of sodium bicarbonate as the electrolyte is especially to be recommended if a sheet iron or cast iron negative electrolyte is used.

Permissible Temperature

Temperature has a great influence on the operation of these rectifiers. The nearer the temperature is to 50 degrees F. the better, yet if it does not exceed 112 degrees, it will be in good condition for giving results.

To reach this result we must

(A) Only require a relatively small yield from the rectifier;

(B) Use a large volume of liquid for a sustained output;

(C) Cool the rectifiers if there is not enough solution by immersing them in cold water, or in a running current;

(D) Use liquid rectifiers of such construction that rapid circulation of the liquid is brought about by the heat generated so that the liquid is cooled against the sides of the containers.

Efficiency of Rectifiers

We should not deceive ourselves on this point, for the efficiency of the system is

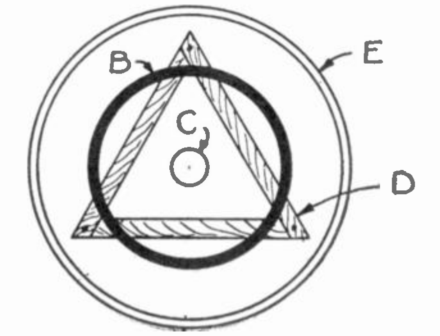


Fig. 4. Plan view of another construction of rectifying cell; (E) is the containing jar; (B), an iron or lead cylinder; (C), a zinc rod; (D), a wooden triangle on which the cylinder rests.

low on account of the energy loss in the shape of heat. Its simplicity, its certainty of operation, and its slight cost of installation, nevertheless insure it a certain success with amateurs who have time to expend for giving it all the attention exacted. For slight yield, where efficiency hardly counts, it is very practical.

It is necessary, if one wants to have results more or less satisfactory, to take out of the rectifiers only one ampere of current per ten square inches of aluminum electrode. The other electrodes should have a surface at least as large.

Different Mountings of Rectifiers

Electrolytic rectifiers can be mounted in different ways; we describe the use of one, three and four elements. A single cell, Fig. 1, can only utilize one-half of the current, as it cuts out one-half alternation per cycle. The other connections, on the contrary, use both portions of the cycle, and the best is the two-element pair of cells, Fig. 7, if the special transformer needed can be obtained. Figs. 1, 3, 7 and 8 show

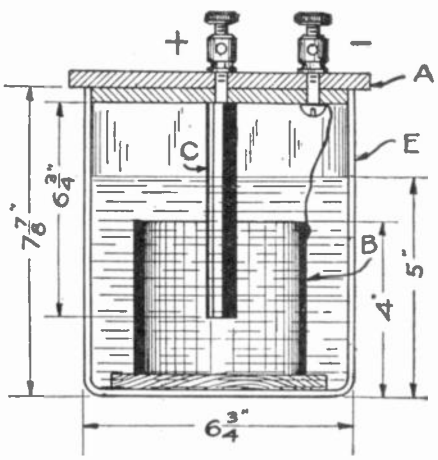


Fig. 5. Elevation of the cell shown above in plan, giving full dimensions. (A) is the wooden top held on by a rabbet formed by the two different sized wooden circles. The other letters refer to the same parts as in the plan.

how these different connections are carried out, and it is immaterial which of the three types of rectifier cells above described are used in them.

We always omit, however, the three-element connection in which the three electrode rectifier is advantageously put together as shown in Figs. 6 and 8. It is best to employ the same kinds of elements in any one of these mountings.

First Type of Rectifier

A small battery jar, Fig. 2, 7 inches high and 5 inches in diameter is perfectly suitable. For it we make a wooden cover (A) which is boiled in paraffin wax, to make

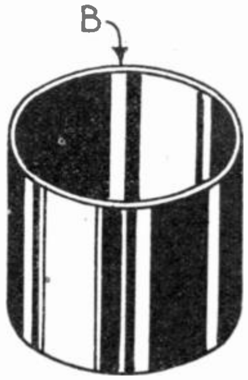


Fig. 6. The lead cylinder of the coil just described; (B) indicates it in both the preceding illustrations.

it insulating and exempt from corrosion by the chemicals. Electrodes (B) and (C) are suspended therefrom, each made of a sheet of pure metal 1¾ inches wide and 6 inches long, bent at a right angle at one end and drilled to receive the screw of a binding post or terminal which, passing through the wooden cover, is used for connecting to the circuit. The two terminals should be separated about 1½ inches from each other.

Second Type of Rectifier

For a current of two amperes the following type of rectifier, Figs. 4 and 5, has given excellent results. The negative electrode is composed of a cylinder of sheet iron (B) 4 inches in diameter and 4 inches high, carried by a wooden triangle (B) about ½ inch thick, resting in the bottom of a glass jar (E) 7 inches in diameter and 8 inches high. The positive electrode (C), composed of an aluminum rod 1¼ inches in diameter, passes through the cover and descends within 1¼ inches of the bottom of the jar. The liquid should stand at about an inch over the top of the iron cylinder, which is connected to its binding post on the cover by a wire soldered to the base of the binding post. This insures the circulation of the liquid and keeps it cool.

Third Type of Rectifier

We now come particularly to the construction of a rectifier with three cells, Figs. 6 and 8, presenting all the advantages of the four-cell connection, of which it is only a simplification. It is the most practical model next to that with two cells, and it avoids the use of a transformer. We therefore will study it in some detail and describe this type.

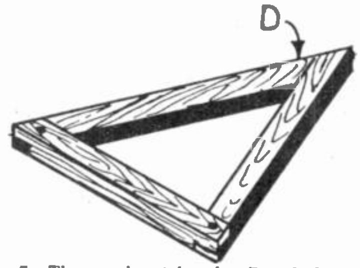


Fig. 7. The wooden triangle (D) of the preceding illustrations which carries the cylinder in this cell.

For a three-cell rectifier we require:

(A) Two sheets of lead 6½ inches by 2 inches by .06 inch.

(B) One sheet of lead 7 inches by 3-32 inch.

(C) Four sheets of aluminum, extra pure, 6½ inches by 2 inches by .06 inch.

(D) Seven machine screws with washer and jam-nut.

(E) Copper wire, rubber insulated, of adequate thickness.

(F) Three one-pint battery jars.

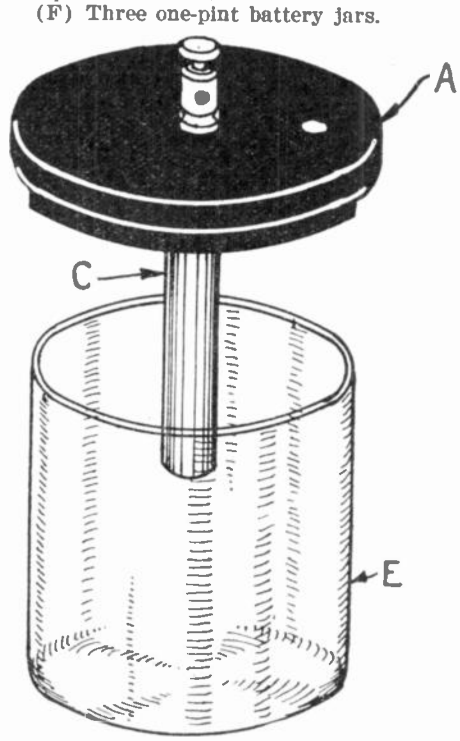


Fig. 8. The cover, the zinc and the jar of the cell just described, with the same letters of reference as before.

(G) One piece of fiber ⅛ inch or more in thickness and large enough to give three discs of 3 inches diameter and three pieces of 1¾ inches or a little less diameter.

Instead of lead plates iron plates of the softest metal can be used.

With some kind of pincers cut the three

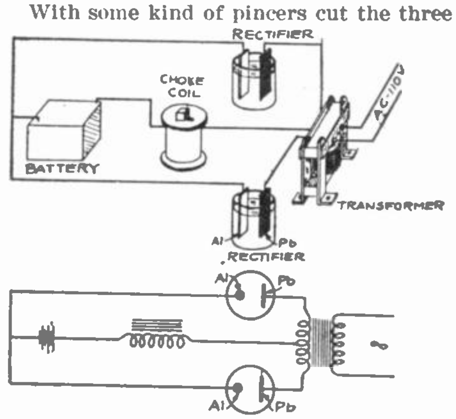


Fig. 9. A two cell connection employing a choke coil and transformer for controlling the amperage.

plates of lead and the four plates of aluminum to the shapes as shown in Fig. 6. Next drill holes with which to start the compass saw, and cut out the discs of such size that three of them exactly fit the neck of the jars. The three others will be large enough for covers. If a piece of fiber cannot be obtained it can be replaced by wood veneer boiled in hot paraffin until no more bubbles appear. These discs are fastened together in twos, preferably by little screws, and holes must be sawed through them to receive the tongues of the plates of metal with a driving fit and with a distance intervening of about one-quarter inch. Two of the covers will have two rectangular openings and the other three such openings, and the last will receive the largest plate of lead in its center and a plate of aluminum on each side of the central plate.

As shown in Fig. 8, each of the tongues will be bent over to prevent the plates from dropping downward, and terminals will be attached to them, the surface of the metal being cleaned with emery or with a scraper. All that remains is to immerse the necks of the vessels for about half an inch in paraffin wax, which paraffin must be barely melted. This is done to prevent creeping of the solution. Then they are to be filled with the electrolyte to within 1½ inches of the cover, when the plates are immersed, for this immersion will raise the level a little. One must be certain that the plates do not touch at any point, and all is now ready for the connection, such as shown in Fig. 8.

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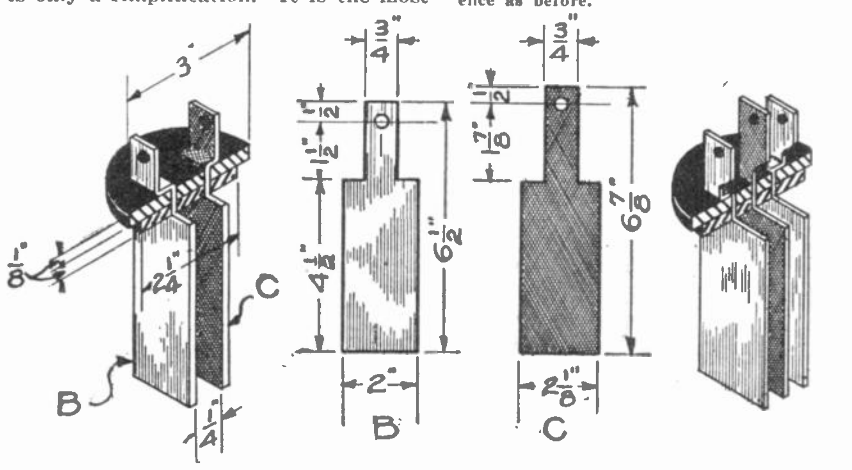


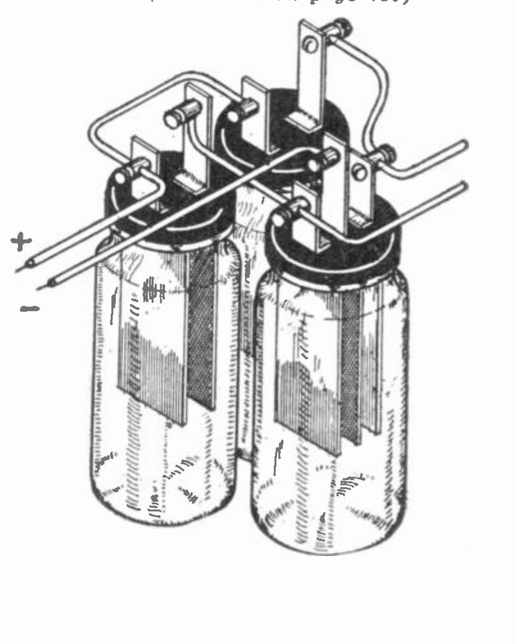


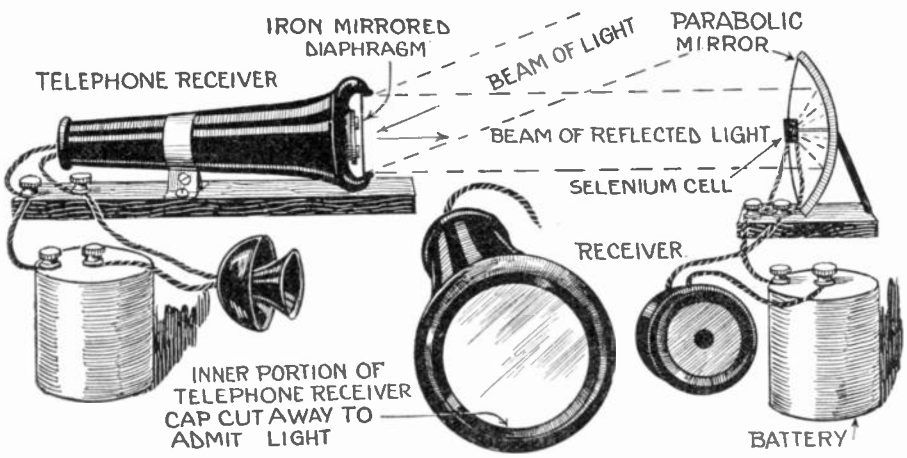
Fig. 10. Full dimensions and construction of a plate electrolytic rectifier employing the three cell connection warmly advocated by our author.

Photophone Transmitter

By H. P. Clay

A SELENIUM cell is very sensitive to rays of light, decreasing in electrical resistance in proportion to the intensity of the light. This peculiar property is utilized in the photophone, which is a device for transmitting sound over a beam of light.

This is an interesting experiment to perform, but usually beyond the resources of the average experimenter, because of the great difficulty of properly controlling the beam of light. The selenium can be obtained at any chemical supply house.



A photophone constructed with an old telephone receiver as its main part, and with a selenium cell as the characteristic and effective feature.

An old telephone receiver altered slightly will serve nicely for regulating the beam of light, enabling transmission for a considerable distance. The illustration shows clearly how this can be done.

The receiver cap is cut with a fine-toothed coping saw so that it has the form of a ring. Enough projection should be left in order that the diaphragm will be still held firmly.

The diaphragm of the receiver must reflect light exactly like a mirror. A diaphragm is made from a piece of highly polished tin, thin enough to be responsive to the pull of the magnets. The bottom piece of a cocoa can will serve the purpose and it can be polished with a small bit of mercury rubbed over it.

The receiver should now be fastened to a stand or tripod in such a way that it can be adjusted to face different directions. Connect batteries and a microphone transmitter in series with the telephone receiver, which completes the sending station with the exception of the light.

The receiving station consists of a parabolic mirror which concentrates the received light on a selenium cell held at the focus point of the mirror. An oil lamp reflector makes a good parabolic mirror. The selenium cell is connected in series with batteries and a 75-ohm receiver.

To operate the photophone it is necessary to have a beam of light shine on the receiver diaphragm and be reflected from there to the parabolic mirror. In the daytime the selenium cell must be shaded as much as possible and sunlight is reflected from the receiver to the mirror. It is best to place the receiving station in a box painted black inside, with a hole cut the size of the light beam. At night reflect the light from a strong flashlight or arc in the manner described above.

Now speak into the transmitter of the sending station and if the receiving station is not too far away, the words will be as distinct as from an ordinary telephone. The vibration of the receiver diaphragm in unison with the voice causes it to alternately become a convex and a concave mirror which consequently changes the intensity of the reflected light beam where it strikes the selenium cell.

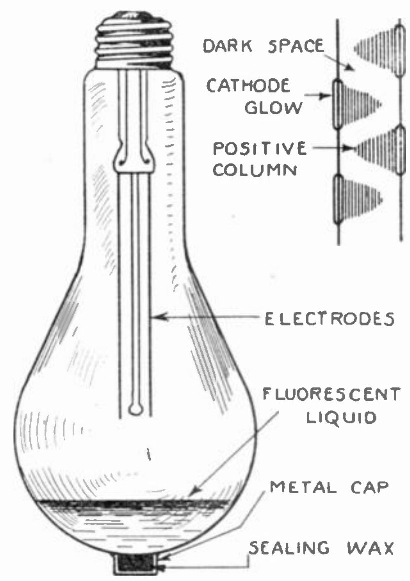
Vacuum Tube Oscilloscope

By Charles D. Savage

THE illustration shows a burned out nitrogen lamp adapted for use as an oscilloscope or Geissler tube. Used in connection with a rotating mirror, it enables one to see the alternations of an electric current, while used alone it serves as a fluorescent Geissler tube.

The tip of a gas-filled lamp is broken off and a stiff wire inserted through the opening. By means of this wire the fragments of the filament are broken off and the heavy copper connecting wires bent so that they are parallel. These form the electrodes of our vacuum tube.

The bulb is now exhausted by boiling a small quantity of fluorescin solution in it and sealing the bulb immediately after removal from the flame. For the sealing process a small metal cap filled with melted sealing wax is used. The wax is applied to the broken tip of the lamp, while still soft and sticky though not fluid, and is hardened by dipping the cap into cold water. If this operation is carried out quickly and carefully, the air in the bulb will be replaced by water vapor at low pressure.



An incandescent lamp gives beautiful Geissler tube effects with fluorescence and can be made to reproduce the wave action of the current.

The bulb requires a potential of 1,000 volts, obtained preferably from a radio power transformer. When the bulb is in operation, it displays the following appearance: Both electrodes are covered with a sharply defined shell or film of lavender light, while the space between them is filled with a bright crimson discharge. The fluorescin glows with brilliant yellow fluorescence, making the combined effect quite striking, especially in the dark.

This vacuum tube will be found useful in X-ray tube circuits, where it is desirable to detect the presence of inverse current. If the current is not purely direct, both electrodes will exhibit the blue cathode glow. This bulb adds very little resistance to the circuit and is much cheaper than the commercial vacuum tubes sold for this purpose.

In order to make the alternations of the exciting current visible, the discharge is examined through a magnifying glass held in front of the bulb; the glass is moved rapidly back and forth in a plane parallel to that of the electrodes. A succession of images will be seen having an appearance similar to that shown in the diagram. Each electrode displays in alternation the blue cathode glow, while the other electrode is quite dark.

A peculiar feature of this bulb is its remarkable sensitivity to temperature changes. The vapor pressure of water varies from .25 mm. of mercury at 40 degrees Fahrenheit to 1.4 mm. at 60 degrees Fahrenheit, while at 212 degrees Fahrenheit the pressure is of course 760 mm. This means that the resistance of the bulb increases with the temperature. An electrical thermometer could doubtless be constructed with this principle as its basis, by measuring the variations in the primary current of the transformer. A low reading ammeter should be used for this measurement in order to obtain the greatest deflection for a given current fluctuation.

Crystodyne Replaces Tubes

One of the most important developments in radio, the Crystodyne principle, was described in the September issue of RADIO NEWS. In the October issue, Mr. I. Podliasky explains how the oscillating crystal may be used as a highly sensitive detector and amplifier and gives some practical circuits which every experimenter should try.

List of Interesting Articles Appearing in the October Issue of "Radio News"

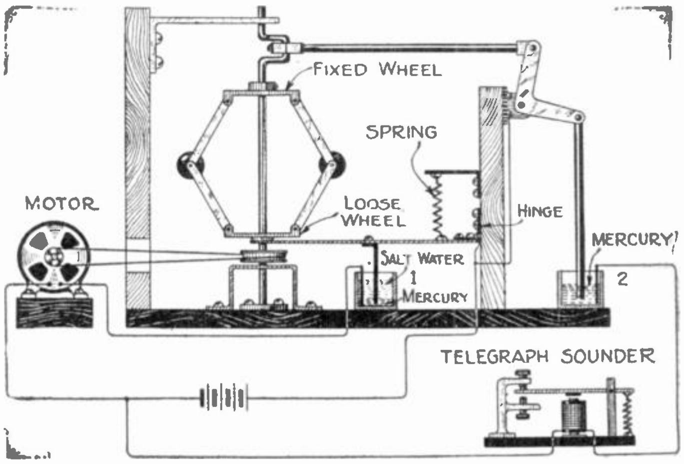
Electric Metronome

By Gordon L. Reed

THIS is a dependable and easily constructed electric metronome for the music student.

The construction is clearly shown. The governor arms can be made of erector parts as shown in the June, 1924, issue of PRACTICAL ELECTRICS, or of iron or brass parts readily found.

When the motor is started the current goes through the mercury in the mercury cup (1) from the batteries and out into the motor. When the motor picks up speed the governor arms fly outward, raising the loose bushing, and the spring carries the lever end up with it. This raises the contact wire out of the mercury so that it only is immersed in the salt water. The solution should be so strong that the motor keeps on gaining speed until the wire is about half way out of the salt water.



A very ingenious metronome driven by an electric motor with mercury and salt water contact, one for regulating the speed, the other for operating the sounder which produces the clicks.

Any rise in the governor speed increases the resistance by further decreasing the surface of the wire in contact with the solution. The motor will come to a steady speed and remain there during the whole time it is run, if the current is constant. Small motors will not keep a steady speed if run under ordinary conditions for any length of time. The crank makes a contact in the second mercury cup once for every revolution of the governor. If this is too often a separate shaft and gears will serve to decrease the number of beats per minute.

A wire is run from the battery to the contact arm and from the mercury to a telegraph sounder and back to the batteries. The salt water solutions will need to be renewed once in a while or may only require water and the loose bushing and all bearings of the governor should be kept well oiled to insure steadiness.

If a telegraph sounder with a switch is used the telegraph instrument can be placed in one room and the apparatus in another and be operated by the switch very conveniently.

Odd Advertising Device

By EDGAR B. CONES

THE attention of the public must first be attracted to a commodity before it can be sold; this is done through the medium of advertising. The best advertisement is one that is in motion. It is a well-known psychological fact that a moving object will not only

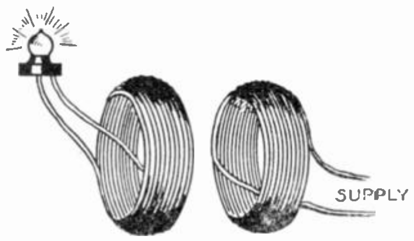


FIG. 1

A diagram illustrating the lighting of an incandescent lamp without contact with the wire leads. The principle is applied as will be seen in the other illustration.

attract attention, but the stimulus received through the eye will cause the spectator's mind to be occupied for some few seconds.

Applying this principle, it is only necessary to transfer the person's attention from the article in motion to the article being advertised. This can be done in various ways, one of which is to cause the moving object to carry the "ad" itself. The public likes to be fooled and mystification is the spice of life. If you can capture a person's mind to the extent that he will think along certain lines for several minutes the advertisement is effective, because you have impressed the conscious mind instead of the subconscious one.

In these days of hurry and scurry the average advertisement is unconsciously seen and realized. This fact, according to experts, makes the average sign one-tenth as effective to an engrossed person as to one whose mind is idle. Granting that the person of consequence has his mind on something else, the best advertisement is one which will divert his thoughts and hold them for some few minutes on the article advertised.

Imagine yourself walking down the street. You see a crowd of people in front of a window. You wonder what all the excitement is about. You look in and see two flashlight bulbs, brilliantly lighted, chasing each other around on a plate of glass.

Now wouldn't you be interested? Of course.

You admit that I've convinced you of such a machine's advertising properties; so why not build such a device? You say that you have no store and could not derive any benefit from it, but I have convinced you and you can convince others. Show me the merchant who will not pay a good price for such an article as this. There is nothing to prevent you from making this device and selling it at a handsome profit. If I can you can. I've known boys who sent themselves through college by hatching up just such schemes as this. They sell, and there is no reason why you should not capitalize on your hobby.

I will first explain the principles of operation, after which the constructional details will be taken up. Every one knows of magnetic induction and how

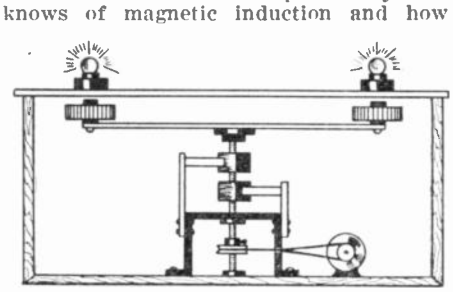


FIG. 2

Section of the apparatus which causes two lamps to circulate and move around on a glass plate in a quite mysterious manner.

alternating current can be transferred as illustrated by Fig. 1. The primary or first coil is energized electrically. This causes magnetic line of force to go out from the coil in such a manner that the conductors of the second coil are cut. This induces current in the second coil and lights the lamp.

If a soft iron core were inserted in the secondary coil and it were placed on a plate of glass, and the primary coil, into which an iron core has also been inserted, were held directly beneath the secondary coil, it would light up the bulb, the brilliancy of which would depend upon

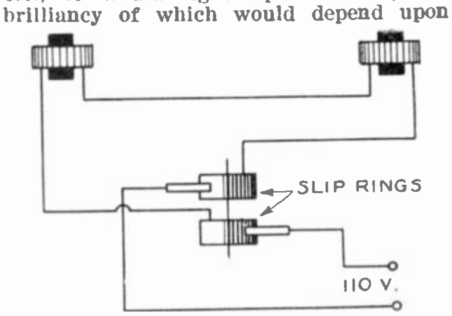


FIG. 3

The circuit showing the relation of slip rings, connections, inductance coils and their cores.

the ratio of the windings. But that is not the only purpose of the primary coil. It also acts as an electro-magnet and if moved about under the glass, will cause the coil on top to follow its every move.

Wind the two primary coils by wrapping 264 turns of No. 23 magnet wire around a soft iron core 1¼ × 1¼ inches. These two coils are to be connected in series and operated direct from the 110-volt A. C. lighting circuit. The secondary coils should be wound on a core ¾ × ¾ inch. The number of turns is left to the constructor and depends upon what size flashlight bulb he desires to use. Let it be said, however, that the secondary coil will be very small. By experimenting the builder can easily determine the number of turns that will best fit his particular need. Two flashlight sockets should be procured, and the two secondary coils affixed to their respective bases.

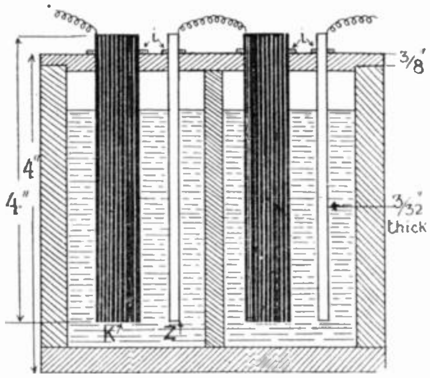
Black sealing wax is to be moulded about the coil and socket. A stiff piece of paper wrapped about the base of the socket will serve very well as a mould into which the ceiling wax can be poured. After the wax cools sufficiently, it should be ground smooth on its bottom so as to

(Continued on page 730)

Making Galvanic Batteries

By Hans Konwiczka

HOME-MADE galvanic batteries can be used for many purposes about a house for bells and telephone, and are useful where intermittent current is required. As an experiment, incandescent lamps may even be supplied for a short time, or motors can be driven. The batteries we describe here can be easily made and give a good current. We need some strips of zinc plate, some old beer glasses or tumblers,

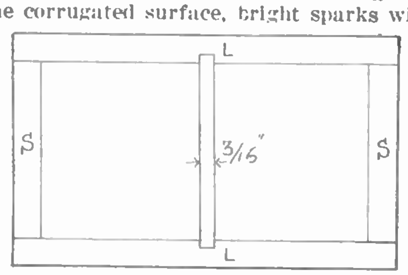


A two cell battery contained in a wooden receptacle with carbon and zinc electrodes.

and some carbons made of retort carbon, or we may use the electrodes sold for the purpose, which are preferable. Wooden containers may be used and will be described.

We will start with carbon plates, 4 inches long, 1¾ inches wide, and zinc plates of corresponding size and about 3/32 inch thick. The plates must not touch the bottom of the vessel, but must hang therein. This is arranged by a little strip of wood which will go across the top and rest on the edge of the container or battery jar, and to this the electrodes, zinc and carbon, are permanently attached by screws or other fastening, so that they will not move about if the battery is disturbed. Holes can be easily drilled in the carbon if care is taken not to split it. To this fastening a connecting wire is attached, and another to the zinc.

If we pour into the vessel, which may be of glass, porcelain, glazed earthenware, stoneware, or wood, as we shall see, a little sulphuric acid, or what is better, a chromic acid solution made for the purpose, on touching the ends of the wires to the tongue we will feel a sour, burning sensation. If one of the wires is attached to a file and the other is drawn along the corrugated surface, bright sparks will



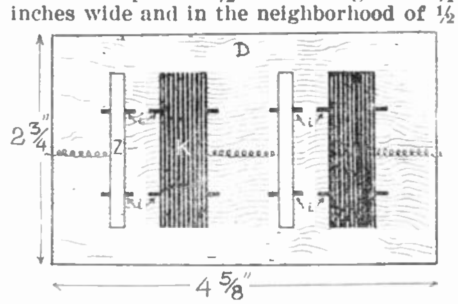
Plan view of the double container, used in the two cell battery.

appear. Our battery cell is now complete. This is only one cell; we must now make a battery.

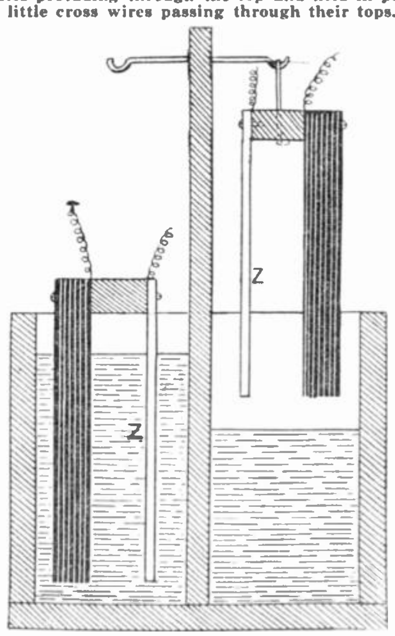
Fig. 1 shows a battery of two cells. The receptacle is made of wood approaching a half inch in thickness; it is 4⅝ inches long, 2¾ inches wide, and 4 inches high. Referring to Figs. 2 and 3, (SS) are the side pieces, (B) is the bottom, the latter is 4⅝×2¾ inches in area; the side pieces (SS) are 4⅝ inches high and 2 inches wide. The long sides (LL) are 4⅝ inches wide and of the same height. These pieces are all screwed not nailed together. Brass screws are advisable. A central cross partition 3/16 inch thick is held in grooves as shown. The whole receptacle is now heated in an oven and filled with hot melted paraffin wax and is painted over on the outside with the same. A wooden receptacle thus constructed is perfectly available for all battery cells. The melted wax is poured out while hot and fluid.

A cover, shown in Fig. 1, of the same size as the bottom is provided, made of two boards screwed together so that one fits inside and the other fits on the edge of the cell, making it what is properly called a rabat. Fig. 3 gives a view of the cover looking down on it.

Referring to these figures, (KK) are the carbon plates 4½ inches long and 1¾ inches wide and in the neighborhood of ½



Top view of the double container showing the plates protuding through the top and held in place by little cross wires passing through their tops.

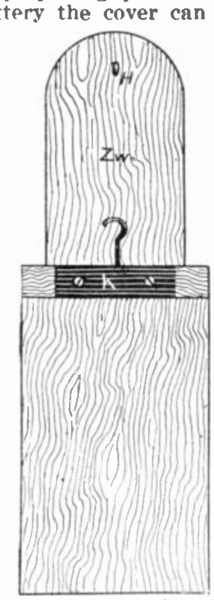


An arrangement for suspending the plates out of the acids. The central partition is extended upward and hooks are attached to the wooden separators of the plates, as shown in the next illustration.

inch in thickness. (ZZ) are the zinc plates of the same length and width as the carbon plates and 3/32 inch thick, although a thinner plate may also be used.

Each division of the container has one carbon and one zinc plate hung in it. The part of the carbon, ¾ inch of its upper end, which is not to be immersed in the solution, is saturated with hot melted paraffin. Two holes are drilled through its top to receive short pieces of wire by which the plates are suspended. They project about ½ inch, and by wire preferably insulated, the zinc and carbons are connected in series.

To prevent the zinc plate from being slowly dissolved when the battery is not in use, the battery may be emptied, or what is simpler, the cover with the two plates attached may be taken out. By attaching projecting pieces to each side of the battery the cover can be held up

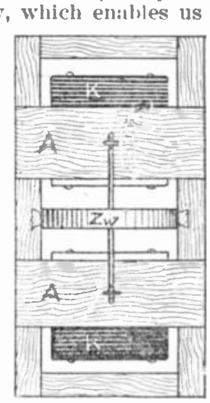


The partition carried upward so that the plates can be suspended out of the electrolytic solution.

so as to keep the plates out of the solution. It is more convenient, however, to use the disposition shown in Fig. 4, in which the partition is carried up to perhaps 4 inches above the receptacle; the cover in this case is made in two pieces. The plates are hung up as shown, on the right of the illustration, when the batteries are not in use. Fig. 5 gives the general proportions. For this arrangement the plates may be screwed to the alternate sides of wooden pieces, 3 inches long, 1 inch wide and about ½ inch thick, as shown in Fig. 4. Wire hooks or screw-eyes are screwed into the middle of the board so it can be hung up on the cross-piece. Fig. 6 shows the battery looking down upon it.

As a solution we may use either sulphuric acid or salt; great precaution is to be taken with sulphuric acid, and in diluting it, the acid must be poured slowly into the water, never the water into the acid. Do not use it until it is cool.

Fig. 7 shows a very simple and practical dip battery, which enables us to immerse



Looking down upon the battery with the extended central partition for holding the plates.

the plates to a greater or less depth in the solution. The picture practically explains itself. The glass cells, supposed to be used here, rest on a base around which there is a ledge to prevent their slipping off. A heavy bar firmly secured to the base goes through the crosspiece to the strips, and soldered. We shall call this the vibrator spring. Next insert a nail upright between the strips and solder to act as a fulcrum for the lever to swing on when the nail is held in place by the arch or standard. The strips are held together at the other end by the telegraph key knob and a small piece of hard rubber which acts as a handle.

Now going back to the vibrator spring. Solder or rivet a 3" length of rather heavy iron wire to the other end of the vibrator spring, leaving a ⅜" length of spring between the 3" piece of wire and the lever. We now shall call the length of iron wire the vibrator.

Procure a small binding post and enlarge the hole enough to accommodate the vibrator rod. To the bottom of this post solder a 1¾" length of watch spring and after taking the temper from its middle bend it as shown. Call this the dot contact spring. The binding post holds it securely upon the vibrator rod besides providing for its adjusting.

The weights, which must be placed on the vibrator, may be made from large binding posts and the required number ascertained by experimenting.

The diagram in the circle shows the vibrator stop which is made from a large binding post and a piece of stiff wire. The adjustable construction of this part will be noted.

Another stop will be noticed at the end of the lever. This is made from an ordinary stove bolt fastened securely through the base. Call it the lever stop.

Both the dot and dash contact posts are alike, being made from binding posts and nails or stiff wire. The posts permit adjusting of the contact points and the latter should be filed clean to insure good contact. It should be remembered that these two posts must be insulated from the base since the base acts as the other side of the circuit.

The neutralizing spring is nothing more than a stiff piece of clock spring inserted and clamped between the strips of which the lever consists. The use of this spring is to hold the lever and vibrator away from the dot contact so that dashes may be made. The use of the vibrator stop will be seen here. This spring must not be so strong that it produces the dash contact without aid of the hand. It must hold the lever and vibrator so that neither dot nor dash is made, or in other words, in a "neutral" position, hence its name.

The switch is merely a bent piece of brass with an insulating handle. There must also be a bent piece of brass on the dash contact post as shown.

The dot and dash contact posts are wired to an insulating binding post which connects to one wire of the plug cord. The other post should not be insulated.

The plug consists of two narrow strips of brass separated by an insulating strip and each soldered to a flexible wire extending to the posts of the "bug." The following is a description of the operation and action of the instrument.

When the handle is pushed to the right the other end of the lever strikes the lever-stop, causing the vibrator to vibrate and make a series of contacts at the dot contact post; these interruptions cause a series of dots on the telegraph line. Now when the handle is pushed to the left, the circuit is merely closed and a dash is made.

To illustrate more fully, say we were to make the character for a period which is . . — — . . . We would first push the lever to the right until the vibrator finished two vibrations or dots, then to the left twice for the two dashes, then back to the right for the remaining two dots after which the hand is removed and the lever comes to a neutral position.

$50 IN PRIZES

A special prize contest for Junior Electricians and Electrical Experimenters will be held each month. There will be three monthly prizes as follows:

First Prize	**$25.00 in gold**
Second Prize	**$15.00 in gold**
Third Prize	**$10.00 in gold**
Total	**$50.00 in gold**

This department desires particularly to publish new and original ideas on how to make things electrical, new electrical wrinkles and ideas that are of benefit to the user of electricity, be he a householder, business man, or in a factory.

There are dozens of valuable little stunts and ideas that we young men run across every month, and we mean to publish these for the benefit of all electrical experimenters.

This prize contest is open to everyone. All prizes will be paid upon publication. If two contestants submit the same idea, both will receive the same prize.

Address *Editor, Electrical Wrinkle Contest,* in care of this publication. Contest closes on the 15th of each month of issue.

Honorable Mention

Easily Made Switchboard

By Robert Rollins

Figure 1 shows the entire board. It is simply an old phonograph record of any size with the switch arm pivoted in the hole in its center, and the taps in a circle about it.

Fig. 2 shows in more detail the construction of the arm, which is but a strip from a tin can with a half-spool for a handle. The pivot is but a small bolt.

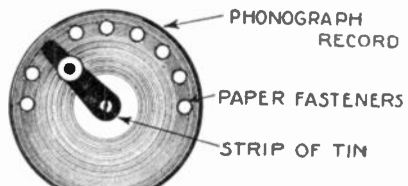


FIG. I

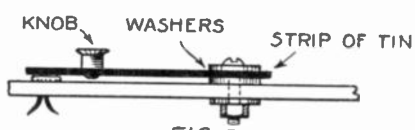


FIG. 2

FIG. 3

Very interesting example of a switchboard, whose base is an old phonograph record, and whose contact studs are paper fasteners, so that a very neat appliance is obtained from every-day articles.

Fig. 3 gives ideas for cheap and satisfactory taps. The heads are smooth and rounded and make a good contact with the arm. The connections are soldered to the ends in back; or the wire may be clipped between the prongs of the paper fasteners if these are used, and no soldering will be necessary.

The holes for the taps should be smaller than their shanks, and the taps are heated and pressed through while hot. They will fit solidly. This board is cheaply made, and will be welcome in any boy's workshop.

Automatic Electric Lantern

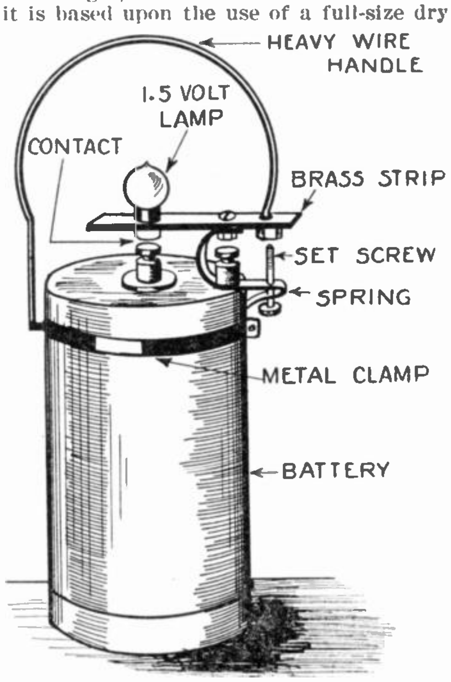
The unusual feature of the electric lantern illustrated is that it lights automatically when lifted and goes out when set down unless thumbscrew is adjusted to secure steady light in any position.

One side of the handle is soldered to a metal clamp, fastened about one inch below the top of the battery. The other end is soldered to a strip of brass one-half inch wide and 2¾ inches long. A 1.5-volt lamp is soldered into a hole drilled at the other end of the brass strip, so that the central contact on the lamp projects one-eighth inch below the strip. A piece of spring brass, one-half inch wide is bent as shown and screwed under the negative or zinc binding post; then fastened to the brass piece which carries the lamp by a small bolt and nut. Another nut is soldered to the top of the spring to take the thumbscrew as shown.

When the lantern is lifted, the strain on the handle pulls against the brass spring and forces the center of the lamp base into contact with the carbon, or positive binding post, thus lighting the lamp. As long as the lantern is carried or hung up by the handle it will remain lighted, but when put down, the spring forces the lamp out of contact with the positive binding post of the battery and the light goes out. One advantage of the automatic feature is that the lantern is not left burning when out of use, unless the thumbscrew has been tightened.

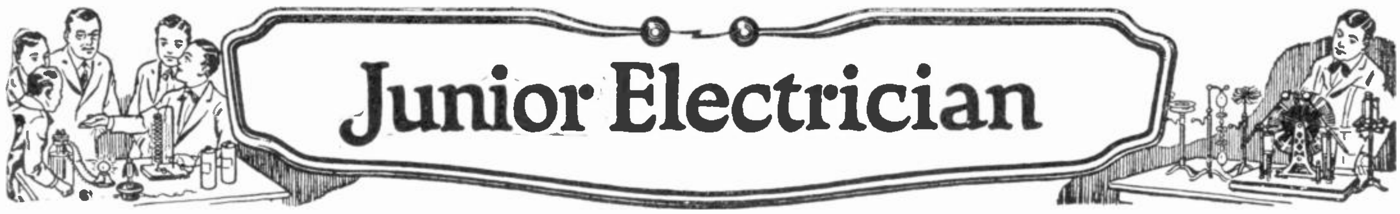
We have illustrated elsewhere a version of the well-known tip battery, which if it had a lamp would act in a similar way to this. In other words, when laid down on its side, the lamp will light, and when placed vertically the lamp will go out. It is of interest to compare the two and see how the same results can be obtained in two widely different ways.

The lamp shown below presents several advantages, not the least of which is that it is based upon the use of a full-size dry battery, and therefore will be of much greater duration than the ordinary flashlight with its almost minute cell.



A lamp which lights when lifted and which goes out when shut down. In this way there is no danger of its being left lighted, so as to exhaust the dry battery on which it is carried.

Contributed by Howard S. Babcock.

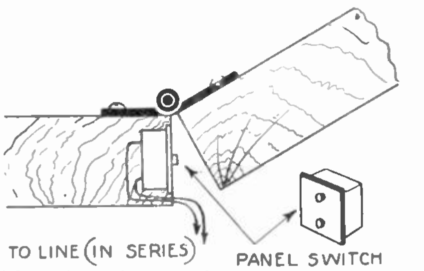


Junior Electrician

Dark Closet Light

A SMALL panel type of switch having two push buttons, one for "on" and the other for "off," makes an ideal contact maker for a lamp in a dark closet.

To make the switch suitable for open circuit work, it is necessary to remove one of the push buttons and slip the little spring and catch inside of the switch housing so that one of the push buttons always remains out; on pushing it in, the circuit opens. You can readily see how the instrument operates. When the housing is removed from this type of dashboard push button switch no trouble will be experienced in releasing and cutting off the catch which holds the one depressed into position.



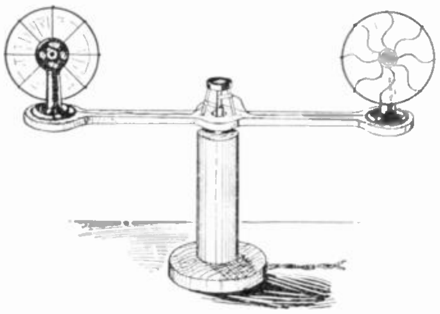
Adaptation of a two-button panel switch to turn on a light in a closet when a door is opened. On closing the door, the light is extinguished.

The switch should be mounted in the jamb of the door, so that when the door is closed the push button is shoved in, thus breaking the contact and extinguishing the lamp. When the door is opened, the button is forced out by the spring and makes contact, thus lighting the lamp in the closet.

Contributed by RAYMOND B. WAILES.

Two Small Fans Do Big Work

WHEN the air is hot and humid, not a breeze stirs, the room is large, and you are too lazy to do anything but suffer and bear it—when you only have two little fans, and the "whole darn family" wants to enjoy their refreshment—then, then is the time to gather your wits and your inventive genius together and get busy on a solution.



Two small fans are mounted on a pillar on the ends of a cross-arm so as to rotate as they operate and throw the air in all directions.

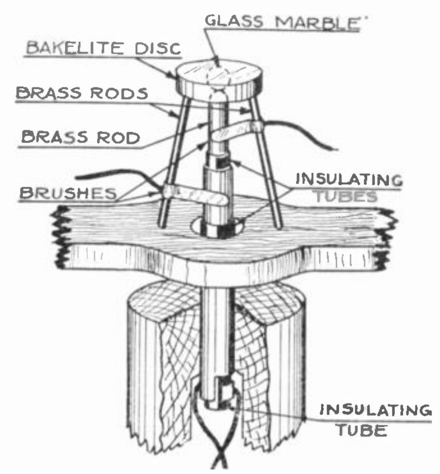
Little fans, bought at a low price, do not oscillate, and their entire breeze goes in one narrow beam in one direction. Those not in that particular direction are the unfortunates. But arrange them so that source of the breeze is in continuous rotation and you have the room full of cooling, moving air.

The illustrations show one arrangement which is extremely effective, and at the same time easy to construct. Here we use two little five-dollar fans, some pieces of wood and some odds and ends of brass, insulating material, and bakelite.

A stand is first built—either plain or ornamental, as your ability and taste dictate. The base must be large enough and heavy enough to keep it from toppling over under the weight and the rotary movement of the fans.

The two arms and the center piece may be either built up or sawed with a band saw from one heavy piece of wood. The discs on the arms should be just large enough to fit the bases of the fans. The hole in the center should be about an inch in diameter.

Next comes the bearing and the electrical contact makers, or slip-rings, which are the most important parts of the structure, and should receive the most attention. The bearing proper consists of a solid brass rod with one end rounded off. Over this, extending to about two inches from the round end, slip on an insulating tube or several layers of empire cloth. Then over this slip a brass tube, which should fit tightly, and extend to within a quarter of an inch of the edge of the insulating tube. Another insulated tube, above this, completes the bearing and provides contacts, or slip-rings.



Details of the support of the fan and of the slip-ring connections for supplying them with current. The fans are their own motors.

The disc that rests on the rounded end of this rod is of heavy bakelite, or some other good insulating substance. In the center of the disc a hole is drilled part of the way through, into which a glass marble is tightly inserted. Two round brass rods are threaded and tapped into the disc at opposite sides, and their lower ends serve to support the disc from the wood center piece. The correct length for these rods can be determined by calculation or experiment. They should be long enough to cause the center of gravity of the arms and fans to be sufficiently low to allow their rotation to be steady.

Two brushes of spring brass should now be attached, one to each of the upright rods, so that one comes in contact with the bearing rod and the other in contact with the outer brass tube.

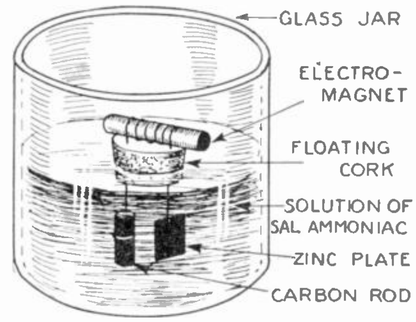
The fans should be pointed in opposite directions, so that when they are in motion the current of air in their wake will tend to force them around.

Contributed by K. MALCOLM.

Floating Electromagnet

AS shown in the diagram, the floating electromagnet is composed of an electromagnet attached to a cork floating on a solution of salammoniac, with its ends attached to a carbon rod and a zinc plate.

The carbon rod, zinc plate and solution of salammoniac form the battery and supply the current. This can be used as a compass as the electromagnet points north and south. Other experiments as that of making it follow an iron bar may be performed.



An interesting old experiment illustrating the action of the magnet and the theoretical ampere currents.

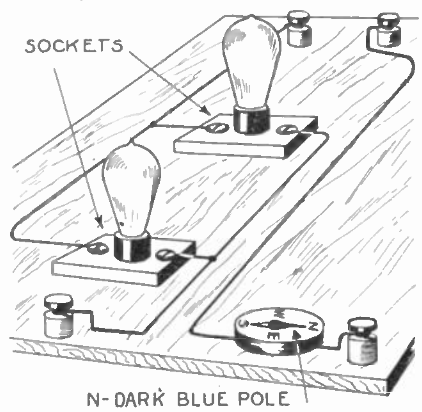
Contributed by ARTHUR A. BLUMENFELD.

Simple Battery Charger

By RAYMOND B. WAILES

HERE is a little battery charger which is intended for use with 110 volts direct current, house lighting circuits, although farm plants employing the 32-volt system can also be used as a source of current.

Two lamps connected in parallel are in series with the line and the load, or with the house socket and the battery. One of the output wires, which are those leading to the battery to be charged, passes under and parallel with the needle of a small pocket compass. A cheap toy compass will serve here just as well as a more expensive and jewelled one.



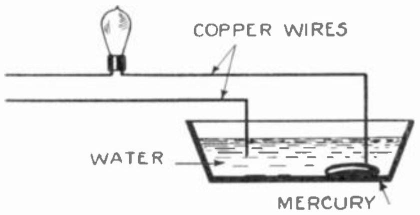
A simple connection for charging a storage battery in which the compass is used to give the polarity to avoid making a wrong connection.

You cannot, with this charger, connect the battery to the lines backward and reverse the formation of the plates, for the compass instantly tells you to which side of the output terminals to connect the positive of the battery.

As connected, according to the diagram, when the two bottom binding posts are connected with each other with a short piece of wire (this operation is not dangerous for no heavy short circuit takes place due to the lamps in the circuit), the compass needle will swing and point to the *positive* terminal. In other words it will swing either right or left. The binding post to which the black end of the compass, or north end, swings, is the positive and the positive terminal of the battery should be connected to this. Of course, the negative terminal of the storage battery to be charged goes to the other terminal.

A lamp cord and socket can be used in place of the top binding posts.

Active Mercury



A globule of mercury is made a terminal for an electric current through an electrolyte. Surface tension brings it into motion.

I HAD poured water in a saucer for the purpose of trying the effect of electric current upon it.

I used the current of the lighting line, the usual electric lamp being inserted in the circuit so as to prevent the fuses from blowing out in case I should accidentally make a short circuit.

The effect being very small, I tried to pour some mercury in the water, so as to make a much larger contact surface between the water and one of the wires bringing the current. To my extreme surprise, as soon as the "juice" was put on, I saw the mercury move, lengthen, then broaden, or crawl like a kind of earthworm.

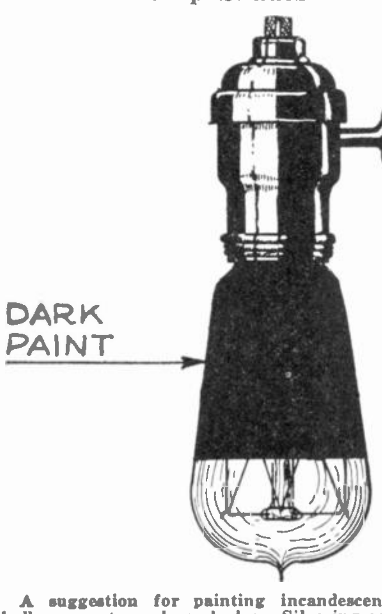
There seemed to be a sort of current in the mercury itself as well as in the water, and the experience is very curious and striking.

The illustration gives fuller explanations about this very simple but very queer experience.

The surface tension of the mercury is constantly changing as more or less current passes, and this causes its peculiar activity.

Contributed by ROBERT G. J. DESME.

Lamp Shades



A suggestion for painting incandescent lamp bulbs so as to replace shades. Silvering will give a reflector.

INSTEAD of buying shades for your lights it is cheaper to paint shades on them. Any dark paint will do. A thin coat of black auto paint will stand the heat and remain opaque. The coat should be as thin as possible and cover as much of the globe as desired. This is merely a suggestion, and the idea can be twisted into a dozen different applications.

Paint the lower half of the globe with white paint, to throw the light up, or else paint one side of the globe. You can make the coat of paint thin to dim and not obscure the light. You can paint the entire globe, leaving open places that will cast designs on the wall when the light is lit.

White paint, reflecting the light inside, will, of course, be more efficient, but it is difficult to get a coat of white paint that will be thin enough to stand the heat and yet be sufficiently opaque. It would be interesting to silver-plate the bulb so as to get a good reflecting effect.

Contributed by ROBERT ROLLINS.

Gravitation Relay

By ROY C. HUNTER

THERE is illustrated here a relay which possesses several advantages over most of such instruments.

When it is used in a circuit as a permanent circuit closer current is consumed only for a fraction of a second, and the relay may be reset and the circuit opened by simply pushing the button again. The construction is simple and the action certain. It can be used in any place where an ordinary relay can be used. One push-button closes and opens the circuit by alternate pushes.

The wooden base (A) is 3½ inches by 5 inches in size and can be finished as desired. On a brass pillar (B) the armature (C) is mounted, pivoted at its center. This armature is an iron bar ¼ inch thick by ⅜ inch wide, and 3 inches long. It is balanced so as to be in what is called unstable equilibrium, and should move easily.

The pieces (E) and (D) are a hammer taken off a large electric bell. They are 3 inches long, fixed in the center of the armature so as to always turn to right or left, never being vertical.

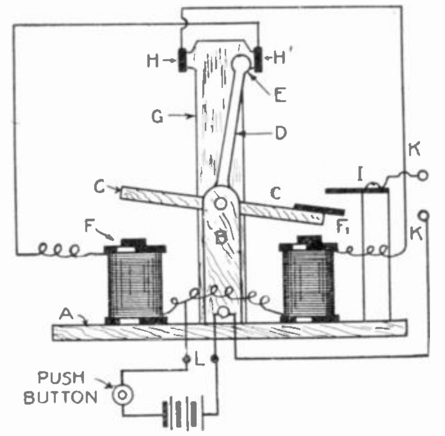
The electromagnets (F) and (F^1) are the kind commonly used in telegraph instruments and the larger type of bells. They should be of the same size. The gap between them and the armature when held parallel with the base should not be over three-sixteenths inch.

The wooden pillar (G) is ¾ inch wide by ½ inch thick and slightly higher than (E). It is screwed to the base just slightly back of (B). (H) and (H^1) are brass strips 1¾ inches by ½ inch, bent at right angles and screwed to (G). When the armature (C) is tipped it will cause (C) to touch either (H) or (H^1). A wire of the circuit is soldered to each.

The spring contact (I) is fixed to (J), which may be made of wood. When the armature is tipped so that (E) will touch (H) it will make contact with (I). The whole apparatus is connected up as shown. The batteries and push-button can be located any place and are connected to binding posts (L).

The action of the relay is as follows, where the relay is to be used as a continuous ringing attachment for a bell, such as a burglar alarm: The push-button for ringing the bell is the one already referred to. The binding posts (K) are connected to a bell and battery and (E) is moved so as to rest on (H). When (E) is moved to either side it overbalances the armature and it will stay in that position until moved by the electromagnets.

When the push-button is pressed current flows through (B) to (E) and (H^1) to electromagnet (F), then back to the battery. This causes electromagnet (F) to pull (C) down on that end and up on the other, which closes the circuit through the bell, and it will ring until the push-button is again pressed, which resets it. The push-button should be pressed for only a short time, or the relay will not work properly.



A relay held in open or closed position by gravitation. One touch of a button reverses its position, so that it can be controlled for a permanent or long-time connection from a distance.

Compensated Ammeter

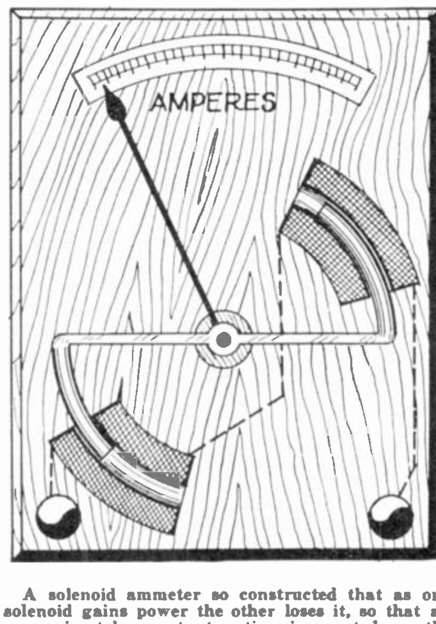
THE solenoid type of ammeter, while forming one of the simplest means of measuring either direct or alternating currents, suffers from the drawback that its readings are not proportional to the current.

This, of course, is due to the peculiar action of a solenoid, which exerts upon its plunger, not a constant attraction, but a force which increases up to a certain point and then begins to diminish.

In the instrument here illustrated, this effect is compensated for by the use of two solenoids, both tending to turn the pointer in the same direction but having their plungers in different positions.

In one, the plunger is just entering the coil and hence will be attracted with increasing force. In the other, the plunger has passed the center of the coil and will be attracted with decreasing force. The net result is a nearly uniform motion of the pointer at different loads.

Contributed by CHARLES D. SAVAGE.

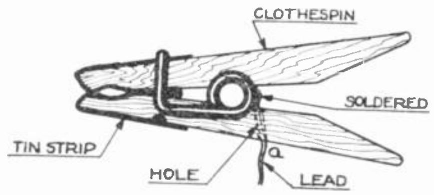


A solenoid ammeter so constructed that as one solenoid gains power the other loses it, so that an approximately constant action is exerted on the indicator.

Handy Clip

HERE is a little device that all electrical "bugs" will appreciate. It is a simple clip made from a spring clothespin and a bit of a tin can. When a circuit is made and broken frequently in the course of a single experiment such a clip as this one will be found highly desirable and efficient. It will provide a contact on the posts of cells, on metal plates, on other wires, any place, in fact, where a good electrical contact is desired.

The strip of tin should be about six or eight inches long and a half of an inch wide. Lift one end of the spring wire that is part of the pin and put one end of the strip under it. This will hold firmly, and the joint can be soldered if desired. Bend the tin strip around the jaws as shown, and fasten the other end like the first. A few small brads will make the strip more secure, but are not necessary.



A common spring clothespin is arranged to act as a quick connection for batteries and motors and other appliances which have to be thrown in and out of circuit repeatedly.

Through a small hole (A) bored in one of the wooden members run the bare end of a piece of insulated wire. Solder this end to the spring, and the handy clip is finished. This arrangement of the lead through a hole lessens the strain on the soldered joint that might otherwise be twisted apart. After the pin has been opened and closed several times the tin will usually break at the sharp bend. But this does not injure it any, and the tin strip can be put on in two pieces if that seems easier.

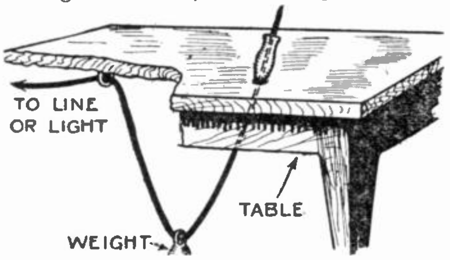
It is, perhaps, needless to remind the "bug" that the jaws must be kept clean so the connection will be a good one. Brass or copper would be better than tin, especially as far as looks are concerned.

Contributed by ROBERT ROLLINS.

Disposing of Test Leads

THE test leads to be found on the benches in every electric shop are very unsightly, besides being in the way of other work half the time.

Keep them clear of the bench top by making them of good lamp cord and running them under the test bench and through two holes, with a weight attached as shown, to keep them pulled under the bench when not in use.



A flexible core used for testing terminals in the laboratory is kept out of the way by being led down through the top of the bench and being weighted to keep it drawn down.

The weights should be only enough to just pull them through the hole, otherwise they may be bothersome while using the leads.

By using a pulley to carry the weight the cord will be more easily drawn upon as it is required.

Contributed by H. W. RISSI.

Improved Transformer

By MAYER RABINOWITZ

THE following describes an improvement on the transformer published on page 119 in January PRACTICAL ELECTRICS.

The mysteries of inductances and resistances can never be completely revealed. As Robert Burns said, "The best laid schemes o' mice and men, gang aft a-gley."

During actual use the transformer (page 119, January issue) overheated immediately which showed lack of sufficient impedance to reduce the current. The remedy for this heating would be a larger core and more windings, and after further experimentation, I have perfected the transformer so as to give the high efficiency. The transformer is now slightly different from the one described in the article. For low voltage the secondary windings (size of wire) were too small to carry the heavy currents in the first transformer.

Disappearing Searchlights Defend Us

The effectiveness of our country's defence depends upon its eyes. Its eyes are electrical. In SCIENCE AND INVENTION for October, the newest disappearing searchlights recently perfected for the coast defence are fully described. One man handles this huge machine which directs the artillery.

In the same issue there will be found descriptions of:

An Electric Winch for Small Boats

A Description of an Electric Surfacer

Lie Detector

The Ladder of Vibrations

Photographic Stunts

And a number of other articles on interesting subjects clearly and interestingly described.

In the new transformer the iron wire core should contain about one and one half pounds of soft annealed iron wire wound on the same form as described. The larger the cross-section of the core the better. The primary winding (size wire) is in accordance to the amount of current desired from the secondary. I have found that No. 24 D. C. C. or No. 22 D. C. C. wire will give the desired results. The former will safely carry .3 ampere at 110 volts which equals approximately 36 watts. Therefore, the secondary windings will have to carry about seven amperes at five volts, 3.6 amperes at ten volts, 2⅓ amperes at fifteen volts, and so on. The amperage is found by dividing the watts by the volts, i. e.,

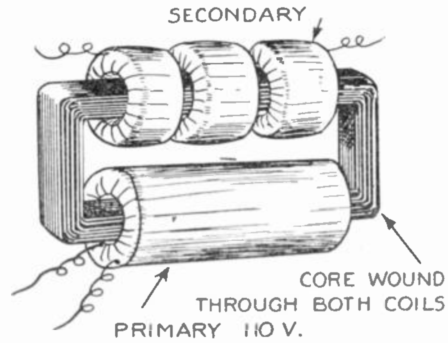
$$\text{Amp.} = \frac{\text{Watts}}{\text{Volts}}$$

The primary winding should contain about 1,000 turns for greatest efficiency. The number of turns for the secondary winding should be worked out using the formula given in the January issue (page 119), but as the primary winding is doubled multiply the answer by two.

Great care should be taken not to counteract the magnetic fields or the results will be nil (see diagrams in January issue and read instructions carefully). If the primary field is counteracted, the transformer will produce a loud hum and a piece of iron or steel held an inch away from it will be instantly attracted. Also the coils will heat up immediately. If the connections are correct the transformer will be almost noiseless in operation and the coils will not heat up perceptibly. If there are not sufficient turns in the primary winding for the core of the size you are using, the transformer will emit a low hum. Wind more wire on until the hum is reduced so it can be faintly heard when the ear is laid against the coils.

For a step-up transformer the primary windings should be the same. The secondary depends on the voltage desired.

If high voltage is needed for sparks, take a few coils out of old spark coils and connect them in series. The primary should then be put on only one end of the core.



An interesting illustration of a transformer. The article gives full description and some calculations.

The iron wire of the core will have to be wound through the coils as the latter contains so many turns it would be almost impossible to wind it around the core.

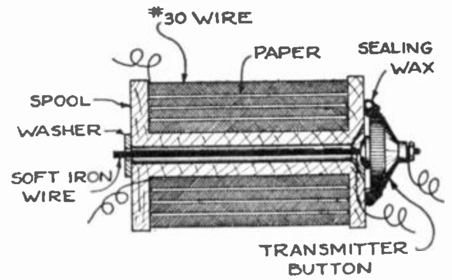
The ends should be brought out (very well insulated) about four inches apart. With three coils as illustrated the transformer should give a spark anywhere from one and one-half inches to two inches between needle points.

Electromagnetic Relay

A RELAY utilizing the plunger action of a solenoid to affect the resistance of a Skinderviken transmitter button is very easy to make.

A wooden or paper spool about two inches long and an inch in diameter is wound with No. 30 wire, with a layer of paper between every two layers of wire. The center of one end of the spool is countersunk to admit the diaphragm electrode of the transmitter button, to which is soldered a soft iron wire or nail. The transmitter button is fastened to the spool with sealing wax. A fiber washer is fastened to the other end of the spool, with small tacks, or with shellac to center the soft iron wire.

The flux caused by the passage of a current through the solenoid will tend to draw the soft iron wire further into the spool and thus actuate the transmitter button. The pressure on the diaphragm electrode will vary directly as the current varies in the solenoid. This variation of pressure will cause the resistance to vary and with it the strength of the relay current passing through the button. The construction of the relay is shown in diagram here.



The Skinderviken button is used in front of a solenoid so as to have its conductivity affected by the movement of the armature, giving an actuating current through a telephone.

Contributed by CLIFFORD C. SORENSEN

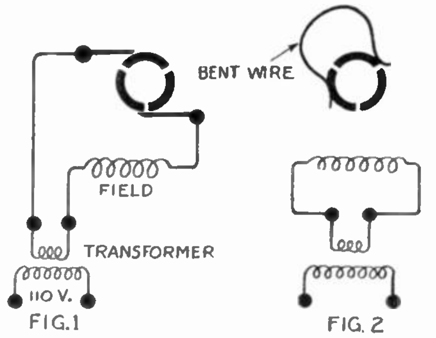
Demonstrations of A. C. Motors

By Constantine Troy

As an aid in the study of A. C. motor design and theory a small toy direct current motor may be utilized to demonstrate the fundamental principles.

To obtain a suitable current for operation of the motor from a 110-volt supply a transformer or lamp bank may be used.

With the motor in shape to operate as a direct current series motor it may be run as an alternating current series mo-

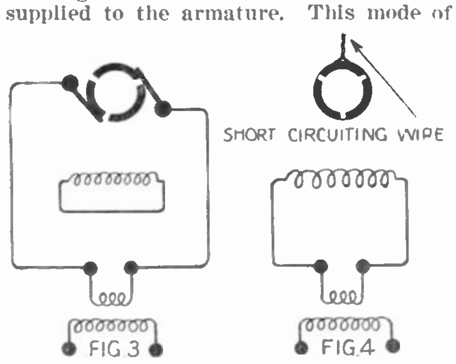


Using a toy motor to demonstrate the action of the A. C. motor. The connections above disclose two of the experiments.

tor. Connect it to the secondary of the step-down transformer or in series with a suitable lamp bank, see Fig. 1. By reversing the current in the armature the direction of rotation will reverse. To reverse the armature current transpose the wires to the brushes.

Fig. 2 illustrates the connections necessary to produce the repulsion motor. In this type only the field coils receive current while the brushes are connected together and shifted to a new position. However, this is probably not practicable on the small motor, so the regular brushes may be removed and a wire, bent as shown in Fig. 2, may be used to connect opposite sides of the commutator. It may be held in position by hand and shifted to obtain the best results.

Fig. 3 shows the inverted repulsion motor, so called from the fact that the field winding is short-circuited and current is supplied to the armature. This mode of



Two more experiments with the toy motor, illustrating among other things the squirrel cage armature.

operation necessitates shifting of brushes also. If the regular brushes may be shifted, connect them as shown; if not, the wires to the commutator may be utilized as brushes and shifted to obtain the best operation by trial, the regular brushes being removed.

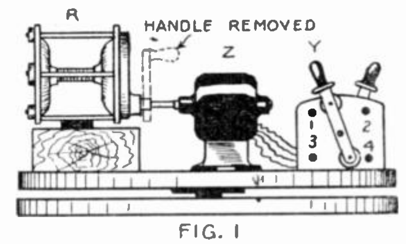
A single-phase induction motor is shown in Fig. 4. In this type the field alone receives current. No connection is made to the armature or rotor, whose winding comprises short-circuited coils or bars. A bare copper wire is wrapped around the commutator, connecting all the segments, and the regular brushes are removed. This is not a self-starting motor, in its simple form as given here, so it must be started by twirling the armature with the fingers in the desired direction. In commercial motors simple modifications are used to make the motor self-starting.

Toy Crane

By Jack Bront

The crane illustrated and described herewith combines electrical operation of the hoist winch and the magnetic "grappler," or lifting magnet.

The entire unit may be constructed of a toy motor, two single-pole switch blades, one fisherman's reel, two cylindrical drums (wood), pivot for the latter, five small pulleys, one small solenoid, one length of flexible wire (picture wire will serve),



Multiple fishing reel, actuated by a toy motor, acts as the windlass of an electric crane.

one length of flexible insulated wire, and a quantity of square bus bar wire, or steel of same approximate size and shape.

Primarily, the construction of the crane boom may be started. Following the design illustrated, it will be found that the bus bar wire can be very easily soldered after cutting to desired dimensions. (The size of the unit being a matter of personal desires—no dimensions are given.)

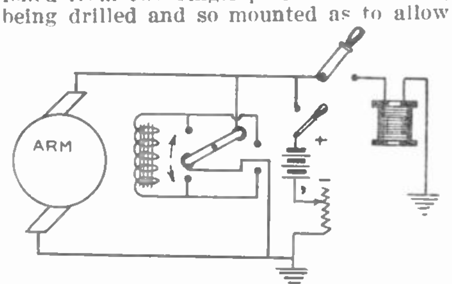
The base of the boom should be firmly attached to the top baseboard, which is mounted on a pivot and revolves over the lower baseboard. Various materials may be salvaged for construction of the pivot.

Four small pulleys are mounted on the boom at the points illustrated. The flexible boom cable (picture wire) connects to one side of the solenoid—and making contact through the pulley (B)—from which one side of the circuit traverses the structure of the boom, and leading out at (D).

The other side of the solenoid winding is connected to a flexible insulated wire which runs over pulleys (C) and (K), and leading down to (S). A counterweight sufficient to keep the flexible wire taut, is suspended from (S). Above, after leading through (S), the flexible wire terminates on a small insulating block between (F) and (K).

The cable of the boom leads down over (F) to the drum (R), which is connected to the motor as shown in Fig. 1.

In the latter illustration is shown the drum itself, mounted on a small block and securely fastened. The motor is immediately to the right, beside which is the control board. The control levers are fashioned from two single pole switch blades, being drilled and so mounted as to allow



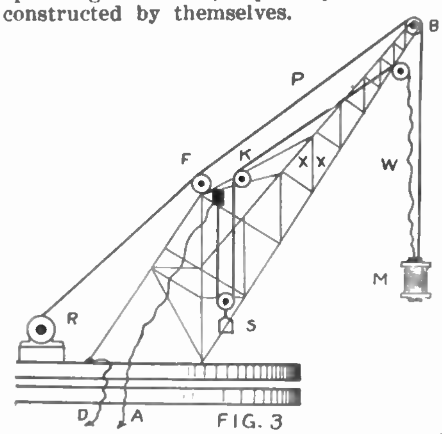
Details of the wiring and connections of the toy electric crane. It is complete as it has its own battery.

the operations indicated by the drawing (Fig. 2).

Lever (Y) controls the polarity of the motor field and thereby the direction of rotation of the armature. Lever (V) serves to release the load on the lifting magnet, at the end of the boom cable, by cutting off the magnetizing current. Both levers are mounted on insulating panels firmly secured to the upper (revolving) baseboard. The batteries are mounted on the base.

The boom of this toy may be swung in any direction by revolution of the upper baseboard. It may be desirable to insert a small rheostat in series with either the battery, with the motor armature, or both.

Mechanically inclined lads will enjoy operating this unit, especially if wholly constructed by themselves.



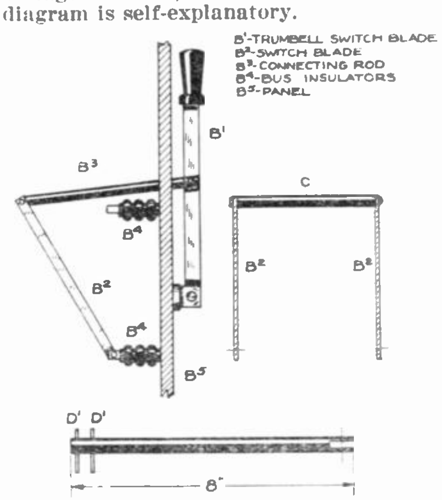
Elevation of the crane, showing the truss work and the connection for the lifting magnet which it employs in strict character with its type.

High Voltage Safety Switch

By Carl J. Wirth

The switch shown in the drawing was made by the writer. It can be used in a number of cases dealing with high voltage. By getting a D. P. D. T. switch with the blades set at an angle it will make a good antenna grounding switch, by using the wall as a panel and running the connecting rod (B^3) through the wall and having the D. P. D. T. outside.

The writer used this switch to handle voltages from 3,000 to 23,500 volts. The diagram is self-explanatory.



A safety switch which has been used on a 23,500-volt connection.

(C) is a fibre bar which has been sawed off, so it will just fit in between the switch blades. A bolt is put through the blades and fibre, and it must be able to turn upon the bolt. The connecting rod (B^3) is of fibre and can be made laminated out of three pieces. (D') are cotter pins, but the rod can be made with a shoulder and only one pin used. A switch jaw could be placed on the face of the panel, so it would catch (B^1). A hole could be drilled through the switch jaw and (B^1) and a lock put there.

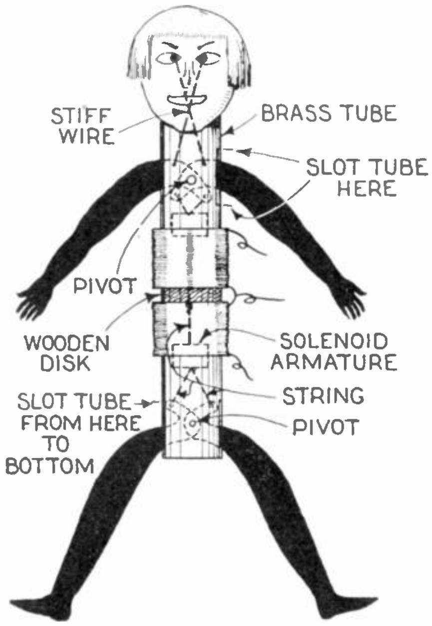
This switch can be opened and closed with wet hands, when it is carrying high voltage, without any danger.

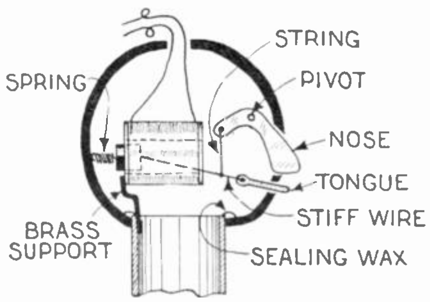
IN this department are published various tricks that can be performed by means of the electrical current. Such tricks may be used for entertaining, for window displays, or for any other purpose. This department will pay monthly a first prize of $3.00 for the best electrical trick, and the Editor invites manuscripts from contributors.

To win the first prize, the trick must necessarily be new and original. All other Elec-Tricks published are paid for at regular space rates.

An Interesting Toy

By Leon L. Adelman





An ingenious automatically worked doll, whose eyes, nose, arms and legs are all made to move by electricity at the will of the manipulator.

AN electrical toy that will bring endless joy to the kiddies can readily be constructed out of a few odds and ends generally found lying about.

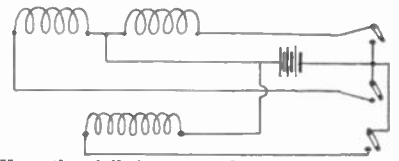
A brass or fiber tube about one inch in diameter and five inches long will do nicely. It should be slotted at one end for a depth of one inch by means of a hacksaw, which is to permit the legs to move. Two separate windings of No. 28 S. C. C. wire are wound on, a quarter of an inch apart. These consist of 200 turns each. A circular wooden disk is driven into the middle of the tube between these windings, and from one side is suspended a soft iron armature three-quarters inch in diameter and one-half inch long sawed off from a bolt. At the other end of the tube another slot one and one-half inches long is made, through which the arms protrude. Both the feet and arms are of tin or aluminum.

The head of the doll should preferably be a large one taken from an old doll. It is fastened to the tube by means of sealing wax. Before fastening, a small solenoid is placed inside in a horizontal position, which operates the amusing, grotesque and unassuming eyes, nose and tongue. This solenoid is made one and one-half inches long, wound with 100 turns of No. 28 S. C. C. wire; it has an iron armature one-half inch in diameter and three-quarters of an inch long. A small spring is fastened to the back of the head and the other end is attached to the solenoid armature. A stiff wire to which is soldered a flat piece of tin which acts as the tongue is fastened to the plunger. Where the nose ordinarily would be, a piece of tin is pivoted horizontally and connected to the tongue by means of a short piece of string.

The feet and arms are cut as shown and pivoted by inserting a small nail through holes drilled through tube and through their crossing place. They are controlled independently by small push buttons mounted on the base of the toy. Thus, while the arms are up, the feet can be down and vice versa. The tongue and nose also are controlled by a separate push button and with a little care and patience one will soon become adept at having the doll perform the most curious antics.

Two pieces of stiff wire which are soldered to the arms and which have a small disk of tin soldered to the other end operate as the eyes so as to evolve a severe case of strabismus when the child presses the button. The eyes are painted blue, the nose black, the tongue red, and for the best effects the remainder is painted in gaudy colors. Light doll clothing should be put on and if care is taken in the construction a very realistically created automaton is the inevitable result.

Three or four dry cells connected in series are very effective in operating the device, although a storage battery can be used. If one so desires, the doll can be suspended by small wires attached to its head, which wires carry the current to operate the solenoids.



How the doll is mounted. Beneath is shown a diagram of the circuit with the three switches for controlling each movement.

Columbus' Egg

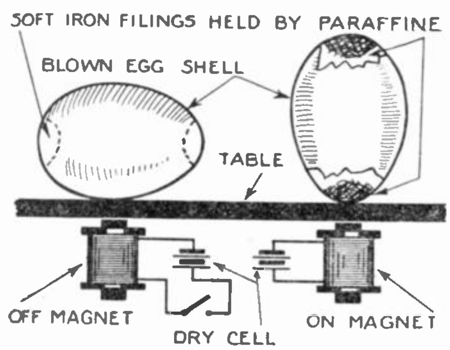
By Arthur A. Blumenfeld

A MODERN version of the famous Columbus' egg is illustrated here. The contents of an eggshell are extracted and a quantity of iron filings put into it, along with some chopped-up wax from a paraffin candle.

This is all shaken down to one end of the egg and the paraffin is melted by a candle flame, or even a match flame held beneath it, care being taken to have the egg truly vertical as regards its long axis. This fixes the iron filings in position.

If set upright the egg may now be capable of remaining balanced, but this is not desired, so a corresponding amount of iron filings mixed with paraffin are secured at the other end of the long axis of the egg. Now it is impossible to balance the egg on an end, and the magician may let his audience attempt the trick ad libitum.

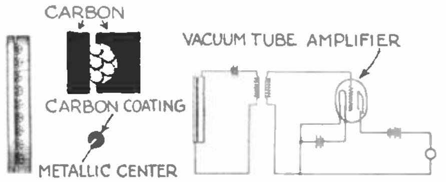
When the magician places the egg on the table, however, it holds its position as did the egg of Columbus. The secret lies in a magnet concealed beneath the table. The egg is placed over the magnet as shown, the switch is secretly closed, and the egg will retain its vertical position as did the renowned one of the discoverer of America.



A mysterious egg, which is caused to stand erect by magnetic attraction, a reminder of Columbus and his critics.

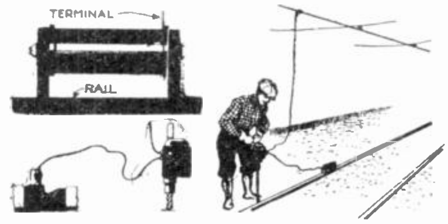
Latest Electrical Patents

Microphone



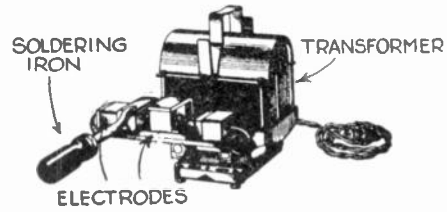
An improved microphone that responds to frequencies within the human speech range but is practically immune to mechanical shocks and low vibrations is the subject of this patent. The selectivity is effected by using metal balls coated with carbon instead of the usual carbon granules. The balls have a higher specific gravity than carbon to which is due the action.
Patent 1,498,597, issued to Ezchiel Weintraub.

Magnetic Connector



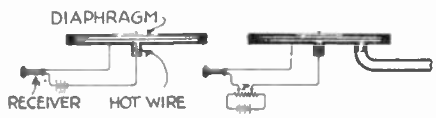
The illustration shows an electrical connector especially adapted for railway work in which no bolts or clamping devices are required. An electromagnet, whose iron core forms one connection, is placed on the rail and the current passing through it tends to maintain a tight contact between the rail and the connector by magnetic attraction.
Patent 1,498,951, issued to Charles B. Coates.

Electric Heater



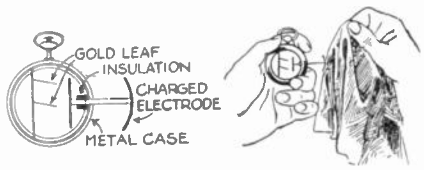
The illustration shows a simple portable electric heater for heating tools, such as soldering irons. It is so constructed that current is used only while the iron is being heated. It consists of a step-down transformer giving a very heavy current at low voltage. The secondary is connected to two electrodes, which are shorted by the soldering iron; the current passing through the iron generates the heat.
Patent 1,502,932, issued to Wilbur L. Young.

Telephone Transmitter



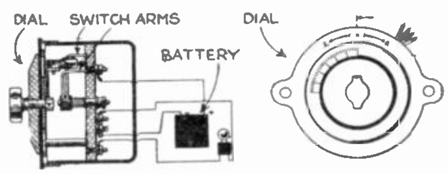
This sensitive telephone transmitter is of the thermionic type. A fine platinum or Wollaston wire, connected in series with a battery and telephone receiver, is acted upon by the sound waves in such a way that its temperature and consequently resistance changes in accordance with the sound impulses. As a further means of cooling, air may be forced through as shown in one of the illustrations.
Patent 1,492,919, issued to Miller R. Hutchinson.

Electroscopic Silk Tester



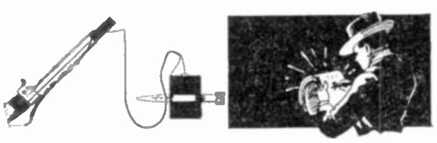
Pure silk or wool is virtually a perfect insulator whereas silk mixed with artificial fibers, cotton, or substances used in the preparation of the dressing are to some extent conductors of electricity. By means of a charged electroscope the genuineness of the silk can be determined by the time required for the electroscope to discharge through the silk. The illustration shows a compact electroscope for this purpose.
Patent 1,502,330, issued to Archiero Bernini.

Switch Lock



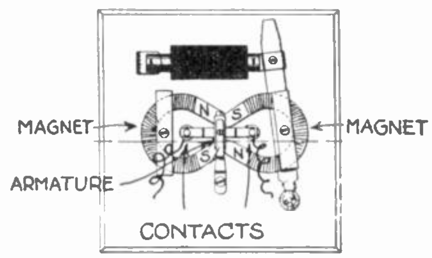
This combination switch lock resembles the ordinary safe lock. A dial is used to shift the three contact arms to the points that close the circuit. The dial is turned in one direction and shifts the long arm, which carries the shorter one, to the desired point, then turned in the opposite direction until the long arm carries the other short one to the desired point, and then shifted back until the long arm is on the correct point, and the circuit is closed.
Patent 1,500,497, issued to Edward Zerman.

Luminous Writing Attachment



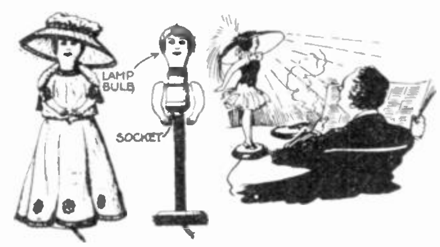
This attachment consists of a frame carrying a small flashlight bulb which may be placed on any pen or pencil. By means of a flexible connecting cord the cell which supplies the lamp may be carried on the wrist, in the pocket, or it may be placed directly on the end of pen or pencil.
Patent 1,498,643, issued to Aloysius J. Cawley.

Magnetic Switch



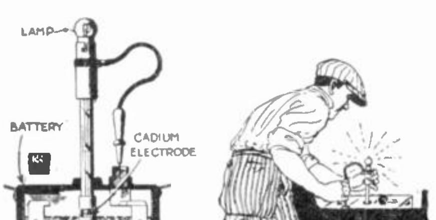
A novel switch whereby a slow motion causes a quick closing of the contacts. When the poles of the two magnets are brought together as shown, the attraction of the armature is slight and the contacts are open. When one magnet is slowly moved away from the other, the stationary magnet attracts the armature, which snaps down quickly and closes the circuit.
Patent 1,493,275, issued to Eugene Pons.

Doll



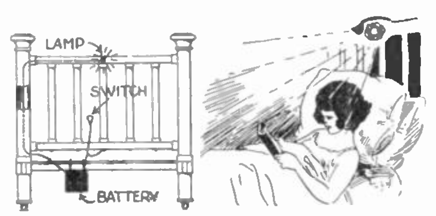
This combination doll and table lamp makes a very attractive ornament. The lamp is supported on a stand and has a bulb of suitable shape to serve as the doll's head. The face is painted on the bulb.
Patent 1,501,777, issued to Helen E. Hollingsworth.

Storage Battery Tester



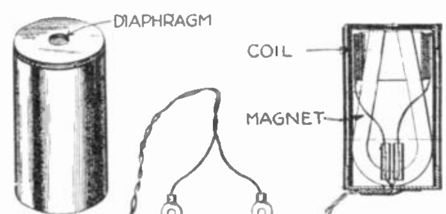
Practically all tests required on a storage battery can be made with this simple tester. It consists of a cadmium electrode, which may be inserted into the electrolyte, a lamp for indicating the condition of the battery, and a flexible connector for connecting to either the positive or negative plates of the cell.
Patent 1,502,928, issued to James L. Thompson.

Bed Lamp



This is a simple arrangement whereby a lamp attached to a bed is turned off or on by a push button switch within easy reach. The switch is arranged so that it may be left in the on-position indefinitely or used for intermittent lighting as is the ordinary flashlight, in which case it is held closed by the finger.
Patent 1,500,057, issued to Alfred J. M. Corns.

Telephone Receiver



Despite the simplicity and cheapness of construction, remarkable results are claimed from this radio telephone receiver. It employs the familiar toy magnet surrounded by a coil of fine wire in front of which is mounted an iron diaphragm. The whole is enclosed in a cardboard container, around which advertising matter may be printed, the receiver is to be given away for advertising purposes.
Patent 1,503,529, issued to Max S. Finley.

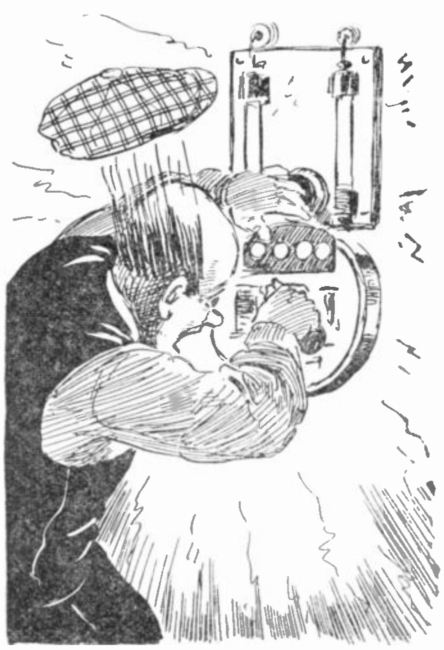
Short-Circuits

THE idea of this department is to present to the layman the dangers of the electrical current in a manner that can be understood by everyone, and that will be instructive, too. We have given monthly prizes of $3.00 for the best idea on "short-circuits." Look at the illustrations and send us your own "Short-Circuit." It is understood that the idea must be possible or probable. If it shows something that occurs as a regular thing, such an idea will have a good chance to win the prize. It is not necessary to make an elaborate sketch, or to write the verses. We will attend to that. Now let's see what you can do!

Cold 'neath this sod
Is old Peter LaRuse.
His transformer was hot
With lighting juice.
—ENRIGNE CORRAL.

Within this tomb
Is Isaiah Marks,
Who oiled the brushes
To stop the sparks.
—C. LINDEN BALLARD.

Deep under this plot
Lies Barney Dundee.
He tried a tram lead
For his Radio "B."
—GEORGE B. ENGELHARDT.



This grave belongs
To Jeremiah C. Hughes,
Who fixed the meter,
Not removing the fuse.
—E. EVERS.

LIVE WIRE KILLS SLEEPER

Reading Man's Stolen Nap in Factory Ends in Death

Special Telegram to Public Ledger

Reading, July 14. — Stewart W. Frederick, twenty-one, of Reading, an employe of the Evansville cement plant, was killed in his sleep in the switchboard room in the plant. He went into the room, a forbidden place, for a nap and came in contact with a 6000-volt wire. He was not found until several hours later.

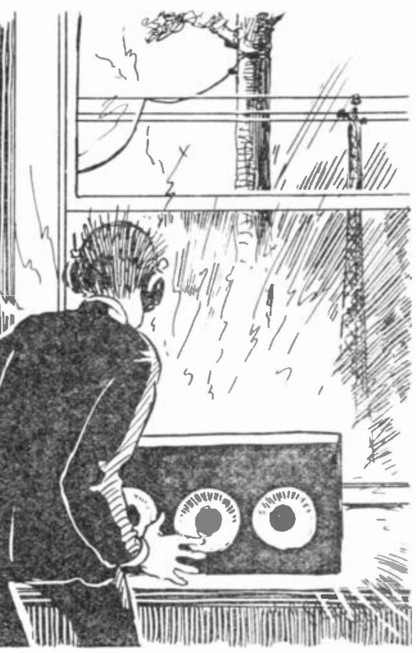
DARING ATTEMPT AT LIBERTY FAILS AS MAN PERSPIRES

COLUMBUS, Ohio, July 26—Ralph Fritsch 22-year-old convict, died in Ohio penitentiary hospital as a result of one of the most unique and daring breaks for freedom in the history of the prison.

Fritsch scaled a pole and was swinging hand over hand along the high tension electric wires which run over the prison wall when the socks he was wearing on his hands as insulation against the current became soaked with perspiration.

The dampness completed a circuit and 6,000 volts of electricity passed through his body, hurling him fifty feet back into the prison yard.

Fritsch was serving a 15 to 20-year sentence for shooting a cashier in a bank at Sharonville, O., near Cincinnati.



Beneath this stone
Lies Josephus Stire,
Whose aerial lead
Touched a power wire.
—ARTHUR A. BLUMENFELD.

THIS department is conducted for the benefit of everyone interested in electricity in all its phases. We are glad to answer questions for the benefit of all, but necessarily can only publish such matter as interests the majority of readers.

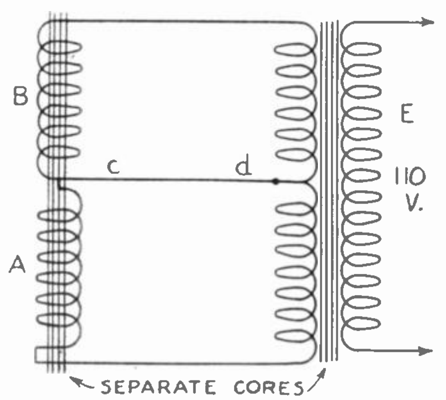
1. Not more than three questions can be answered for each correspondent.
2. Write on only one side of the paper; all matter should be typewritten, or else written in ink. No attention can be paid to penciled letters.
3. Sketches, diagrams, etc., must always be on separate sheets.
4. This department does not answer questions by mail free of charge. The editor will, however, be glad to answer special questions at the rate of 25 cents for each. On questions entailing research work, intricate calculations, patent research work, etc., a special charge will be made. Correspondents will be informed as to such charge.

Kindly oblige us by making your letter as short as possible.

Queer Transformer

(471)—Harry Neale, Bronx, N. Y., writes:

Q. 1.—Here is a transformer with primary, secondary and tertiary coils. Coil (A) is wound opposite to coil (B). Suppose A. C. flowed in coil (E), would not the induced current in coils (A) and (B) be such that a unidirectional current would flow in the wire (c-d), which could be used for charging batteries, etc.?



An odd suggestion for a transformer. The answer involves quite a good explanation of the action of induction of currents.

A. 1.—The fact that coil (A) bucks coil (B) would have no effect on the direction of the current flow. The inductance of the two coils would be neutralized and they would have the same effect as short-circuiting the secondary, the resistance of the winding only impeding the current flow. There would be no current flow in the wire (c-d).

Cadmium Test

(472)—Walter Washburne, Hackensack, N. J., inquires:

Q. 1.—What is meant by the "cadmium test" for storage batteries?

A. 1.—When a storage battery is being charged or discharged chemical changes take place on both positive and negative plates. It sometimes happens that the plates of a cell are unevenly acted upon, and either the positive or negative plate may become fully discharged before the other. When the cell is discharged, it is evident that under these conditions the voltage will fall off sooner than it should, because the capacity of the cell will be limited by the capacity of the plate that is only partially converted. Therefore each plate must be tested separately as the voltage of the cell will not indicate the condition of the individual plates. The cadmium test is used to determine the condition of each individual plate instead of the two plates as a unit.

To make this test a third electrode is used which consists of a piece of cadmium. Cadmium is a white metal with a bluish tinge belonging to the same chemical family as zinc. It has a resistance of 60 ohms per mil foot and a specific gravity of 8.60. It is used in the form of a rod about the size of a four-inch nail with a handle and insulated with a perforated hard rubber covering to prevent it touching either plate when inserted in the cell between the plates.

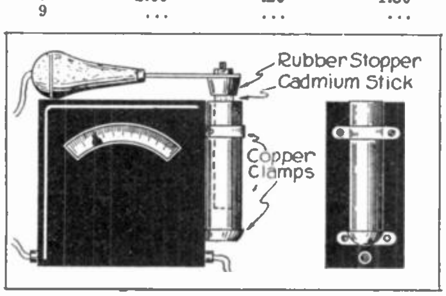
The cadmium electrode is dipped into the electrolyte and the voltage between it and the plates of the cell is measured by a low reading voltmeter. The voltage between the cadmium electrode and the plates is measured and varies on charge and discharge as shown in the accompanying table. When the cell is fully discharged the electrode is positive to both plates; when fully charged the cadmium is positive to the positive plate and negative to the negative plate. These readings, and the polarity of the cadmium are based on the assumption that the normal charging or discharging current is flowing when the test is made. When fully charged, the voltage of the cell will be the sum of the two test readings. When discharged the voltage of the cell will be the difference between the two readings.

Q. 2.—What precautions should be taken in the care of the cadmium test apparatus?

A. 2.—It is well to keep the cadmium stick under water so as to prevent it from oxidizing. The illustration shows a simple test set consisting of a low reading voltmeter on which is attached a glass tube. The cadmium stick is attached to a handle and fitted with a cork as shown so as to fit tightly in the glass tube. The tube is kept full of water when the cadmium is inserted.

CADMIUM TEST VOLTAGES

Hours	Cadmium to + Plate	Cadmium to − Plate	Cell Voltage
	Charge		
0	2.24	.15	2.10
1	2.26	.11	2.16
2	2.27	.09	2.18
3	2.29	.08	2.21
4	2.30	.08	2.22
5	2.32	.07	2.24
6	2.34	.06	2.26
7	2.36	.04	2.30
8	2.44	—.03	2.49
9	2.50	—.09	2.60
	Discharge		
0	2.18	.14	2.04
1	2.17	.16	2.02
2	2.17	.17	2.00
3	2.17	.17	2.00
4	2.17	.18	2.00
5	2.16	.19	1.98
6	2.14	.19	1.95
7	2.08	.20	1.90
8	2.00	.20	1.80
9	...	...	...



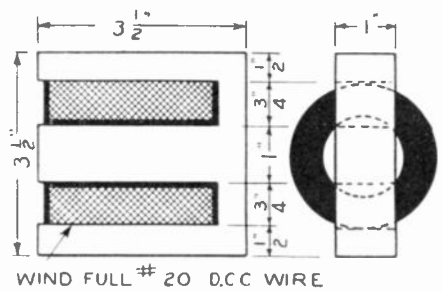
A suggestion from one of our readers; how to keep a cadmium bar in good order for storage battery work.

Electromagnet

(473)—Sadie Silver, Waterbury, Conn., wants to know:

Q. 1.—I am in need of a magnet about 3½ inches long and it must be powerful enough to hold a piece of metal on the opposite side of a window pane. Will you please give details of its construction?

A. 1.—Not knowing the weight of the metal you wish to hold against the pane we can give you no specific details, but the electromagnet shown in the illustration is a very powerful one and will no doubt meet your requirements. It is doubtful if a permanent magnet could be used. The magnet shown has a laminated core made similar to transformer cores. Perhaps an old transformer core might be used for the purpose, as it is not necessary to use the exact dimensions given in the drawing. A fiber tube and fiber washers should be constructed for holding the wire. This spool is wound full of No. 20 D. C. C. wire, and slipped over the center leg of the core. For experimental purposes spools of different size windings can be made and thus the magnet can be adapted to a variety of purposes. This magnet may be operated from a six to twelve volt storage battery or from the lighting line with a lamp bank resistance in series. Either A. C. or D. C. may be used, as the core is laminated.



An interesting construction of an electromagnet, using an old transformer coil and a specially wound bobbin for the wire.

Treasure Hunting

(474)—J. W. Davis, New Orleans, La., writes:

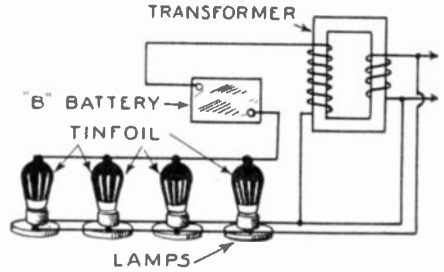
Q. 1.—I have tried several of the electrical treasure hunting devices described in your magazine, but all have proved a fizzle. There is one spot which I have in view which is 20 to 30 feet deep, and if possible please publish a correct diagram of a reliable outfit, that will indicate the presence of metal underground.

A. 1.—We know of no reliable outfit that will give the location of buried metals. Practically all of the schemes so far devised are theoretically feasible, but in practice fail to work nine times out of ten. Probably the only way to devise a reliable method would be to bury a large metal object and then try all various proposed schemes and experiment until results are obtained.

Simple Rectifier

(475)—William Stevens, Houston, Tex., asks:

Q. 1.—It is well known that if the outside of a lamp bulb is coated with tinfoil a current can be passed from the coating to the filament, but not in the reverse direction. This action takes place after the glass becomes hot. Would not a few lamps so coated make an excellent rectifier for use in charging small storage batteries, such as radio "B" batteries?



A. C. current rectifier based on the use of tinfoil coated incandescent lamps.

A. 1.—Although these lamps act as rectifiers they are not very efficient. It would be necessary to use several lamps as shown in the illustration and also to use a step-up transformer, giving about 500 volts on the secondary, for charging the battery. Should you try this system we shall be pleased to hear of your results.

Ammeter Windings

(476)—Henry Wesley, Hoboken, N. J., writes:

Q. 1.—I have an electromagnetic ammeter with laminated iron core of the following dimensions: Height of legs, 4 inches; interval between them, 2 inches; cross-section, $\frac{3}{4} \times 1$ inch. Suggested I put on five turns of number six wire around the core and then send a current of 35 amperes through the winding. The ammeter scale showed deflection of about 2 amperes. I then put ten times the number of turns around the legs to get a greater reading, but the result was still smaller. I have tried thicker and thinner wires without result.

A. 1.—The distance between the wire which carries the 35 amperes and the iron core is too great. It follows that most of the lines of force go through the air and the iron core only receives a small proportion. The E. M. F. induced in the five turns can therefore not be very great as measured by the ammeter; in the test with ten turns for the same current strength the number of counter E. M. F. turns for the secondary will double, and will reduce further the field in the iron core, so that still smaller readings are given on the ammeter. You must bring the winding as close as possible to the iron core and preferably make the core round.

This same effect is also noticeable in telephone receiver windings. A telephone receiver was wound for 1,000 ohms, using number 40 wire. This rĕceiver was to be used in connection with a vacuum tube amplifier. Although it gave fair results it was far from being satisfactory. After unwinding about 25 per cent of the number of turns and thus reducing the resistance considerably, the sensitivity of the receiver was increased enormously. In this case the outside turns were so far from the iron core that they had little effect on the magnetism and their presence caused losses.

Generator Query

(477)—Chas. W. Shepherd, Hopewell, Va., asks:

Q. 1.—In reference to the article on the small generator described in the June, 1924, issue by Otto Kuhne, can you tell me how much current that machine will generate?

A. 1.—This machine will generate a current of from 3 to 5 amperes at about 10 volts.

Q. 2.—What is the best speed to run this generator?

A. 2.—As an alternator, a 60-cycle current will be generated when run at a speed of 900 R.P.M. This is easily calculated. As there are eight poles, one revolution of the armature will give four cycles; 900 revolutions will give 3,600 cycles per minute, or 60 cycles per second.

Q. 3.—How much power would be required to drive this machine?

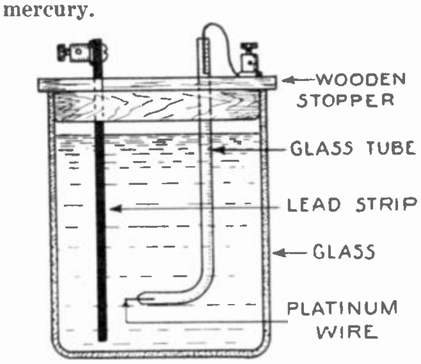
A. 3.—Five amperes at 10 volts would be 50 watts. Assuming that the generator efficiency is 50 per cent, it would require 100 watts to run it, or about one-eighth horsepower.

Wehnelt Interrupter

(478)—Arthur Sommer, Omaha, Neb., asks:

Q. 1.—Please give instructions for making a sulphuric acid interrupter for use with an induction coil.

A. 1.—Into a glass jar or wide mouth bottle rather less than quart size put a strip of thin sheet lead the length of the jar. A piece of one-eighth inch glass tube has an inch at one end bent at right angles and into this bent end is fused a half inch of fine platinum wire so that just the tip of the wire protrudes beyond the glass. The tube is filled with mercury and lowered into the jar in such a position that the platinum tip is near the lead strip. Both the strip and the tube are fastened to the cover of the jar and the distance between them adjusted by turning the tube. Connections are made by clamping the wire to the lead and dipping a wire into the mercury in the tube. The jar is then three-quarters filled with dilute sulphuric acid, using four parts of water to one of acid. Forty volts should be used for satisfactory operation of the interrupter, and with its use a condenser is not required on the spark coil. The current is broken by the formation of bubbles of gas from the electrolyzed fluid accumulating on the platinum tip. See that the platinum wire extends well into the tube so as to make contact with the mercury.



An electrolytic rectifier, operating by the production and release of electrolytic oxygen.

Electric Razor

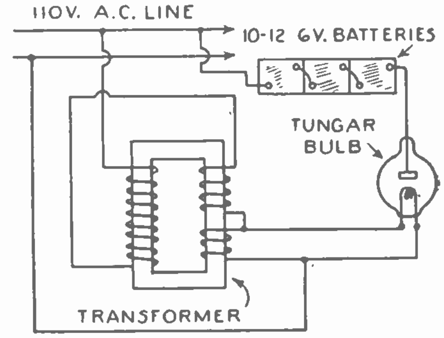
(479)—Robert Hunter, Somerset, Pa., inquires:

Q. 1.—Have been reading Practical Electrics for some time, but have never seen mention of an electric razor. Will you please let me know where they may be had?

A. 1.—We know of no concerns manufacturing electric razors. There used to be one on the market that operated on a vibrating principle, but it is doubtful if the vibrations improved its usefulness. This is a splendid opportunity for some experimenter to develop a practical razor incorporating some electrical feature that improves it. One proposed method was to use a very fine wire heated by electricity and burn the hair off close to the skin at such a fast rate that the skin would not burn, but this, of course, is impractical.

Battery Charger

(480)—Jack Tomko, Cleveland, Ohio, asks:



Tungar charging hook-up; the transformer does nothing but heat the filament.

Q. 1.—How many six-volt batteries can I charge at one time on the tungar rectifier described in the March, 1923, issue?

A. 1.—This depends upon the size of the batteries. The more batteries connected to the charger the longer it will take to charge them, as the charger will only deliver six amperes. If you have ten or twelve six-volt batteries you can charge them all in series by connecting as shown in the diagram, and in doing so charge all in the same time as it would require to charge one with the charger. In this diagram the transformer is used only for lighting the filament of the bulb.

Q. 2.—What kind of tungar bulb is best to use with this charger?

A. 2.—A six-ampere bulb should be used.

Q. 3.—If a six-volt eighty-ampere-hour battery is charging at the rate of four amperes, how many amperes shall I use in charging three of the same kind of batteries at the same time?

A. 3.—Four amperes. Each battery will then receive one and one-third amperes and it will take three times as long to charge them.

Experimental Transformer

(481)—Ellsworth Curry, Los Angeles, Calif., inquires:

Q. 1.—I am building a step-up transformer calculated for 500 watts. Please tell me what is the best secondary voltage for all round laboratory use for operating Tesla coils, etc.

A. 1.—It is well to wind the secondary for as high a voltage as is possible, which would be about 20,000 volts. It is difficult to insulate the windings for higher voltages.

Q. 2.—Please illustrate the easiest and best way for winding the secondary.

A. 2.—It is best to split the secondary into ten sections, or pies, and wind each pie separately. A wooden spool or form should be made of the correct size for winding one pie. This spool should be fastened to a shaft and crank for winding and the wire passed under rollers submerged in a pan of melted paraffin. Then when the pie is completed the wire will be completely impregnated with paraffin and the wooden spool on which it was wound can be removed and the next pie wound. The ten pies should all be wound in the same direction and then placed on a fiber tube with one-eighth inch thick hard rubber or mica discs between each pie. In placing the pies on the tube be sure to alternate them and connect all in series. The connecting wires from pie to pie will then be from inside to inside and outside to outside, and there will be less possibility of breakdown.

Simple Ball Motor

(*Continued from page 684*)

it around the circle passing the now inactive magnet as it goes on its way. The connections are such that the brushes when pressed together by the ball close the magnet circuit. When the ball no longer presses them they spring apart and the circuit is opened.

It would be advisable to draw the temper of the ball and a coat of thin smooth paint would serve to conceal the fact that it is of iron. The magnet is to be concealed. Several magnets and pairs of brushes may be used.

Electric Stimulator

(*Continued from page 684*)

regulated by turning the potentiometer slider or knob.

In connecting the instrument, one side of the house mains is led to one side of the potentiometer and also from this point to a handle. The other side of the house current is led to one terminal of the light socket; the remaining terminal of the socket is connected to the slider of the potentiometer, which is usually the middle of the three binding posts of these instruments. The free terminal binding post of the potentiometer is connected to the other handle or body electrode of the apparatus. . . . So it can be seen that the entire resistance of the potentiometer, as it may be set, is shunted directly across the electrodes or shocking handles.

By turning the knob of the potentiometer the light in the socket will vary in brilliancy; the brighter the light, the weaker will be the shocks delivered by the handles. The greatest shocks are felt when the lamp is very dim, which is caused by all of the resistance of the potentiometer being in the circuit.

Another method of varying the current is by placing different wattage lamps in the socket. Usually the 25-watt lamp will be used, for this passes very little current, and the current from it is about the correct strength for the average person. Too high a wattage lamp in the socket will produce a large stimulating current and at the same time pass so much current through the potentiometer that it will heat up.

The device is fool-proof. If the handles touch each other a short circuit cannot be formed, for the lamp is in series with the line at all times. A lamp cord with plug for attaching to a nearby convenience outlet or socket gives the instrument a fine appearance.

The handles can be made from brass or copper tubing. Such items as barrels of bicycle pumps, curtain poles of brass, and old gas fixtures afford the constructor a source of supply for these important items.

It is best to mount the potentiometer upon a board as well as the socket as shown. This will prevent the potentiometer from becoming overheated, as the heat due to the resistance is readily dissipated into the air.

A scale can be affixed to the potentiometer so that the "strength" of the current can be read off directly.

The Radio Vision

(*Continued from page 687*)

light to illumine the objects of which I wish to transmit the images. By this method the reproduced pictures are composed of shades of varying gray.

"If the televiser in its present state will transmit pictures for five miles then I can interest enough capital to enable us to develop the device for commercial use, so that you are likely to obtain more than just your meager wages by working for me."

The Log Cabin and Its Contents

Owen had only the transmitting part of the televiser in his laboratory, the receiver was in a log cabin seven miles away, situated in the mountains that nearly approached the edge of the town. The transmitter was completely enclosed in a box in one end of which was a two-inch quartz glass lens for throwing a perfect image on the selenium screen of whatever stood before it. Suspended from the ceiling over the box was the arc light for illuminating objects with certain vibrations of light so that their picture could be transmitted.

My Duties

My duties included staying at the receiving station of the television apparatus and reporting with a radiophone anything that Owen asked about or ought to know. The cabin was built of heavy logs in such a way that it was practically a small fort, capable of resisting the attacks of a small army until assistance could be brought from town. Owen had bought the building from a group of settlers living nearby, and had then added to the structure for the purpose of making a safe experimental laboratory or station.

My specific knowledge of the work was not extensive, but fortunately I knew enough in order to understand the theory and operation of the television receiver in a general way. Owen gave me concise instructions on every point before he left for town to begin his momentous and famous experiments.

A Warning

"Before I go," said Owen, "I believe that I should warn you against the persons from whom I bought this cabin. They are what might be termed a religious colony even though they are making their living at mining, and while I have nothing to say against religion itself, I do object to the way certain people practice it. I do not know much about this colony but my impressions are that they combine ignorance and fanaticism in their beliefs. If you ever have the slightest suspicion of danger do not hesitate to call me."

The cabin had two rooms, one was the kitchen and bedroom and the other was the "laboratory," containing the radiophone and the television receiver. The two devices filled nearly the whole space of the small room, leaving just a little more than enough vacancy for a chair to be used comfortably. The television receiver was also inclosed in a box with the two-foot square translucent screen placed at one end facing the center of the room. The radio vacuum tubes were set on a separate table, while the half dozen storage batteries were placed on the floor with a maze of wires going to the instruments. The radiophone had been assembled hastily and required even more space.

A Threatening Visitor

It was past nine o'clock in the evening when I had arranged everything to my satisfaction. I had just switched on the current to both devices preparatory to beginning the experiments when a loud knock sounded at the door. I locked the "laboratory" and admitted the visitor into the kitchen. He was the person whom Owen had pointed out to me to be the leader of the colony.

"I've been told you've got a telegraph o' some kind here," he said brusquely.

"It is not a telegraph," I answered, "It is a radiophone used to send speech through the air."

"It works with lightning don't it?" he questioned.

Had I paused for a moment's thought I probably would have realized how serious my visitor would regard any answer I gave to his query, but since he lived within a few miles of civilization I took it for granted that he was familiar enough with radio to know that its affinity to lightning did not prevent it from being harmless with ordinary care. But the colony had practically removed itself from the influencing contact of humanity for several years, which fact accounts for the events that follow.

"Yes," I answered, "It does, only the lightning as you call it is under constant control."

"Well," he said, and was silent for a moment, "Let me see the radio-thing. I want to know how th' thing works."

I should not have allowed him to see the instruments, but as he was the head of the colony it would not be of any advantage to arouse his antagonism by refusing his request.

The Visitor Gets a Shock

He seemed to be satisfied with my demonstration of the radiophone. Luckily Owen happened to be in his laboratory at the time and he spoke to my visitor for several minutes. All would have been well if he had not taken a last look about when leaving, and put his bare hand on a part of the radiophone he had not examined. Two hundred and seventy volts of a heavy battery current burned its way into his hand, and a resultant short circuit caused a brilliant blaze of sparks. He jumped to the other side of the room and plunged out of the building.

The humor of the occurrence was lost on me, for I knew that I was now in a bad situation. My visitor's anger would not be directed against me so much as against the instruments that were in my care, and it would be possible that he would order his followers to destroy everything in the cabin. I did not have a gun or any other weapon and to bar the door would be only a temporary act of security.

Averting the Trouble

I called Owen on the radiophone and told him of what had occurred.

"Just sit tight," he replied, "I believe that I can find a way to avert the disaster. Do not resist if they should come and attempt to injure the instruments, but bar the door, for if that holds them off a few minutes help will arrive in time. I heard what happened over the radiophone and immediately sent assistance to you. When I told you to allow the leader to see the instruments if he desired to I did that to prevent any ill feelings on his part. Ordinarily he is absolutely trustworthy. A last word; turn on all the switches of both instruments and leave them in operating condition."

A Violent Invasion

At that instant a tremendous pounding sounded on the door.

"Open it, open it before we have to bust it down," shouted several voices at once accompanied by heavy blows on the door.

"Stand back," someone commanded, "And you, young feller inside that house, get away from the door. I'm going to shoot the lock to pieces."

Shooting the Lock

A muffled report sounded and the bullet struck the lock. A pause and then four reports came in rapid succession. Judging from the damage accomplished I believe that a high power rifle was used to smash the lock.

Gagged and Bound

The door swung inward propelled by several rough appearing men. In about the same length it takes to tell it I was securely bound with two or three pieces of rope and a dirty rag was forced into my mouth and tied there with the idea of preventing me from obtaining aid by means of the radiophone. I do not believe that the leader imagined that I had spoken of the accident except, perhaps, in a joking way to Owen, since I had not been threatened in any way when he had left so precipitantly.

"Where's the key to the next room?" the leader shouted, giving me a violent shaking.

I refused to answer him. I couldn't if I had wished to.

"Don't try to be a mummy. Won't do you any good," he shook me again, "You can see I ain't goin' to be gentle with you and if you holler too loud when I take that gag out you can know what to expect!"

He removed it with a jerk.

"You're wondering how I can be religious and still act this way. Well, my religion teaches different than yours prob'bly does. I believe that man should be under the rule of nature and not try to overcome it like you're doing when you make that lightning go wherever you want to. I think I'd have left you to your folly if you hadn't tried to kill me with a bolt of lightning a few minutes ago."

"It was purely an accident," I protested, "I had no reason to do you any harm."

"Maybe it was, but that don't make that machine any less dangerous. When that lightning goes through the air that way what's to stop it from hitting some of the members of this colony? I don't want to waste no more time. Give me that key or I'll shoot the lock out."

The Inner Room Entered

I told him where it was. I reasoned that the bullets would undoubtedly damage the instruments and since Owen had told me that he could probably stop them from injuring the apparatus, to allow them to go into the room under such circumstances seemed the most logical thing to do, as the persons coming from town would be forced to go slow because of the poor road.

The gag was again forced into my mouth and I was picked up like a sack of meal and carried into the next room. I was placed in a sitting position in a chair facing the apparatus so that I was able to see all that occurred.

The group of rough men, of course, were acting with more haste than thought; but now that they had time to think the matter over they were hesitating and I believe that, but for the presence of the leader, their plans to destroy the instruments would have been dropped.

"How'll we smash up this trash without gettin' hurt?" the leader asked of no one in particular.

A Conflagration Determined On

"How about burnin' all of it? We can get 'way off at a distance when the fire is goin' good," offered one of the men.

"A fine idea," commended the leader, "A couple of you fellows go get most of the gasoline and kerosene we got, and then we'll soak the building and have a grand bonfire." He glanced at me, "Don't get scared young feller; you'll be taken out of here before we touch it off."

Three men were left now including the leader. My thoughts were rather chaotic as I watched them move restlessly about. It seemed so impossible and absurd that these people should be as superstitious as the most ignorant African savage; but then it may have been possible that they had a grudge against the rest of the world because of ridicule of their peculiar religion.

Suddenly the leader said, "I'll do some fixing myself before they get back with the gasoline." He stepped into the kitchen and got a chair. Gripping the back of it with both hands he raised it above his head preparatory to using it as a means of destruction but in the interval that he held it poised, a voice, that filled that small room, commanded:

The Inventor's Voice

"Stop."

It was Owen's voice coming from the radiophone.

The leader paused and turned toward the radio-speaker resting on top of the television box and the chair slipped from his hands and crashed on the floor.

On the translucent screen of the television appeared Owen's face, tinted a bluish-green but perfectly recognizable. Because of some optical effect of the colors his face seemed to stand out in relief presenting a most life-like appearance.

The Summons from Afar

"What does this mean?" demanded Owen, his lips, of course, moving in synchronism with the sounds from the radio-speaker since both the radiophone and television apparatus were being used at the same time.

"Why, you see we considered the machines here were dangerous," the leader replied, a tremor in his voice.

"They are not!" snapped Owen, "And it would not be a poor idea to force you to submit to arrest. You may have some interesting things to explain, besides your unwarranted action in attempting to damage my property. The three of you raise your hands to the ceiling and keep 'em there."

The Vision on the Screen

On the screen Owen pointed a business-like automatic at the three men who obeyed him with alacrity. A loud report filled the room and a cloud of blue-green smoke burst from the mouth of the automatic. After that demonstration the three men had not the slightest apparent doubt but that Owen was somehow actually there in person threatening them.

When the two men with pails full of gasoline returned they also reached for the ceiling without argument.

All Is Saved

The men Owen had sent out from town arrived a few minutes later and found the strange situation of five husky men subdued by an automatic held by a man, neither of which were more substantial than a light beam.

So the first trial of Owen's television apparatus proved it a wonderful success.

What Is Lightning?

(Continued from page 688)

Franklin's famous experiment proved that it is caused by electricity. Sending a kite up into the air, he was enabled to collect enough electricity passing down the string to charge a Leyden jar.

If electricity is produced by friction we must then find the cause of the friction in the atmosphere. Most of the theories are inadequate. It has been suggested that friction between dust particles and the water-drops may be its origin.

A new theory has been put forward which is rapidly gaining weight among scientists. It has been proved that breaking a water drop in two parts will cause enough friction to charge each droplet positively, the negative charge passing to the air and thence to the ground.

When enough electricity is stored up in the cloud its force will be sufficient to overcome the resistance of the air and a flash of lightning will occur as the electricity leaps from the cloud to Earth. If a voltmeter were attached to the cloud and the ground before the flash it would register about a hundred million volts. The time of passage of the current is only about a millionth of a second.

Heated air expands. The intense heat of the lightning flash starts a wave of air which reaches us in the form of sound-thunder. The heavy crash comes from the main stem while the smaller crackles emanate from the branches. Although both the flash and the sound start at the same time, the latter travels much slower. Therefore we hear the crash some time after we see the light.

There are several kinds of lightning; chain lightning is the most common form; sheet lightning which appears in the sky (usually near the horizon) as a bright uniform flash, and ball-lightning. Sheet lightning is usually the reflection from some distant flash of chain lightning, while ball-lightning is still a mystery. A study of several hundred authentic cases failed to reveal any prominent laws governing this form of lightning.

The Spithead Review

(Continued from page 688)

and the illustration shows night scenes on the occasion of the recent review of the warships by King George. Two views of the long white plumes sent far up into the air from the great projectors, with the silhouettes of the spectators in the foreground, are most impressive. Slight mistiness of the air brings out the spectacle more clearly than otherwise. Were the air perfectly clear little or nothing would be seen.

A ray of so-called "visible light" is quite invisible, and can only be revealed by reflection from material substances of some kind. A beam of sunlight passing through a dark room has its path marked in sharp definition by particles of dust floating in the air. If the air were dustless nothing would be seen.

The misty English air, when not too foggy, lends itself to such displays of the electric light.

In another view the fleet is shown outlined by innumerable incandescent lights.

It is a far step from Sir Humphry Davy's pencils of charcoal supplied from a self-exhausting battery and the Spithead exhibition, where coal and oil transformed their thermal units into volt-coulombs and lit up the waters.

Hornless Loud Speaker

(Continued from page 690)

parts, a voltage amplifier and a power amplifier. The voltage amplifier consists of two stages of 201-A pliotrons and one 210 pliotron, coupled in cascade by resistance and capacity. The power amplifier consists of a one kilowatt low impedance pliotron. The plate current for all these tubes is supplied by a 2,000 volt, full-wave kenetron rectifier which is operated from the A. C. current public lighting mains. Filament current for the tubes is furnished by transformers.

The radio programs of WGY, the General Electric Station, which is located only four miles from the park, are picked up by means of a loop about fifteen inches in diameter situated fifteen feet from the loud speaker.

Odd Advertising Device

(Continued from page 730)

iron or brass. The diagram makes it clear as to how they should be bent.

The lower part of the axle is fitted with a large pulley which, in turn, is belted directly to the driving motor. The pulley ratio should be arranged so that the lights will go around the circle very slowly. This, of course, also depends on the speed of the motor used. The upper part of the axle carries two metal slip rings which are connected respectively to one wire from each coil of the primary. The other two wires coming from the coils are connected together. The slip rings must be insulated from each other at their centers next to the axle. The brushes can be supported by insulating strips so as to make constant contact with the metal rings. These brushes are connected directly to the 110-volt lighting circuit. Fig. 3 gives a detail sketch of the electrical connections used.

The machine is now ready for operation and if directions have been followed, you will have a device that will attract and hold the attention of the most skeptical public.

Conducting Paints

THE manufacture of a material to be applied like paint, which when so applied is conductive of electricity, represents a real need of the day. Of various attempts, the most obvious perhaps is the mixing with a vehicle, varnish or the like, of a pulverulent conductor such as metal filings, making a species of paint. This is defective because the vehicle itself, oil or varnish as it may be, introduces resistance, and the oxidation of the surfaces of the particles of metal also increases the resistance to the flow of the current. Usually with such materials considerable heat is developed by passage of the current.

The conducting metallic paint powder, bronze powder or copper powder, as the case may be, as an experiment, may be divided into two parts. One part is treated with hydrochloric acid as a thick paste, and the other is left as it comes. The treated portion has the acid washed out by water, is dried and mixed with celluloid varnish to which acetone, or amyl acetate is added. The untreated powder is mixed separately with the same varnish. Stripes of equal cross-section or width are painted on a surface with the two samples, when it will be found that the untreated powder has given lines of high resistance, while the other, which has been treated with acid, affords a good conductivity.

But this is not practical, as the conductivity soon disappears. An ingenious innovation has been patented by a German firm. A powder of fusible metal, such as Woods alloy, is used. This is an alloy of four parts of bismuth, two parts of lead, one part zinc and one part of cadmium, which melts at 161 degrees F. This alloy is pulverized, mixed with colored printing ink and applied as a paint. Its easy fusibility may be a disadvantage, as it can be melted by too strong a current.

A German patent has recently been issued which uses "cohering," familiar as the operating feature of the radio or Branly coherer, for the purpose. The process of the patent not only applies electricity so as to make the particles of a metallic powder cohere, but the process is so carried out that the setting or hardening of the vehicle shall take place as soon as possible after the cohering is effected, and the paper is so supported while drying that agitation or jarring will not reduce the conductivity as the tapping does in the Branly coherer.

Abstract from GEORGE V. HASSEL.

The Telehor and Distant Vision

(Continued from page 697)

throw a strong, greatly diminished image of the object upon the diminutive mirror (d) of the oscillograph (c), which is to be made visible at the distant station. The reflected rays diverging produce an image of about natural size on the diaphragm (e), behind which the selenium cell (SE) is to be found. It is now clear that in this way by a resulting movement of the mirror (D) it is possible to get the movements of the image on the diaphragm in all directions.

If now we pass a high frequency current through the oscillograph wires, the mirror (D) will be caused to oscillate at right angles to the plane of the picture. The image will hereby be moved back and forth over the minute aperture in the diaphragm (E) at high frequency, but naturally only the elements of the picture fall in small streaks upon the selenium cell. But if we excite the oscillograph mirror (D) to slow side swingings, so that during each up and down movement of the picture the same will be displaced sideways according to the size of the opening in the diaphragm, the entire picture will then be reproduced in vertical lines or streaks, which by the quick oscillations of the mirror will be brought together as united elements of the picture.

These elements of the picture will one after the other be projected on the selenium cell (Se). These small side oscillations of the mirror (D) can be obtained, as shown in Fig. 3, when the bar which carries the oscillograph is pivoted in its center at (F_1) between screw points, and one end of it is connected with the crank (F_2) of the synchronous motor (G). This small motor produces at the same time the high frequency current which sets the mirror (D) in vibration by a sort of commutator circuit-breaker (K_1, K_2).

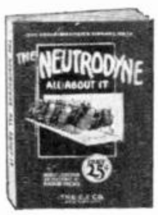
Fig. 6 gives an idea of the sequence of appearance in which the individual elements of the picture are developed.

The selenium cell (Se) is coupled up in series with a 30- to 40-volt battery. The slight current changes occasioned by the different degrees of illumination of the individual elements of the picture are amplified by a high vacuum audion and then carried by a wire line directly to the receiving station, or caused to operate on a high frequency current, if the transmission is to be done by wireless.

The most important part of the reproduction apparatus is a so-called light relay, which changes back the varying current into the picture elements of various brightness. The light relay, (see also Fig. 2), is a highly sensitive oscillograph, which can vibrate from 20,000 to 25,000 times per second.

The arc lamp (O) projects a small but very intense ray of light on the mirror (P) of the light ray oscillograph (A). If no current is going through the wires of the oscillograph, this ray of light is reflected back from the mirror (P) to a point alongside the opening in the diaphragm, which has the shape indicated in Fig. 2, so that no light can pass through the diaphragm. But now if picture-currents come from the transmitting station, the mirror (P) begins to vibrate in proportion to the strength of the currents and in this way a greater or less portion of the light rays pass through the diaphragm.

This light ray passes through a cylindrical lens (I) so as to be brought into parallelism and finally falls upon the mirror (d) of the oscillograph (c) which produces oscillations absolutely synchronous with those of the transmitting oscillograph.



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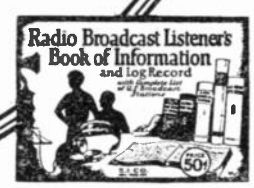

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Making Galvanic Batteries

(Continued from page 709)

tery. It must be remembered that amalgamating makes zinc extremely brittle, so that when treated with mercury it must be handled more carefully than if it were glass. In making up a battery the positive and negative poles are connected in the regular way.

A few words may be said here about the arrangement of battery cells. The difference between large and small elements lies in the smaller resistance of the larger ones. If we wish to have small resistance in our battery we must arrange the cells in parallel with each other. To do this all the zinc plates are connected and all the carbon plates are connected, one to the other, which gives the zinc the effect of a single cell of two or three times the size, according to the number thus connected.

But if we arrange the cells in series zinc to carbon, all down the line, we get what we may call a high potential connection, but this increase of potential has to be paid for by our accepting two, three or more times the battery resistance of a single cell. Thus, ten cells in series have ten times the resistance of a single cell. Ten cells in parallel have one-tenth the resistance of a single cell.

Talking Transformers and Dynamos

(Continued from page 711)

rior in every respect to the vibrating diaphragm receiver. In the diaphragm receiver only the diaphragm vibrates, while in this experiment the whole mass of iron and wire vibrated; also disagreeable noises were entirely done away with.

The experiments included the use of commercial transformers for loud speakers. Large transformers were used before audiences and everyone in the assembly was able to easily distinguish every syllable reproduced by this device.

The last experiments were with dynamos as the reproducer. The machines were at rest during the experiments, and the only requirements necessary to insure results were the use of batteries and rheostats suited for the size of the dynamo.

Carbon Pressure Rheostat

(Continued from page 706)

bons are in series with each other. The carbons are about half an inch or three-quarters of an inch long. Another row or two rows of carbon rods can be added if desired, thereby increasing the capacity of the series resistances.

This should be of hard asbestos board, or of an ordinary asbestos board soaked in a dilute solution of water glass and dried to harden it. The left end piece is of metal and has attached to it two hooks as shown. The screw standards on the right have corresponding opposite hooks. In operation, a strip of hardened asbestos is laid under the hooks. This prevents the little carbon resistance rods from flying into the air when pressure is exerted by the adjusting screws.

The adjusting screws press against oblong square rods of brass or copper which in turn press against the first carbon rod resistance. Connection is made with each of the adjusting screws by binding posts. For a split connection, another binding post can be used if desired.

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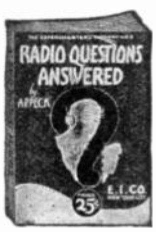

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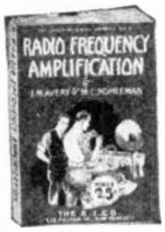

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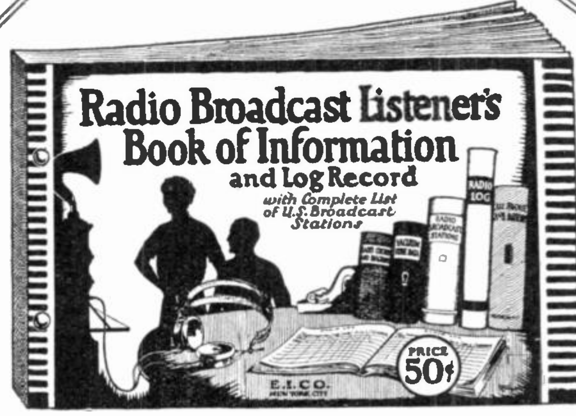

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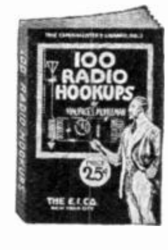

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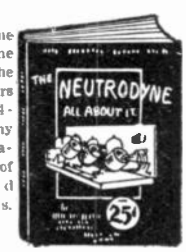

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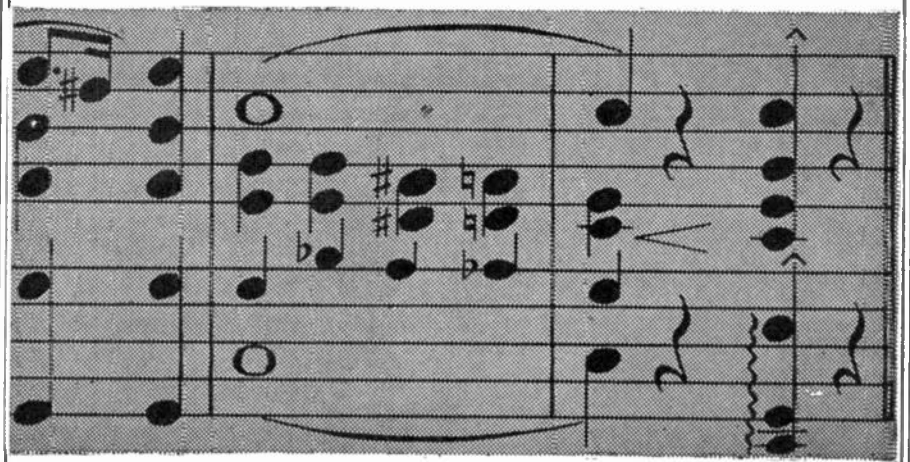

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The How and Why of Radio Apparatus, by H. W. Secor, E.E. This newest book on radio matters fulfills a distinct gap in wireless literature in that, while the treatment is made as understandable and as free from mathematics as possible, it at the same time incorporates a wealth of technique and instruction for the Radio Amateur—the Radio Operator—the Installation and Designing Expert—as well as teachers and students of the subject in general. A very broad field has been covered by the author, at the same time giving a great deal of information not found in other text books. If you are engaged in any branch of the Radio or allied arts at all, you will surely need this latest contribution to radio literature, which is destined to be found on every radio man's book shelf before long. A glance at the following list of chapters gives but a very scant idea of the extensive and useful radio knowledge provided in its text: The Induction Coil; The Alternating Current Transformer; Radio-Transmitting Condensers; The Spark Gaps; Radio-Transmitting Inductances; Radio Receiving Tuners; Radio Receiving Condensers; Detectors; Telephone Receivers; Radio Amplifiers; Construction of a Direct Reading Wavemeter and Decremeter; Antenna Construction; The Calculation and Measurement of Inductances; Appendix containing very useful tables, covering all subjects treated in this very unusual book. This newest of Radio Works, cloth bound in Vellum de Luxe, Gold Stamped and Hand Sewed, has 160 pages. Size of book 6x9 inches. The How and Why of Radio Apparatus, Postpaid, $1.75. Experimenter Publishing Co., Book Dept., 53 Park Place, New York City.

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World Radio History

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