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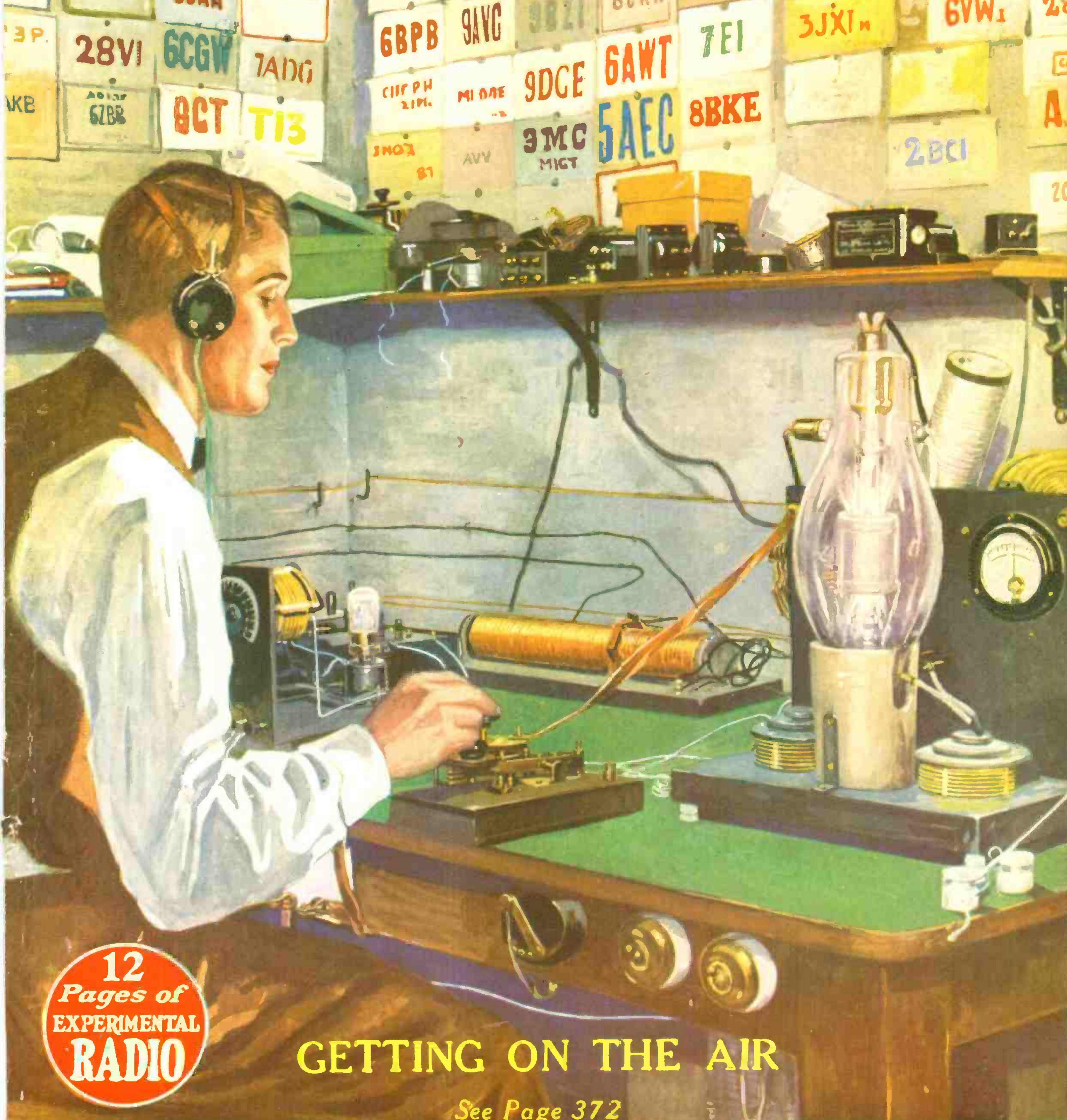
The EXPERIMENTER

Electricity ~ Radio ~ Chemistry

Edited by HUGO GERNSBACK



12 Pages of EXPERIMENTAL RADIO

GETTING ON THE AIR

See Page 372

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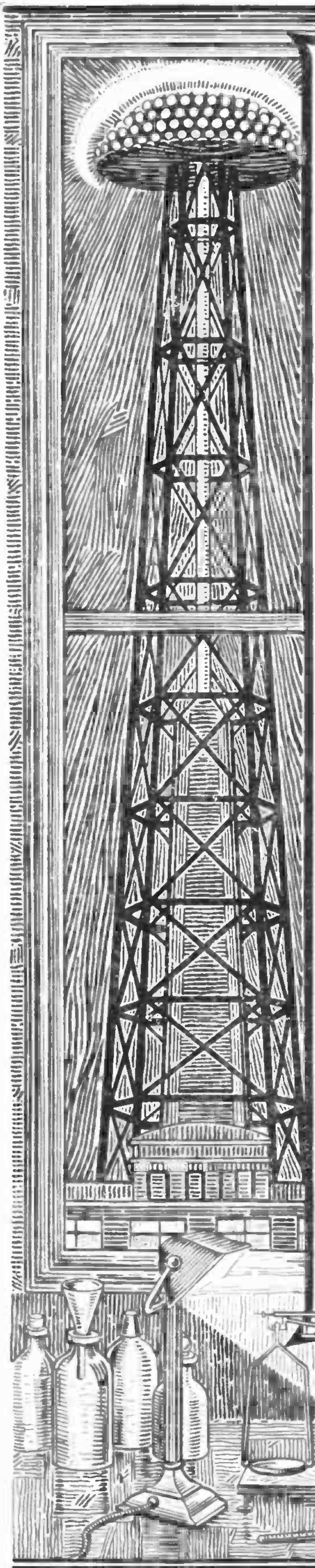

The EXPERIMENTER

Vol. 4 **Contents** No. 6

FOR APRIL

IMPORTANT ARTICLES IN MAY ISSUE

ELECTRICAL TRANSMISSION OF PICTURES. A process with numerous illustrations of Belin's celebrated work in the transmission of pictures by radio and telegraph.

LABORATORY REPRODUCTION OF THE SOLVAY PROCESS. The Solvay process which has displaced the famous Le Blanc process, which held sway for many years after the Napoleonic era, is here described so as to be done experimentally in the laboratory.

INTERNAL RESISTANCE OF CELLS. A very interesting article giving analogies of electric circuits and simple formulae for calculating their factors. Of use to every experimenter.

EXPERIMENTS WITH TESLA RESONATOR. This is a very simple presentation of a rather novel line of work, to be done by the high frequency coil.

FUN WITH SPARK COIL. One of Esten Meon's illuminative and highly humorous articles.

CIGAR BOX MOTOR. This is a motor whose prominent parts are a spool and some pieces of a cigar box. This will interest the younger experimenter and perhaps his elders.

STRANGE GUN POWDER PHENOMENON. Gun powder remains unignited in the middle of a large gas flame.

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4-25

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Volume 4
No. 6

The EXPERIMENTER
Electricity ~ Radio ~ Chemistry

April
1925

H. GERNSBACK, Editor and Publisher   T. O'CONOR SLOANE, Ph.D., Associate Editor

Experimenting and Patents

By Hugo Gernsback

"An ounce of experimenting is worth a pound of theorizing"

In most cases of experimental work, it may be said that as a rule the end and object of the work is to derive financial benefit from it. While not all experimenting starts out in this fashion, the chances are that much of it turns that way, even though the original intention had not been to exploit the experiment at all. This is particularly the case when one experiments as a hobby, and has no thoughts of commercializing an idea.

Some time in the future, however, an old experiment may become the basis of a valuable invention, that was not even considered at the time of the first experiment in the laboratory. If the experimenter has a good knowledge of the patent phase it will often not only save him a good deal of money, but may be the direct cause of proving a real gold mine.

As the writer has mentioned a number of times before, the most important thing to remember is to keep full descriptions of every phase of all experimental work, and to preserve these notes; if necessary having them witnessed by a notary public or by witnesses, if the subject is important enough. It happens very frequently that the most innocent experiment conducted years ago will prove of great importance many years later.

The DeForest audion is a good illustration of this. As is well known, Dr. DeForest once noticed a flickering of the gas light whenever he started to send wireless signals by means of a spark coil. He at once concluded that there was some connection between the electrical waves and the gas light. Investigation proved that this was not the case. Nevertheless, this particular observation had lain dormant in Dr. DeForest's mind for many years before he started to experiment with it again, only to obtain, after the long interval, entirely different results.

In other words, the first experiment was erroneous, but it led to others which later proved correct. Nevertheless, it is true that the original, though incorrect, deduction later on proved the basis for a revolutionary invention. In other words, it is often the insignificant that proves most important. If we persevere sufficiently and experiment enough to prove our theories, sooner or later these experiments will mature into something concrete that can be patented.

Now as to the patent phase, there are diverging opinions as to what one should patent and what one should not patent. By looking through the Patent Gazette every week, we find hundreds upon hundreds of patents, most of which, to the unitiated, seem to be valueless and some of them downright foolish and even silly. The saying goes that not one in a hundred patents is of value or will ever be exploited.

This is perhaps true, but nevertheless the patents keep on coming at a great rate, rather increasing in number per annum than decreasing. There are many experimenters and investigators who have ideas that they have worked out and which can readily be patented. Nevertheless, they do not think enough of the ideas to do this. On the other hand, an intelligent experimenter, such as Edison, patents almost everything that he comes across. The contention in such a case is that you never know when a patent may become valuable. A thing that looks foolish today may be valuable tomorrow.

Thus, for instance, the writer, before the radio boom, had a great many radio patents on various devices which before the advent of broadcasting were worth just so much paper. When radio became popular, however, some of these patents became valuable, a number of radio concerns having been licensed under some of these patents. And the strangest thing is that the patents which the writer considered best are the ones that turned out the least valuable, and the ones which were held to be of practically no importance turned out to be the most valuable ones. From this it will be seen that no hard and fast rule can be laid down as to what to patent and what not to patent.

The average cost of a patent in this country is, roughly speaking, $125. If you can afford it, the writer would advise that you patent anything that looks half-way good AS LONG AS IT IS PRACTICABLE. The money invested in the patent may, in a few years, prove to be a handsome investment.

If, on the other hand, you are not readily supplied with money to patent every idea, it is often, in that case, a good idea to try to get one or more of your friends interested, giving them a share in the invention to reimburse them for their investment in the cost of the patent application.

And while we are on the subject, it may not be amiss to say a few words as to trusting individuals and patent attorneys with your invention. Nearly every inventor has the idea lurking in the back of his mind that the minute he shows the drawings or models to anyone, the said person stands ready to steal his invention from him. While such ideas are often exploited in fiction, there are practically no authenticated cases where this has ever happened. When it comes to patent attorneys, these people, as a rule, being so close to the grindstone, are not interested in patents at all, and pay no more attention to the worth of patents than you do to Captain Kidd's treasure. As a matter of fact, the very last person in the whole world to steal a patent would probably be a patent attorney. He sees so many patents every day and knows that so few are of value, that he has neither the time nor the inclination to pay any attention whatsoever to the worth of the patent before him.

Furhermore, every patent attorney who has any reputation at all knows full well that there is no safer road to ruin than to play with a client's patent in an unethical manner. Patent attorneys, like doctors, are professional men, who cannot risk their reputation and their entire future career by disclosing a client's secrets.

As to trusting your friends with patent information, this is a matter for you to decide. If you have friends of long standing, the writer's advice is not to hesitate to disclose the invention to them. No patent, to the writer's knowledge, has ever been stolen by friends who were entrusted with the information in this manner. Papers can readily be drawn up by any notary or any attorney to safeguard you as to the patent, but, of course, before this happens it is necessary that you tell your friend or friends what the invention is supposed to to and can do. It is not necessary in all cases to divulge the actual secret if you do not wish to do so.

Suppose, as an illustration, you have invented an electric lamp that will consume one-fifth as much current as present lamps. The mere fact that you can show a model to your friends with certain meters connected to the lamp, would usually satisfy the most skeptical, and papers could readily be drawn up in advance to the effect that if they go in with you, certain considerations would be given to you, the value of which is up to you to decide. This, as a rule, gives the inventor all of the protection that he desires.

Then, should you still be suspicious of your patent attorney—and the writer repeats that this is the height of foolishness—you can, on a large sheet of paper, disclose your entire invention with text and illustrations. This can be witnessed by a notary public and by your friends. Note that the date is all important. After that, the details can be furnished to your patent attorney, and with all of this protection you may be sure that no one is going to steal your idea.

Finally, when you do get a patent, and when you are not able to exploit it yourself, by manufacturing the device, it is often an excellent idea to get a few hundred copies of the patent, which the Patent Office sells for 10c apiece. Copies of the patent can be sent to manufacturers or to the industry that will be most interested in such an invention. A letter should accompany the patent copy, stating that the patent is either for sale or that the device can be manufactured under royalty.

As a general rule, it is better to keep control of the patent, licensing the manufacture, rather than to sell the patent outright.

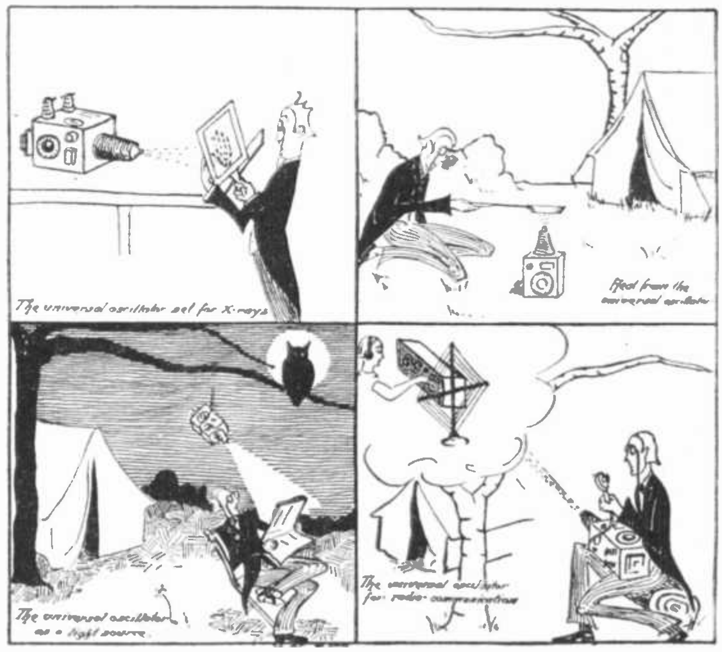
Some Speculations on Ether

By Philomath

THESE rambling notes on ether* were not, as a malicious critic remarked, written under ether, but occurred to us during moments of sober thinking. Science has always commanded our respect and sometimes our attention, for not infrequently we pause amidst our cross-word puzzles and other routine pursuits of life to contemplate the cosmos.

Such was the case when poring over much scientific lore, we pondered over the imponderable ether. We wrote a treatise and imparted to it all the decorum we were capable of. It might here be noted that literary dignity was ever our aim but never our achievement and so we were not surprised when the editor, with customary editorial severity, protested that this article is too frivolous and too light for publication. But, we argued, ether is said to have no weight and is, therefore, not heavy; if not heavy it must be light, *ergo*, our subject is essentially of a light nature and must be so treated.

Our theme, of course, is old, though it reached the lay public only with the advent of radio. It is even claimed by one misguided archeologist that wireless communication existed during the reign of the Pharaos, for excavations, while yielding much curious apparatus, gave *no* signs of wires anywhere in Egypt. We leave it to our readers to decide on the veracity of the archeologist's conclusion.



These artistic efforts speak for themselves. Light ought to be producable with hardly any expenditure of power. The right hand illustrations show how nice such a condition would be.

Perhaps the readers of this article will also get indignant—we hope they will not be bored. The poet says nobody forbids a laughing man to tell the truth.

As to ourselves, we prefer to be concerned with the radio of the future, rather than that of the past. We were, for instance, much interested in the recent wave of excitement that swept the scientific world as Mars approached our own planet. We wondered whether Martians were as delightfully foolhardy as Man and as willing to pause in the business of life to send a neighborly signal to their fellow travelers through the Universe. And it occurred to us that for communication over the vast, silent spaces separating the two planets, a means closer than radio waves could perhaps be found.

We have learned that many natural phenomena are due directly to the movements of the ether and that many of those formerly thought essentially different have been resolved to similar disturbances of this medium. Thus light, heat and electromagnetism all are but ether waves of varying length.

Suppose, for instance, that we had at hand an apparatus that could set up ether vibrations of any frequency we choose, a sort of universal oscillator, a device radiating ether waves of so large a range as to cover all wave-lengths from the extremely minute to the enormously extensive ones. We set this device in operation and by means of it radiate ether waves of extremely short length—the shortest known waves, the so-called gamma rays. Our apparatus in this condition would closely resemble a radioactive substance emitting such waves. Now let us increase the wave-length and again test the nature of the radiations. We find that this time our oscillator behaves like an X-ray tube.

Lengthening the waves still further we detect ultra-violet rays radiated from the transmitter, and as we continue in this way to adjust the universal oscillator its effects will go through astonishing transformation. Passing through the ultra-violet region it will become a luminous source and emit a barely visible violet light which, gaining in strength, turns to indigo and then to blue. Gradually the radiations become green and then yellow merging into orange till, having traversed the entire spectrum, it is a deeper and deeper red, becoming barely visible, and then the eye can no longer detect it. At this point and even before it other sensory organs of the body become effected and we feel a gentle wave of heat coming from the apparatus. This heat, increasing as we pass further and further into the region of longer wave-lengths, reaches a maximum, and diminishes until you are aware of no radiations of any sort. You try every variety of ether wave detector in vain, for you can detect no oscillation in the ether. Yet you are sure that the oscillator has not ceased to act. You continue to increase the wave-length and this seemingly inert condition persists until the oscillator reaches a frequency of 300,000,000 cycles per second, and at this point you can detect its oscillation with a radio receiver. The oscillator is now in the region of radio waves and becomes the ordinary radio transmitter. The waves radiated by it are common in radio communication and can be detected with a properly tuned receiver.

Now it occurred to us that it is not unlikely that thought should be a form of ether vibration in the region which just now we found unable to detect. Some unconscious faculty of the mind sets up these vibrations which are received, detected and interpreted by some conscious mental faculty acting as a tuned receiver. Our own thought transmitters and receivers are in tune, so we readily apprehend our own thoughts, but because we are not practiced in tuning our brains to that of others we are unaware of their thoughts unless they are transmitted to us in the crude form of language.

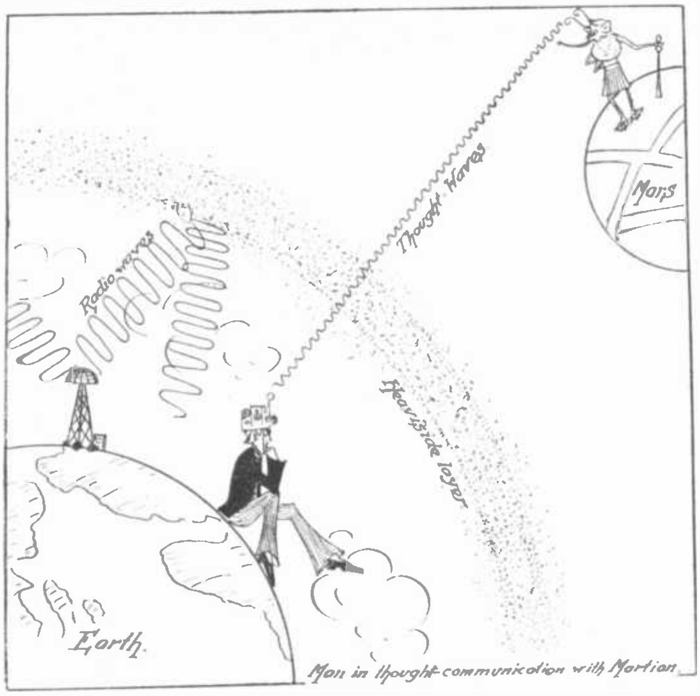
Language at best can give but approximate expression to ideas. Yet is has been productive of much pregnant thought and great beauty. But how much better shall we understand each other when we shall train ourselves to telepathy and by means of ether waves bridge the chasm that today separates our mind.

However, it was of Mars and the Martians that we spoke before embarking on this long digression. We ventured to suggest above that we might best communicate with Martians, if there are Martians, over thought waves, if there are thought waves. For radio waves, it is suspected, traveling through the ether, are reflected from a conducting layer in our atmosphere, the so-called Heaviside layer. And our radio messages, instead of reaching the Martians, are returned to the earth.

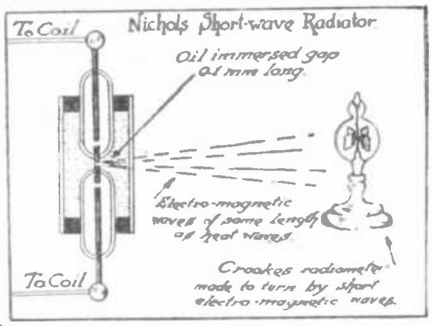
According to the physicist, Professor Vegard of Sweden, this Heaviside layer is composed of frozen nitrogen particles which move up and down about 200 miles above the surface of the earth. Now it is known that objects opaque to ordinary light are transparent to the shorter ether waves of X-rays and gamma rays. Could not the short thought-waves penetrate where the comparatively longer radio waves are totally reflected? Here, then, in thought waves, we have a medium not only more intimate to our minds but more apt to penetrate to the inhabitants of the distant planet.

Science, despite popular belief, offers a life of adventure—adventures of the mind, to be sure, but adventures none the less. The student of science must ever be ready to reorganize his opinions in the face of facts newly discovered. We have, for instance, hardly finished writing the above notes when our attention was called to the

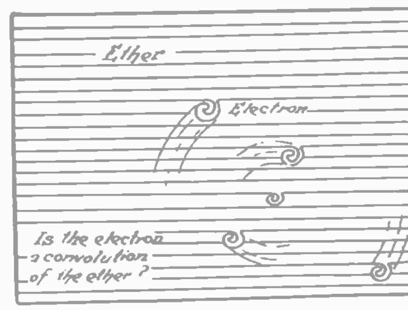
*The Editor shares with many other present-day physicists the belief that there is no such thing as Ether. To his mind all electromagnetic phenomena can be explained just as well on the basis of empty space.



On the left is seen a man supposed to be in thought-communication with an inhabitant of the canal-traversed planet. We are not informed as to whether the gentleman is Professor Todd or not.



On the right is shown the general principle of Professor Nichols' experiment, in which a radiometer was made to rotate by the action of short waves produced by a spark gap in oil.



A suggestion of the nature of electrons is shown on the right, where they may be represented as convolutions of the ether, assuming that there is such a thing as ether.

researches of Dr. Nichols, a prominent American scientist, whose experiments bear directly on the subject of this article (if this article can be said to have any particular subject).

Our noted contemporary magazine, Science and Invention, gives a brief account of Dr. Nichols' work in demonstrating the identity of heat and electromagnetic waves. Concerning this we might have more to say in some future issue of The Experimenter. For the present, we are concerned with Dr. Nichols' success in producing electromagnetic waves of a length corresponding to that of heat waves; that is ether vibrations of .0002 meters wave-length.

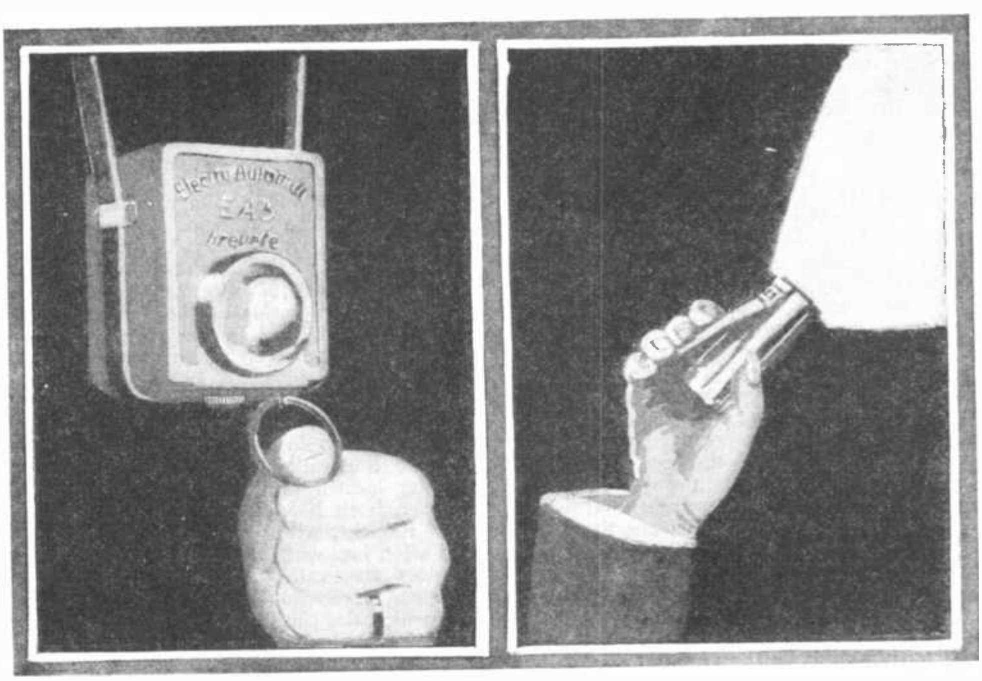
It will be recalled that we said above that the band of vibrations between the heat waves and the short radio waves could not be detected, but it appears that Dr. Nichols has not only succeeded in generating such electromagnetic waves, but has succeeded in detecting them. There is now no "dead" region in the range of ether vibrations, and the entire range has been shown to be electromagnetic in nature.

In the January, 1925, issue of The Experimenter we commented on the structure of matter and showed its ultimate resolution into its constituent electrons and protons. In our present discussion we find that all radiations of energy take the form of ether waves. It would seem, then, that there are two fundamental constituents of our Universe: electrons and ether vibration.

Are these two factors of natural phenomena really distinct or are they merely two forms of the same thing? May not, for instance, the electron be but a convolution of the ether? This, perhaps, would explain why, as an electron moves through space it sets up electromagnetic fields, or, as its position is altered, within the atom it radiates ether waves.

It is a curious thought—one that without robbing life of its zest—would reduce it to one all-pervading medium. To think that the food we eat is but an aggregate of little twists, little "knots" in the ether, which have the power of sustaining us, who ourselves are but forms of ether, and that by the action of another peculiar cluster of ether convolutions, which we call our brain, we can give rise to the ether vibrations which we call thought, and which we are now engaged in rendering in an intelligible form through the medium of ink and paper which are themselves forms of electrons, that is, of ether convolutions—these may seem whimsical, but certainly not impossible. Ether would then be both the cause and effect of this article, indeed, the beginning and the end of all things.

Electro-Automate Lamps



Two models of the Automate lamp are shown above, one operated by a chain-pull, and one by a lever.

IN the electro-automate lamps, the current necessary is produced by a small and compact magneto ingeniously built inside of the body of the lamp.

This magneto is actuated through a simple mechanism by the operation of a lever in some models, or of a chain operated in either case easily by hand.

(Model 2.) The illustration shows one of the most popular types.

They require a very small amount of power to operate, and this is a feature only obtained by the design of the magneto proper and by the good workmanship of all the parts: the normal speed of the revolving element, which is the permanent magnet composed of a *cylinder* to which two pole pieces are attached, is approximately 1,200 revolutions per minute, and the voltage obtained of 2.5 volts supplies a lamp giving a very white and brilliant light: a bull's-eye type of bulb is employed which takes only .15 ampere

The absence of batteries give these lamps a well marked advantage in reliability: also the upkeep expenses being nil makes them economical in use.

The sample illustrated weighs only 12 ounces and there is a model having as body a plain cylindrical tube which weighs only 10 ounces, thus making them very convenient to carry in the pocket.

(*Continued on page* 416)

EXPERIMENTAL RADIO

Conducted by Clyde J. Fitch

Radio Power Transmission

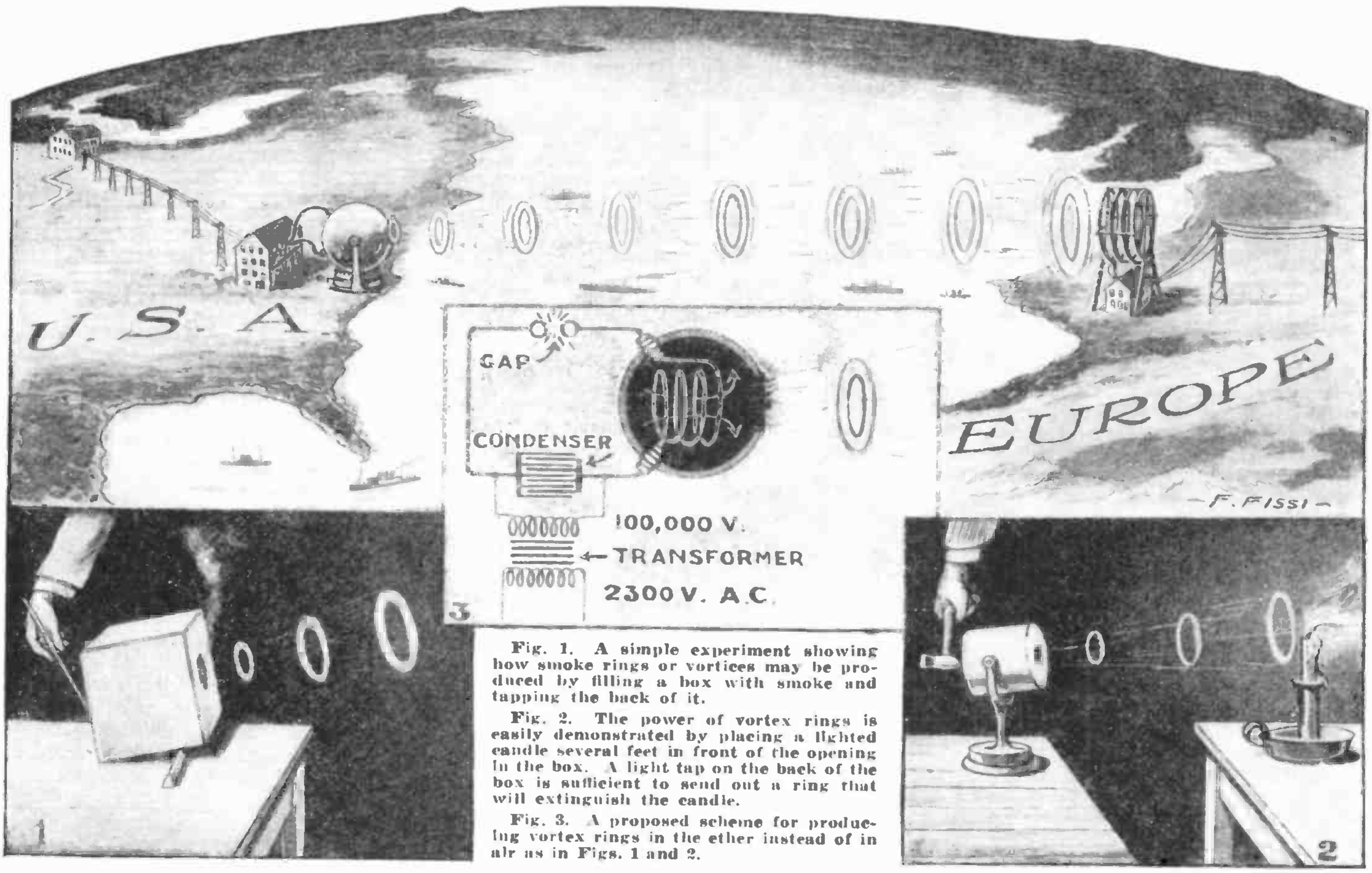


Fig. 1. A simple experiment showing how smoke rings or vortices may be produced by filling a box with smoke and tapping the back of it.

Fig. 2. The power of vortex rings is easily demonstrated by placing a lighted candle several feet in front of the opening in the box. A light tap on the back of the box is sufficient to send out a ring that will extinguish the candle.

Fig. 3. A proposed scheme for producing vortex rings in the ether instead of in air as in Figs. 1 and 2.

EVER since Hertz demonstrated the principles of electric wave transmission, scientists have been trying to utilize this phenomenon for sending power over great distances without wires. Upon leaving the aerial system, radio waves radiate in all directions and very little energy is picked up at the receiver. In order to transmit power by radio, the waves must be concentrated so that a large portion of the energy can be absorbed at the receiver. Loop transmission and the Marconi beam systems have concentrated the waves to a certain extent, but not sufficiently for power transmission.

Among the various schemes proposed perhaps the wildest one is depicted above. Before describing this in detail, we shall consider the simple experiment shown in Fig. 1. We are all familiar with vortex rings. Textbooks for instruction in the high schools and colleges have for years carried descriptions of the vortex ring experiments which have always been considered a physical oddity.

A box of ordinary cardboard from six to ten inches on a side and six inches in depth will serve. A circular hole of three inches in diameter is cut in the front. When filled with smoke, light taps with the finger on the back of the box will send out a series of smoke rings. Sometimes a drum head on the back of the box gives better results.

The experimenter will note that by placing a lighted candle from 10 to 20 feet in front of the box, only a small tap on the back is necessary to extinguish the candle. This is illustrated in Fig. 2. In this case, a ring of air shoots out from the opening with considerable speed and blows out the candle. The invisible air ring extinguishes the candle long before the smoke ring reaches it. The smoke ring is but a visible trace of an invisible vortex ring. Every smoker at some time or other has blown smoke rings from his mouth.

The great power of these rings has recently been demonstrated when a box kite at a distance of 100 feet was completely wrecked by a small vortex ring machine in which an explosion of gas ejected the ring from a hollow sphere.

It has been proposed to erect huge vortex ring machines that will emit a series of explosions, machine-gun style, and send out a series of rings for destroying enemy airplanes. The diameters of these tense rings will be regulated by the focal length of the vortex chamber and by the size of the aperture from which they emerge, so at the point of impact with an enemy plane the direction of the upward forces will tend to tear the wings from the body of the plane and drop it a hopeless wreck, possibly in flames, to the ground below.

The question now arises as to how vortex rings in ether, or the medium through which radio waves travel, can be formed. If such rings can be formed in ether, it seems that the release of a large amount of energy in a properly designed *radio* vortex-ring machine would send out an ether wave in the form of a ring a considerable distance at the speed of light and the entire energy would be concentrated in this ring.

The illustration shows the radio vortex ring machine as a huge metal sphere with an opening in one side. Inside of the sphere is an inductance coil which is connected externally to a high voltage condenser and spark gap. The condenser is charged by a high voltage transformer until the gap breaks down as in the old spark transmitters. This sets up powerful electromagnetic waves about the coil inside of the sphere. These waves are reflected by the sphere and pass out of the aperture, producing the invisible radio vortex rings. A succession of spark discharges would send out a series of rings a considerable distance and little energy would be lost in the transmission.

The illustration above shows the transmitter located in the United States, where power from Niagara Falls is available, and the receiver, which consists of a large loop of wire, located in Europe. Transmission of power across the Atlantic Ocean is illustrated, merely to show the great distances at which the rings might possibly be propagated. Perhaps these radio rings may be used to destroy enemy airplanes by inducing high voltages in the metal parts or in the ignition system which would break down the insulation and stop the motors.

Electrostatic Loud Speaker

By Vilh. Wardinghausen

COPENHAGEN, DENMARK

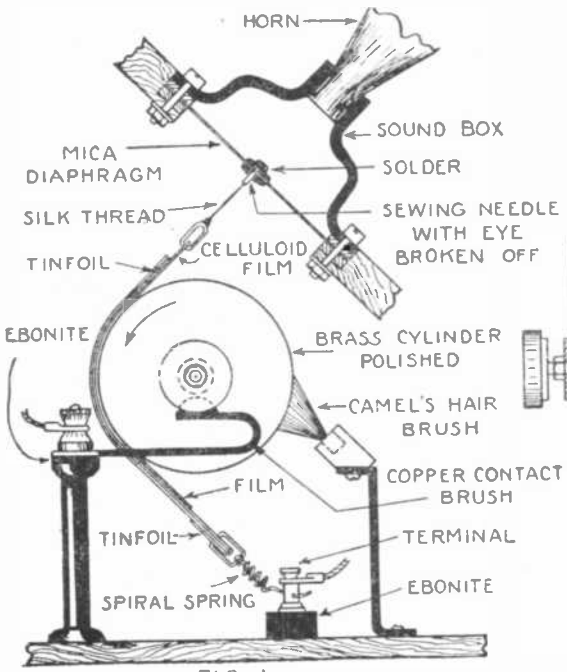


FIG. 1

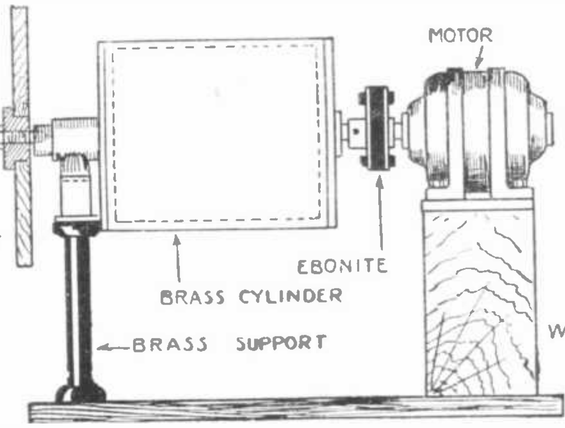


FIG. 2

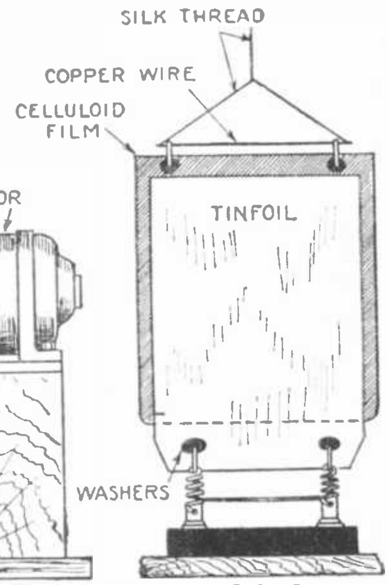


FIG. 3

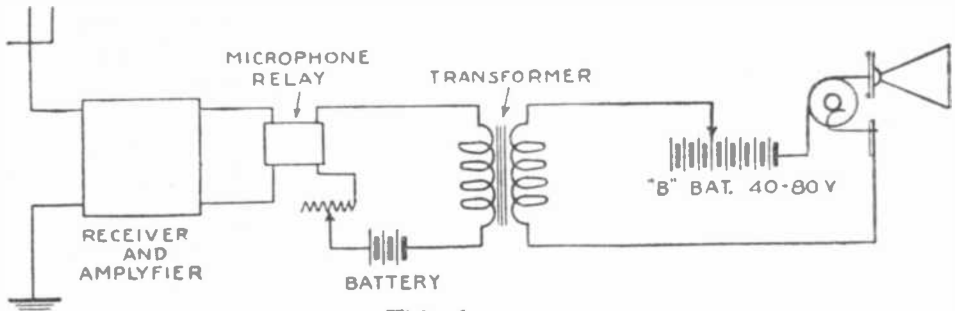


FIG. 4

In the electrostatic loud speaker shown in detail above, the diaphragm is actuated by the tension on a celluloid film which forms the dielectric of a condenser whose plates are represented by a rotating brass cylinder and a sheet of tinfoil. A battery of from 40 to 80 volts is connected between the tinfoil and the cylinder, causing an attractive force between these latter. This force is varied in accordance with the audio frequency currents impressed on the circuit, and these variations are then communicated to the diaphragm of the loud speaker. The electrical circuit is shown at the left.

THIS is a cheap, reliable loud speaker, based on the electrostatic principle of attraction between conductors and semi-conductors (Johnsen-Rahbeck, talking stones), and it is now replacing, in Denmark, the expensive loud speakers such as Magnavox, Amplion, etc., and it will soon be introduced to the American people and perhaps will be utilized in the coming election of the new President in the United States.

The accompanying illustrations show the details of construction. An insulated brass cylinder 60 mm. (2⅜ inches) in diameter, 75 mm. (3 inches) long, with shafts and necessary bearings, is coupled to a motor or other means for rotating it at a uniform speed The surface must be free from scratches and is highly polished, and is kept clean by a soft camel's hair brush, pressed lightly against the surface. A phosphor bronze spring 100 mm. x 12 mm. (2½ inches x ½ inch) is bent as shown in Fig. 1 and is fitted with a soft copper brush, which passes firmly against the shaft of the cylinder, while the other end is supported by a brass binding post for connecting to a wireless set.

The semi-conductor consists of an ordinary photographic film 100 mm. x 65 mm. (4 x 2⅝ inches). It is freed from the film in warm water, cleaned and dried and then covered on one side with three or four layers of tinfoil 100 mm. x 59 mm. (4 x 2½ inches) in a condenser, Fig. 3, and the foil is fastened as smooth as possible with varnish (celluloid scraps dissolved in acetone or amylacetate). One end of the celluloid is fastened to a mica diaphragm about 70 mm. in diameter (2¾ inches) as shown in Fig. 1, the band passed around the cylinder and the tinfoil end is then connected to a binding post as shown for connecting to the battery by spiral springs, giving the necessary friction between metal surface and celluloid.

The whole apparatus is placed in a wooden box and the mica diaphragm is fastened between two metal rings at the front side, which preferably is slightly inclined, thereby increasing the friction between conductor and semi-conductor. An old gramophone horn is placed over the diaphragm, and a regulating resistance for the motor is preferable. The batteries are ordinary dry cells, "B" batteries of 40 to 80 volts.

The celluloid band with tinfoil and brass cylinder surface together constitute an electric condenser. The cylinder being highly polished, the distance between surfaces of contact is as small as 1/100 to 1/200 mm. (1/2500 to 1/5000 inch), and as the effect of a condenser, of course, is stronger as the two conductor plates come closer together, this system is bound to give excellent results. When the circuit is closed, a feeble current is found to flow through the celluloid band, which, strange to say, firmly clings to the metal surface and is immediately released, when the circuit is broken. The mica diaphragm is, therefore, actuated in accordance with the fluctuations of the current supplied when the cylinder is rotated.

In *Practical Electrics* of June, 1922, page 307, there will be found a very interesting article on electrical adhesion, for which we were indebted to the Electro-Technische Zeitung, the great German authority.

In this apparatus the adhesion between a polished brass plate and an agate cylinder is modified by the very minute electric current which can be passed through the junction. The current will, of course, be cut down greatly by the resistance of the agate cylinder, and our readers will see in it a close approach to the loud speaker which is described in the present article.

The use of a rotating cylinder with an electrode bearing upon it, the resistance between cylinder and electrode being varied by changing electric currents, was used by Mr. Edison in his famous chalk loud speaking telephone. In it a cylinder of chalk, which was impregnated with an electrolyte, was rotated, and the passage of current affected the adhesion, which in turn acted on a diaphragm as shown in the new loud speaker described here.

It is quite interesting to trace this use of a cylinder from Mr. Edison's very wonderful old-time invention through the agate cylinder phase, and then down to the present loud speaker in which the high resistance element is represented by a film of celluloid, there being no high resistance cylinder.

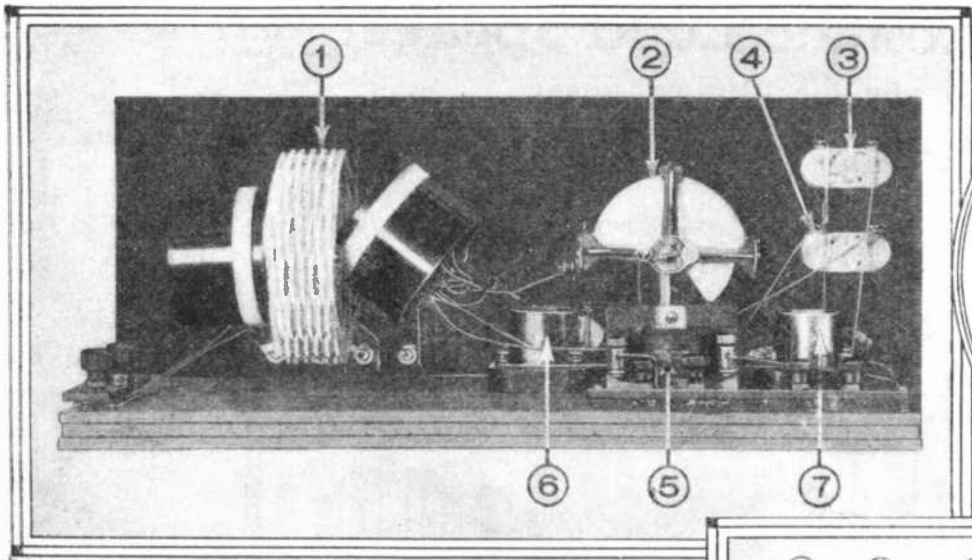
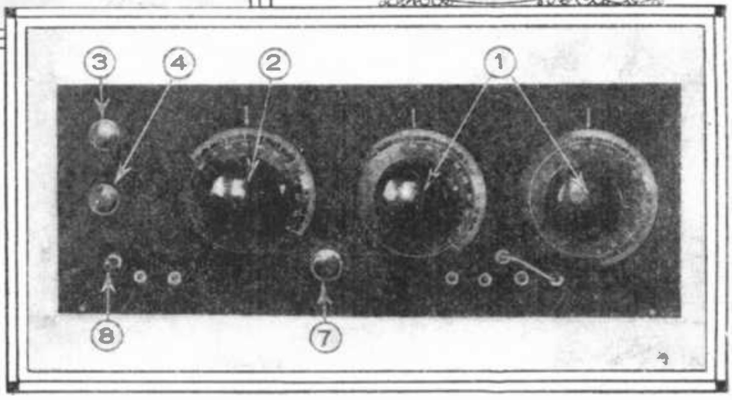


Fig. 1 below. Front view of the short-wave receiver. This set covers a wave-length range of 40 to 205 meters. It may be adapted to broadcast reception by connecting a fixed condenser to the contacts provided for it. Fig. 2 below. Rear view of the short-wave receiver showing the arrangement of parts. The numbers indicate the following parts: 1, low loss coupler. 2, low loss condenser. 3 and 4, filament rheostats. 5, audio transformer. 6 and 7, vacuum tube socket. 8, filament switch.



Getting on the Air

By A. P. Peck, 3MO, Assoc. I. R. E.

(This second article by Mr. Peck, dealing with amateur radio, covers the design and construction of an efficient type of short wave receiver.)

THOSE who read the first article of this series appearing in the preceding issue of this magazine are by this time undoubtedly very anxious to begin the construction of a receiving set which will enable them to listen in on the various amateur stations distributed throughout this country and put into actual practice the code which they spent many hours in learning. Such a receiving set is described in the paragraphs below and is illustrated here.

You may wonder why this article of this series does not deal with the construction of an aerial. Seemingly, the aerial would be the most logical part of an amateur station to describe next. This, however, is not entirely true as the antenna of an amateur's station is important only in transmission. Practically any aerial not over 100 feet long can be used for amateur reception with a receiver of the type we describe. An antenna erected for broadcast reception can be employed just as well as any other because of the untuned primary used in this receiving set. An antenna suitable for short wave transmission will be described in a future article. In the meantime you can go ahead and assemble your receiving set following the plan given herewith and you may be sure that it will give excellent results. A receiver of this type is now in use in the writer's station. It is situated in central New Jersey, and practically every district in the United States has been copied within a very short time.

The writer claims nothing new for this circuit. It is the usual type of so-called three circuit tuner utilizing two tubes—one as detector and the other as an audio amplifier. The circuit is shown in Fig. 4. The tuning coil is of rather unconventional construction, but nevertheless is very efficient.

OUR COVER

We are pleased to present in connection with this short wave series our cover illustration of a well-known amateur short wave station. This is amateur station 3BQ, Box Hill, Victoria, Australia, which has worked many U. S. A. and English amateur stations. The transmitter is supplied with 1500 volts through an electrolytic rectifier consisting of 104 jars. The tube is a Philips Z4 operated at a normal plate current of 100 milliamperes. The remarkable work accomplished by this station and many similar stations throughout the world should stimulate the interest of our readers in amateur radio.

The Coupler

The most logical point to start the description of a set of this nature is with the coupler or tuner. This instrument will be noted in the various photographs, Figs. 2 and 3, as being mounted on an aluminum framework which gives rigidity to the coils and at the same time places them far enough away from the panel, so that little, if any, body capacity effect will be noticed. If the amateur makes his own coupler, it can of course be mounted in any manner desired. It is preferable, however, to mount it at least four inches from the panel using bakelite or metal rods as may be desired to control the two movable coils. The primary of this coupler is wound on a 2¾-inch bakelite tube and consists of six turns of No. 16 or 18 D.C.C. wire, wound on the end of the tube as shown. The shaft is fastened to the other end. By using this offset method of control, extremely loose coupling may be used when such a procedure is desired or rendered necessary by interference from local stations. The tickler coil is wound on a similar tube and mounted in the same manner, but the winding consists of 10 turns of No. 20 D.C.C. wire.

It was found that when these dimensions were used in constructing the coupler that variation of the tickler coil had practically no effect whatsoever on the wave-length to which the set is tuned. This is of great advantage, particularly on the shorter waves.

The secondary which in this case is stationary and is supported by two bakelite strips is wound in the basket or Lorenz

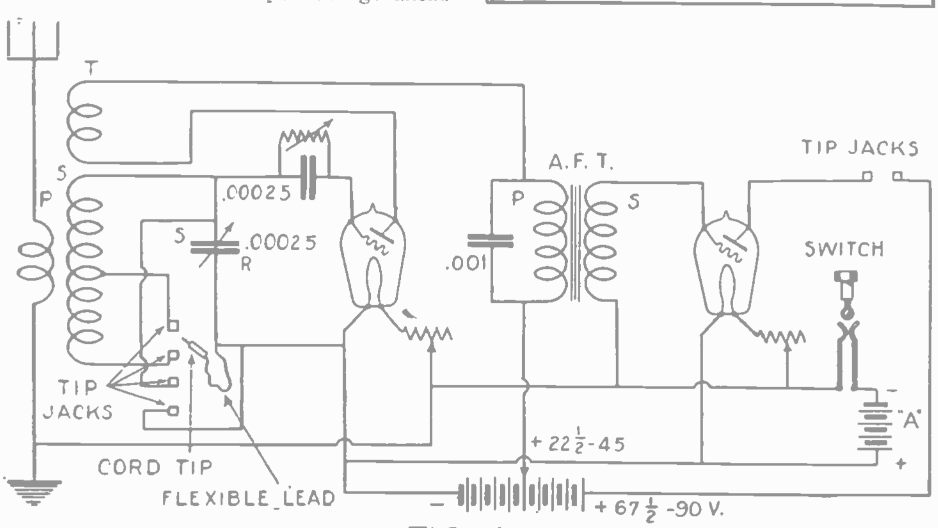
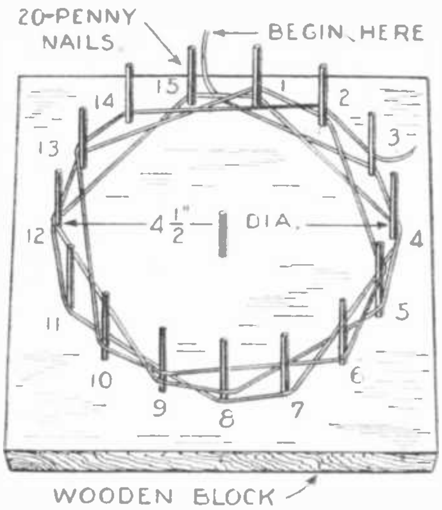


FIG. 4

Hook-up of Mr. Peck's short-wave receiver. Note that a standard regenerative circuit is employed. The tip jacks allow for adapting the receiver to the broadcasting wave lengths.



Winding form for the low loss coupler coils used in this short wave receiver.

form. It is four inches in diameter and consists of 19 turns of No. 12 or 14 D.C.C. wire with a tap at the 10th turn. A tap placed in this manner enables the tuner to be operated on a wave-length as low as forty meters.

The winding form of the secondary consists of 15 twenty-penny nails with their heads cut off, placed in a circle four inches in diameter (see Fig. 5). The winding is accomplished by bringing the wire under every third nail and over the intermediate ones as shown. After the required number of turns have been wound, the entire winding is pulled part way up the spikes from the base and bound with cord in three or four places. The wire may then, with care, be entirely removed from the circle of nails and waxed cord is threaded in and out as shown in the photographs, placing an overhand knot at each intersection of the core. After this is accomplished it will be found that the wire will support itself quite firmly and it may be mounted in the manner shown.

The Condenser

It must be realized by all that when reception is accomplished on the shorter wave-lengths, all losses must, as far as possible, be eliminated from the apparatus. Therefore, a standard type of very efficient low loss condenser was selected for this receiver. It may be seen in the illustrations, Figs. 2 and 3. With this condenser it is possible to tune the set as low as 40 meters wave-length, using the tap on the secondary inductance as one of the connections.

Tube Control

In a receiver which must be kept in oscillation during practically all reception, the subject of tube control is an important one. The filaments must be controlled in a smooth and even manner, and it is of great advantage to have this control absolutely noiseless. There must be no breaks in the filament circuit as the series resistance (rheostat) is varied. Therefore, the Bradleystats shown in the photographs, Figs. 2 and 3, were selected as fulfilling all of the required conditions. Furthermore, with the improved instruments, it is possible to use any tubes in the circuit without changing the rheostats. It is only necessary to change the voltage of the "A" battery. By doing this, either 1.1 or 5 volt tubes may be used in the same socket and with the same rheostats.

In an oscillating circuit, the adjustment of the grid leak is a very important point. Therefore, a carbon pile type of leak was chosen. Using this instrument, wonderfully smooth control of oscillation was obtained, and it was possible to quickly determine the correct grid leak resistance for any particular tube used. Furthermore, under certain conditions, some signals may be brought in much louder by correct manipulation of the grid leak, which manipulation can be learned quickly by practice. With the leak described, a small grid condenser can be fitted across the terminals of the leak, which will eliminate the necessity of making connections between these two instruments.

Mounting the Instruments

In order to avoid crowding of the instruments and a consequent possibility of interaction between the fields of the condenser and the coils, a panel 7 in. by 18 in. was selected for mounting this set. Since the shafts of the manufactured coupler were of such a distance apart that two 4-inch dials mounted thereon would leave a space of ¾ of an inch between their edges, the condenser was so mounted that there would be ¾ of an inch between the edge of its dial and the edge of the coupler dial nearest to it. Then so as to cut down the length of the lead from the grid condenser to the tube socket, the leak was mounted directly between the condenser and the coupler with the knob on the front of the panel as shown. The two rheostats were then placed on the left-hand end of the panel with a filament switch directly below them (see Fig. 1).

List of Parts Used in Short Wave Set

- 1 Lopez low loss coupler—40 to 205 meters.
- 1 Bruno condenser—.00025 mf.
- 2 Vacuum tube sockets.
- 1 Audio frequency transformer.
- 2 Bradleystats.
- 1 Bradley leak and condenser.
- 6 Cord-tip jacks.
- 1 Extra cord-tip.
- 1 Bradley switch.
- 3 Dials.
- 1 7 in. by 18 in. panel.
- 2 Small binding post strips.
- 6 Binding posts.
- Wire for connections.

The use of a switch of this type is always desired, particularly when a storage battery is used. By means of it the filament circuit may be opened when the set is not in use, and the rheostats may be left just below their correct working positions.

In order to eliminate all binding posts from the front of the panel and still have the phone connections conveniently located, two cord-tip jacks were placed next to the filament switch. These are little devices such as illustrated in Fig. 6. Using them, it is only necessary to push a cord tip into each of the small holes. Good connection is thereby made and the use of a plug is avoided.

Four more of these cord-tip jacks were used on the tuner and they were connected as shown in the diagram. A flexible lead was connected in the circuit as shown and brought out through a bushing in the panel and a standard cord-tip soldered on the end. By placing this cord-tip in the extreme right-hand jack, short waves from about 40 to 100 meters may be tuned in. Placing the plug in the second jack from the right-hand end enables the operator to cover a wave-length band of approximately 100 to 205 meters.

Sometimes the owner of a short wave set will desire to listen to broadcasting. This may be accomplished by equipping two fixed condensers with cord tips which will just plug into the two remaining jacks of the set of four (see Fig. 7). One of these condensers should have a capacity of .0005 mf. and the other of .00075 mf. These capacities will enable the operator to cover practically the entire band of broadcasting wave-lengths and at the same time by merely removing the fixed condenser from the circuit, amateur stations may be quickly tuned in. The entire arrangement of the various pieces of apparatus and the cord-tip jacks makes a very symmetrical layout as may be seen in the photograph of the front of the panel, Fig. 1.

It will be noted in the top view of this set, Fig. 3, that the binding post panel of the coupler is inverted and you will undoubtedly wonder why such a procedure was adopted. Also, you will notice that the antenna and ground binding posts are at the right-hand end of the set instead of at the left, as is usually the practice. Here is the secret. When copying amateur stations, it is often necessary to finish the fine part of the tuning of some particular station with the left hand, while the right hand is busy copying the signals. Therefore, the set is arranged "left-handed," so that this work may be easily accomplished. Furthermore, the receiving set is placed at the left-hand side of the antenna switch, as will be illustrated in a future article, and the transmitting apparatus with the key and its attendant instruments are placed on the right-hand side. In this way, everything is as handy as it is possible to make it. This fact also accounts for the inverting of the coupler. It was, of course, desired to have the antenna tuning dial nearest to the right-hand end of the panel so as to carry out the scheme of a left-handed set. For this and for one other reason the coupler was inverted. The other reason is that such a procedure makes for shorter leads to the antenna, ground, grid and filament of the vacuum tube circuit.

Tuning the Set

The tuning of this set is simple. Only one tuning control is used and the coupler is so designed that variations of the tickler have little effect on the wave-length. When placing in operation, all the batteries and antenna and ground connections are first made. The tube is then lighted by

(Continued on page 417)

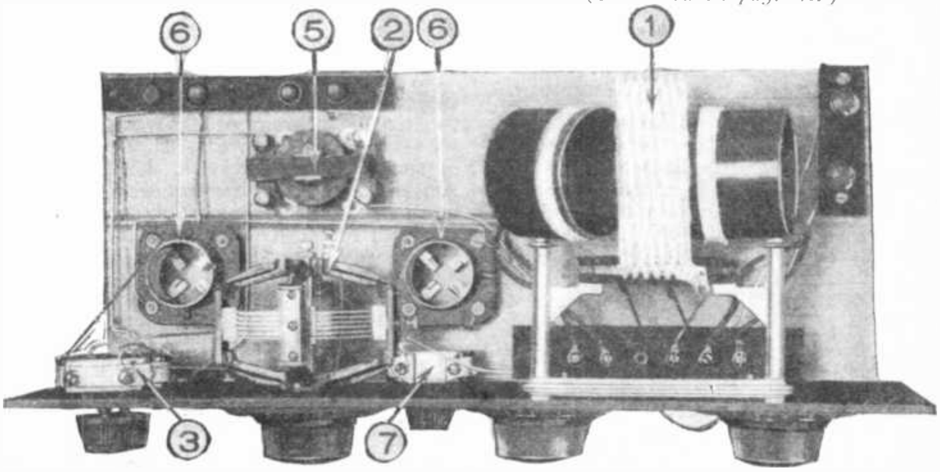
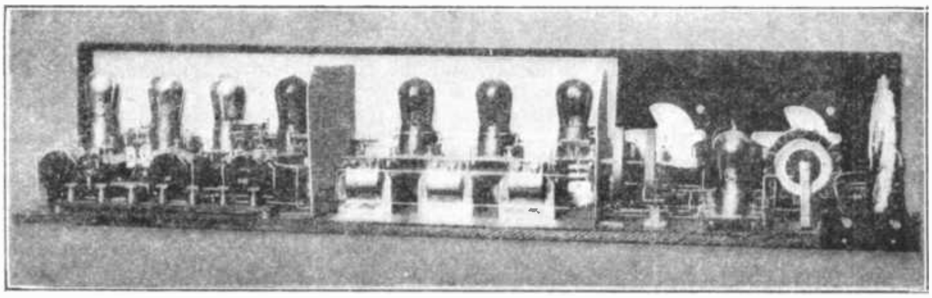


Fig. 3. Top view of the short wave receiver showing the location of the parts on the baseboard. The parts are numbered according to the numbering in the other illustrations.

Super-Heterodyne Circuits

By Clyde J. Fitch

THE experimenter who is thoroughly interested in radio should not fail to investigate the super-heterodyne method of reception. Actual tests have proved that the super-heterodyne is by far the most sensitive receiver in existence today. With a loop, aerial reception may be obtained from coast to coast of the United States. But with all this extreme sensitivity, reports indicate that only about 20 per cent. of those who build this receiver attain what might be called normal reception. A little better understanding of the theory and operation of the super-heterodyne is necessary in order to produce maximum results. We are, therefore, showing five super-heterodyne circuits and will point out the main features of each so that the experimenter can try them out for himself and make his own investigations. Actual constructional data is not given. In trying out these circuits the experimenter should mount the apparatus on a board with plenty of room for connections and binding posts similar to the style outlined in previous articles in this magazine.



Rear view of a typical 9-tube super-heterodyne employing the standard circuit, Fig. 1, with push-pull audio amplification. Note the metal shields between the audio and intermediate amplifiers.

Standard Super-Heterodyne Circuit

Fig. 1 shows a standard super-heterodyne circuit. It is well to start with this circuit as a basis to work on and make all changes and improvements from it. In building this circuit it is well to use a loop aerial exclusively, as when properly constructed the set with a loop will give as good results as any other radio set will give with an outdoor aerial. By using a loop aerial, the comparative efficiency of the set is more easily observed.

We will not go deeply into the theory of the super-heterodyne as this has been covered elsewhere. It suffices to say that this receiver is divided into four parts: namely, the frequency changer, the intermediate frequency amplifier, the detector, and the audio frequency amplifier. The frequency changer consists of an oscillator, tube 1, Fig. 1 and a detector, tube 2. The purpose of the oscillator is to heterodyne the radio currents received by the loop, thus setting up a beat note of a much lower frequency than either the signal frequency or the oscillator frequency. The beat note frequency is equal to the difference between the oscillator frequency and the signal frequency, indicating that the oscillator may be adjusted to a frequency above or below the signal frequency and consequently all stations will be received on two settings of the oscillator condenser dial.

The beat frequency or intermediate frequency may lie anywhere between the incoming radio frequency and the audio frequency at the output. In practice it usually is at a frequency having a wave-length between 1,000 meters and 10,000 meters (300,000 to 30,000 cycles). Excellent results are obtained at a frequency of 50,000 cycles (6,000 meters), and this frequency may be chosen as a basis to work on. The intermediate frequency amplifier consisting of tubes 3, 4 and 5 must be adjusted to amplify at this intermediate frequency of 50,000 cycles.

The intermediate frequency transformers are usually of the iron core type. In Fig. 1 we show the method used in the standard super-heterodyne. The first three transformers are designed to operate over a wide range of wave-lengths from about 2,000 to 10,000 meters. But as sharp tuning is required for this amplifier in order to obtain selectivity, some form of filter coupler is required that will by-pass currents of one frequency only. This consists of a transformer made up of two honeycomb coils, one of which is sharply tuned by a variable condenser. This coil is connected in the grid circuit of the detector, tube 6. Tubes 7 and 8 are audio frequency amplifiers and as the connections are standard, they need not be described here. Note that a variable resistance (R) is connected across the second transformer to control the volume and prevent or reduce circuit noises. A .006 mfd. condenser is absolutely necessary across the primary of the first audio transformer to by-pass the powerful intermediate frequency currents. Low ratio transformers of about 3 to 1 give best results in both audio stages.

The data for building this set is as follows: The loop aerial should be of standard design for broadcast reception. It may be tapped if desired for use for amateur or short wave reception. It is shunted by a .0005 mfd. variable condenser. The oscillator coils may be wound on a three-inch tube, spaced one-half inch from one another. For broadcast reception coil L-1 should have 55 turns when shunted by a .0005 mfd. condenser. For amateur reception it may have 20 turns. Coil L-2 should have 30 turns for broadcast reception and for amateur reception 10 turns wound in the same direction as coil L-1. Coil L-3 is the pickup coil and consists of about 6 turns. No. 22 DCC wire may be used for all these coils.

The intermediate transformers may be obtained from any reliable radio dealer. There are many types on the market. The filter coupler as shown consists of a 300-turn honeycomb coil and a 600-turn honeycomb coil shunted by a .0005 variable condenser. The constants of the other parts are indicated in the drawing.

Model L-2 Ultradyne

As an improvement over the standard super-heterodyne we are showing in Fig. 2 the circuit diagram of the popular eight-tube Ultradyne receiver. This receiver is of simplified construction in that it employs Amperites for the filament current control instead of the usual filament rheostats. There are eight tubes. The oscillator, tube 1, may be constructed according to the instructions given in connection with Fig. 1. The circuit shows two coils of 55 turns and 45 turns, the 55 turn coil being shunted by a .0005 mfd. condenser. The other constants of the circuits are given. Note the 20-turn and 30-turn coils in the modulator, tube 2, for regeneration. Any small variocoupler may be used for this.

In trying these circuits it may be well for the experimenter to build an intermediate amplifier, detector, and audio amplifier in one unit so that the unit may be used for all experiments.

Second Harmonic Superheterodyne

Another improvement on the standard super-heterodyne is depicted in Fig. 3 which shows the circuit diagram of the six-tube super-heterodyne sold by the Radio Corporation of America. Due to lack of information on this receiver we cannot give constructional data for building the set. The action may be described with reference to the diagram and will show experimenters the steps taken by radio engineers for improving the super.

Tube 1 is used as a short wave radio frequency amplifier. It is connected to the loop aerial and the tuning condenser. In the plate circuit of this tube we have a fixed radio frequency transformer designed to cover the entire broadcast range from 200 to 600 meters. This transformer no doubt is of the iron core type and has a secondary winding of only a few turns. The secondary is connected to the grid circuit of the oscillator, tube 2. The oscillator coils and condensers are proportioned so as to give a frequency of half the signal frequency, so that the second harmonic of the oscillator frequency heterodynes the signal frequency. In other words, the oscillator should be designed to cover a wave-length range of 400 to 1200 meters. The grid condenser and leak shown in this circuit may or may not be used.

The plate circuit of the oscillator tube feeds into the intermediate frequency transformer No. 1 which is reflexed back into the first tube as shown. The secondary is connected in parallel with the loop. Therefore, tube 1 amplifies both signal frequency and intermediate frequency. Intermediate frequency transformer No. 2 is connected in the plate circuit of tube 1 and feeds into tube 3. The remaining part of the circuit is standard. The complete circuit gives the equivalent of one stage of short wave R.F. amplification, detector, oscillator, two stages of intermediate amplification, detector, and two stages of audio amplification.

The Tropadyne Receiver

Another simple six-tube super-heterodyne circuit is shown in Fig. 4. In this circuit the first detector and oscillator are combined in the one tube by connecting the loop circuit between the filament and nodal point or center tap of the oscillator circuit. This eliminates one tube from the standard, and by using special tuned intermediate transformers, the volume is increased to such a point that only one stage of audio amplification is required, with the result that six tubes do the work of eight.

The oscillator coupler may be any variocoupler now on the market, and connections are made to the center turn of the secondary coil as shown. Fifty-five turns on a three-inch tube shunted by a .0005 mfd. condenser are suitable for broadcast reception. The constants of the circuit are given and need not be mentioned again. The only critical part of the whole circuit is the grid leak which preferably should be adjustable.

Special Super-Heterodyne

A new super-heterodyne circuit which has

(Continued on page 429)

Super-Heterodyne Circuits

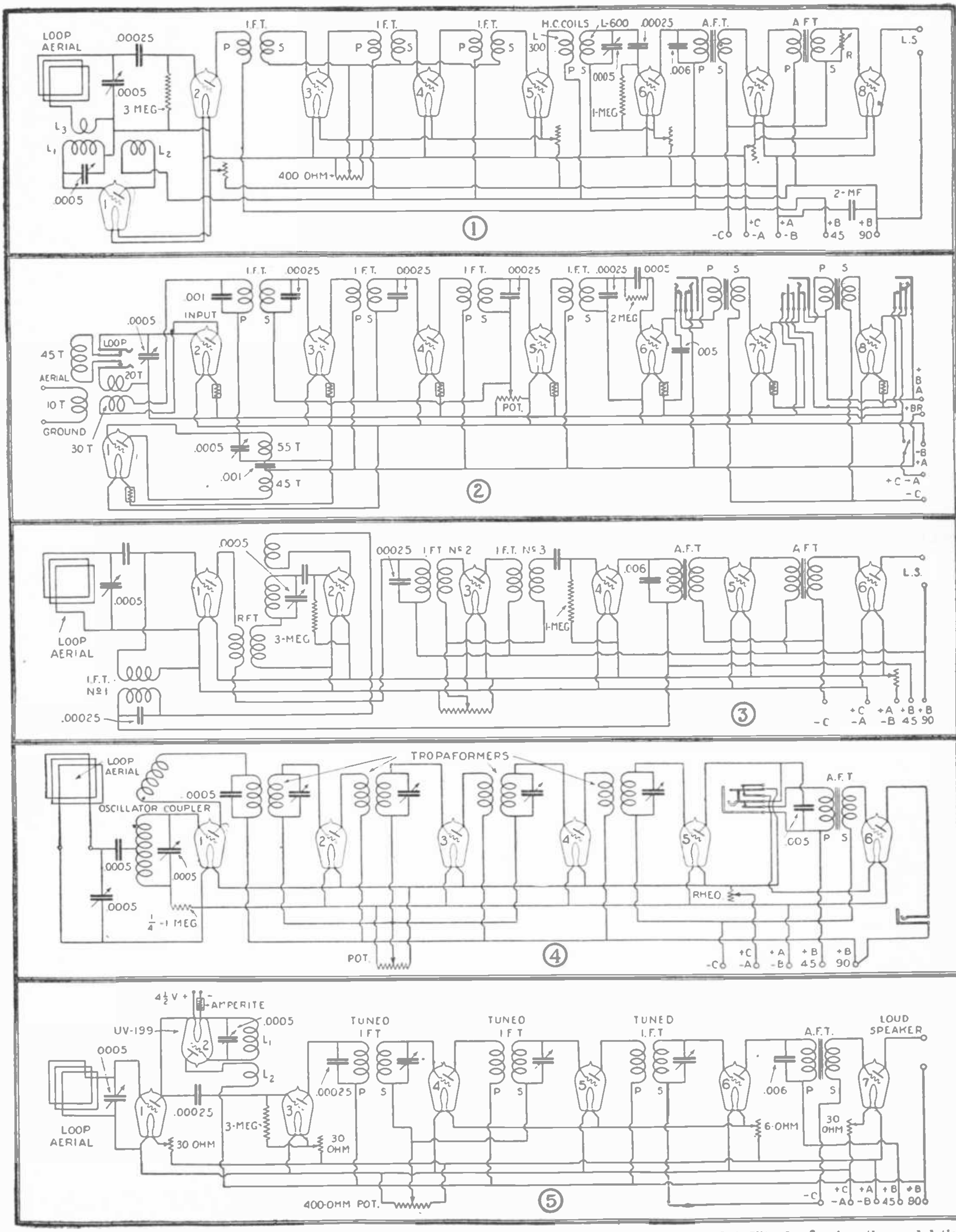


Fig. 1. The standard 8-tube super-heterodyne using transformer coupled amplifiers. **Fig. 2.** The L-2 Ultradyne using the modulation system and regeneration. **Fig. 3.** The 6-tube second harmonic super-heterodyne. **Fig. 4.** The 6-tube Tropadyne using tuned intermediate transformers. **Fig. 5.** A special 7-tube super-heterodyne.

Electrons, Magnets, and Vacuum Tubes

By Jacques Avon

THE little electron about which we are inclined to rant so carelessly is still as mysterious as it is elusive. Like the Hindoo with his bag of tricks, we have learned to make it do certain things under certain physical conditions, but the duration of our "show" is surprisingly short.

There are but two forces which we control that are able to influence it at all. These, aside from heat, are at the same time the only two forces which, to our present knowledge, the electron will respond to. One is a magnetic field, the other an electrostatic field. In our vacuum tubes we take advantage of electrostatic attraction to cause the electrons liberated by the filament to move in the necessary direction. Under certain conditions, we could cause a magnetic field to do the very same thing and it is with the object of awakening experimenters to the possibilities of new work along this line that the writer has prepared this article.

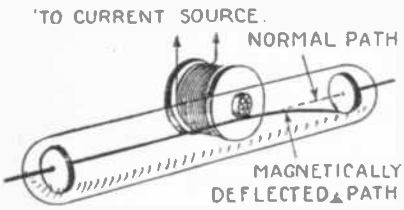


FIG. I

A simple experiment demonstrating the fact that an electron stream is deflected when passing through a magnetic field.

In the early days of the vacuum tube, amateurs used to be alert to every trick that would in any way better their tube operation, for vacuum tubes in those days were not nearly as efficient as they are today. It was generally known at the time that a magnet, when placed in a certain position outside the tube, would beneficially affect tube operation. Of course, this was done by controlling the electron stream; aiding the electrostatic field with the magnetic field. Such a thing would often double the sensitivity of tubes without in any way interfering with the quality of the reception. The modern vacuum tube is still susceptible to this treatment and one-bulb set operators will often be able to materially increase their range of reception by finding just the right spot in which to place the magnet. The magnet used should be a fairly strong one. The type supplied with magnetos is beautifully suited to work of this nature.

Some idea of the influence of a magnetic field upon an electron stream can be had from the classical experiment, usually performed in the physics course for the benefit of college students. An electron stream is caused to flow between an anode and a cathode in a highly evacuated tube. When no magnetic field is present, this stream

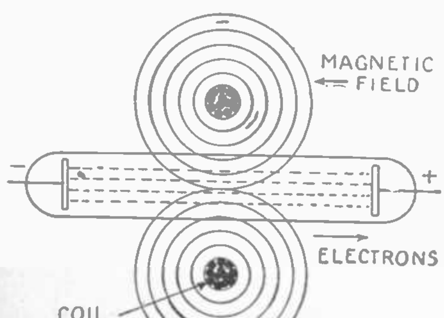
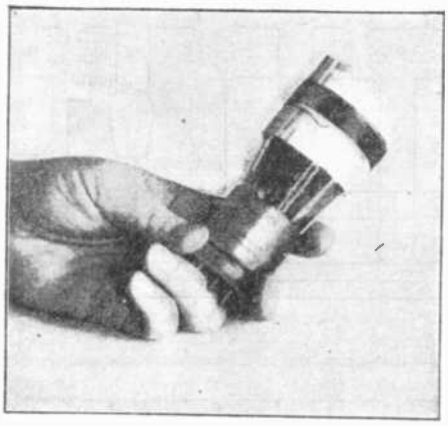


FIG. 2

By proper arrangement of the magnet coils the magnetic field increases the flow of electrons.



The method of winding a magnet coil around a detector tube is clearly illustrated in this photograph.

flows in a perfectly straight line. If a strong magnet is brought near the tube the course of the stream is immediately changed, as will be seen by reference to Fig. 1. The polarity of this magnetic field is also important and if it is brought to a certain relation to the direction of the motion of the electron but very little influence will be exerted.

This latter fact can best be appreciated by studying the action of a magnetic field created by a coil of wire upon electron flow. In Fig. 2 the writer has shown how this action takes place; that is, how the magnetic field must be arranged to affect the flow of electrons in such a manner as to increase the sensitivity of a vacuum tube. Of course, reversing the direction of the current reverses the field and, consequently, interferes with the free flow of the electrons across the vacuous space.

Before continuing with the remainder of

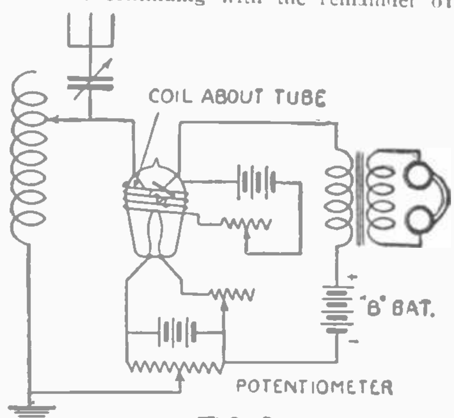


FIG. 3

A practical receiving circuit using a coil of wire around the tube. Note that no grid condenser and leak is used.

the article, the writer wishes to inform the reader that the following material is partly due to the researches of Capt. H. De A. Donisthorpe, who has investigated this subject thoroughly, especially in connection with the modern types of vacuum tubes.

In Fig. 3 the reader will see one of the experimental circuits used by the Captain in his work. Here an absolutely independent circuit containing a small battery, a coil of wire and a rheostat will be seen. The coil of wire is placed around the vacuum tube and the rheostat is included to regulate the intensity of the field produced. It will also be noticed that a potentiometer is employed in place of the usual grid leak and condenser. The remainder of the circuit is not in the least unusual.

Captain Donisthorpe plotted tube curves with this circuit, using both the hard and soft variety of tube. Some of the results of his investigation will be seen in Fig. 4, where the curves for hard and soft tubes are given. In the case of a real hard tube a reduction in plate results if the magnetic field is suitably placed in the path of the electrons. Curve A illustrates just what happens when this effect is produced.

When a soft tube is subjected to this action, an actual increase in the plate current is noted, as will be seen by reference to the diagram in Fig. 4. With this result it must be assumed that the effect of the magnetic field is to increase the electron flow to the plate. It is believed that the molecules of the stray gas left in a soft tube are bombarded by the electron stream and that these striking electron succeed in dislodging other electrons, which are carried away to the plate.

In Fig. 5 the reader will notice how the intensity of the magnetic field is caused to

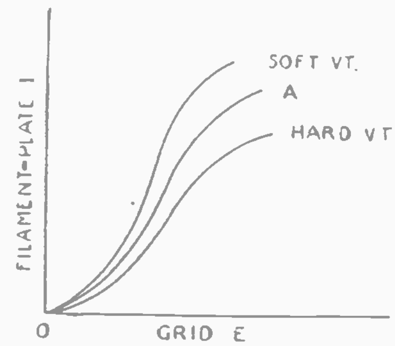


FIG. 4

Curves showing the effect of a magnetic field about a hard and a soft vacuum tube. Note that in one case the plate current is decreased and in the other it is increased from the normal, curve A.

either increase or decrease the flow of current in the plate circuit of the tube. When a magnetic field is applied to a tube there is always a point where further increase in the strength of the field will not increase the flow of current in the plate circuit.

The generally accepted theory of the effect of magnetic field on electron emission is simple enough to understand. In the hard tube there is an absence of ions (molecules that have lost electrons). This leaves nothing but negative electrons subjected to the action of the magnetic field, and some of these are lured out of their regular pathway between the filament and the plate. Consequently there is a reduction in the plate current.

In the case of the soft tube there are a number of stray electrons and ions present. These electrons are caught up and carried on to the plate under the combined action of the magnetic field and the plate charge. The net result of this action is to increase the plate current and consequently the signal strength produced.

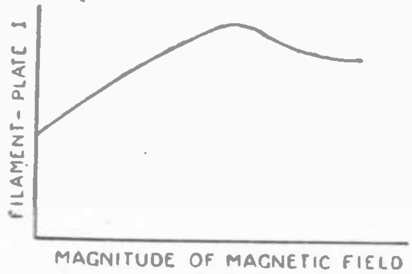
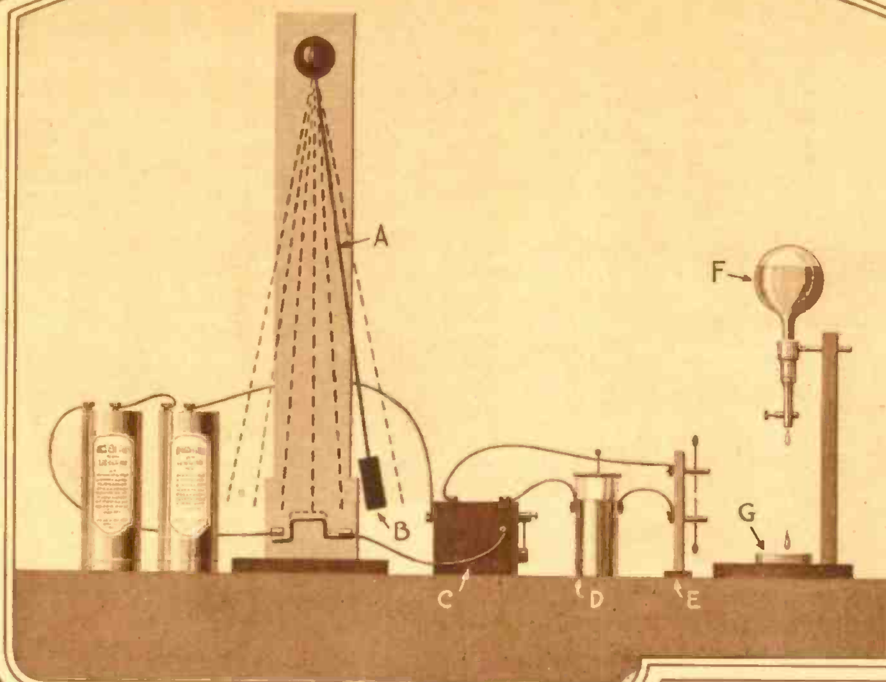


FIG. 5

Curve showing the variation of plate current with the magnetic field in which the tube is placed. The hump in the curve shows the necessity of a rheostat in the magnet coil circuit.

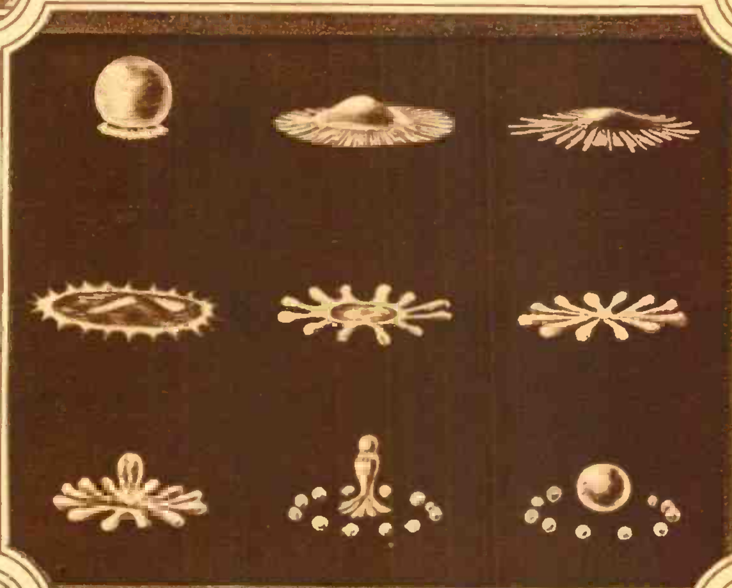
Observing the Splash of a Drop

By Rex Milner

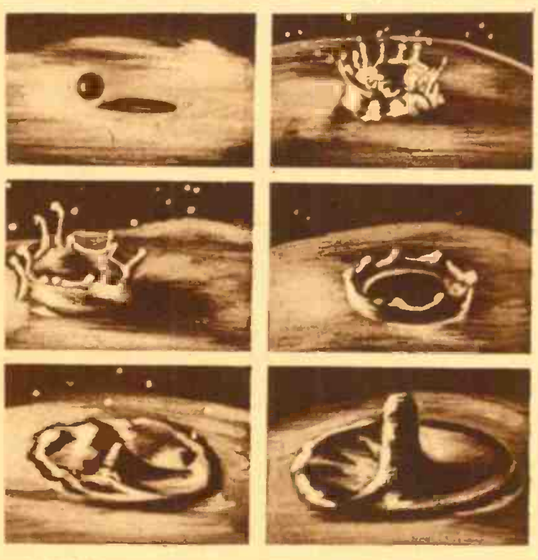


The apparatus at the left is designed to produce sparks at the gap E at intervals determined by the period of oscillation of the pendulum A. By means of this periodic illumination, when the occurrence of these sparks is synchyronous with the fall of drops from the flask F, instantaneous forms of the droplets can be observed.

Above: The bob, B, of the pendulum, A, is a permanent magnet which in its passage over a sheet iron strip attracts the latter and causes it to close the primary circuit of the spark coil C. The secondary circuit of the coil, shunted by the condenser, D, discharges through the gap, E.



The pictures at the right show the successive forms which a drop of mercury assumes upon striking the surface. These observations were made by Professor A. M. Worthington with an apparatus similar to that shown above.



Another set of pictures taken by Professor Worthington showing the splash of a drop falling sixteen inches into milk. The interval of time represented by these pictures is about .1 second.

Falling Drops of Liquid

It is well known that drops of liquid striking a surface, which may be a solid surface or a liquid, will assume remarkable forms. Ordinarily these beautiful patterns cannot be seen, but when observed by the periodic light of a spark gap such as that illustrated above, the drop will be instantaneously illuminated and will give the appearance of a permanent pattern. It is, of course, necessary that the splash of the drop and the spark occur simultaneously. By careful adjustment the spark may be made to occur at different stages of the splash and illuminate different patterns. The illustrations of the drops shown above were obtained in this manner.

Another form of pendulum may be provided with a sharp contact point at its lower extremity connected to the battery. As the pendulum passes the vertical position this point comes into contact with a drop of mercury held in a shallow cup connected to the primary of the induction coil. This form is quite suitable, though not as rigid as the contact device illustrated above.

The Ark of the Covenant

By Victor Mac Clure

[What Has Gone Before]

A number of New York banks have been robbed The time is near the end of this century. The President of one of the banks stands by his son's bedside early in the morning and wakes him. Instinctively the son realized that something was wrong. and seeing that his father was in deadly earnest, no questions were asked, but with his roadster and air plane he undertook to rush him to the city.

They find that throughout the financial district policemen, watchmen, chauffeurs and pedestrians have fallen senseless. Automobile engines have mysteriously stopped. Everything of gold, watches, coins, gold leaf signs and the like have been tarnished. The vaults of a number of banks have been cut open, apparently by oxyacetylene, and robbed.

The tarnishing of the gold is a problem for the chemist, and curiously enough, powdered glass is found in the street to add to the strange events. Heavy little boxes came into the Post Office by mail. Bombs were suspected and upon being opened the boxes were found to contain lead cases whose weight indicated that they were quite thick.

The wonderful Merlin takes an active part in the story, the fastest of all airplanes. The range of the speed dial is insufficient. The mystery deepens when it is found that some millions of dollars of securities have been returned to the banks, but a slightly larger amount of gold has been taken. Anaesthetic bombs are thought of. It develops that the boxes in the Post Office contained some radium compound which accounted for the lead cases. An unheard of amount of the rare salt seems to be in there. A provision store has been robbed and money left to pay for it. Thousands of gallons of gasoline have disappeared from a Standard Oil station.

They go out on the famous Merlin in search of the liner Parnassic after having without success tried to find out how the quantity of gasoline was taken from the Standard Oil station on land; they hear that there was a cabin in the air when the robbery was being perpetrated. Going out to sea, they find the Parnassic apparently abandoned and land upon her. Everyone on her is recovering from a trance, and eventually the Captain goes with them to the treasure safe and finds that it has been robbed.

Lord Almeric, a well preserved man of 60, joins them. The crew recovers. A discussion ensues and it is concluded that the raiders used an air plane. The Merlin starts off after the ship's engines begin to turn, taking with them the charming Miss Torrance, the niece of Lord Almeric, who is also of the party. The personality of the young lady begins to have its effect on the male members of the party. Finally the question arises of how the mystery can ever be solved, what the extraordinary quantity of radium salt means, and as the Parnassic reaches port, investigations into her robbery are in order. Miss Torrance begins again to acquire a more impressive place in the story.

A Louisville Bank is Robbed

"Maybe that's why she asked me to get her one, Mr. Boon. She's a very independent young lady."

Funny how Milliken sizes people up. I never thought of that, and I sort of kicked myself for having so blatantly offered the use of a bus.

We locked the *Merlin* up in a private shed. It was the only way I could induce my mechanic to leave her and come with me to an hotel, though the machine was fully protected in the matter of patents. After dinner we both went along to look up a man in the Air Department, and spent the remainder of the evening talking shop. We got back to our hotel at a late hour and went to bed.

I was awakened at eight o'clock in the morning by a negro bell-hop bringing me a cup of tea.

"Papeh, suh?" he said. "They's bin anuthuh of them bank robbin' businesses down at Louahville, suh—ma home town as wuz. Them robbers is shoh the piratinest white men ah evah see——"

He handed me an extra edition that still smelled of wet printing ink, and across the front page in staring letters ran this announcement:

"THE *PARNASSIC* TRICK PULLED ON LOUISVILLE!

Town Put to Sleep While Four Banks Are Robbed!

Mysterious Radium Gifts Appear Again."

I jumped out of bed and ran into Milliken's room.

"Milliken! Milliken! The raiders have been at it again down at Louisville this morning!"

"A white-faced inspector met us inside the building, and he was immediately joined by a Subaltern of one of His Majesty's Footguards—the Coldstream, I think it was. This officer was as white faced as the policeman, but keeping a stiff upper lip in spite of his obvious misery."

Milliken, who was shaving himself with an old-fashioned razor, turned and looked at me calmly.

"Gracious Jinks!" he said—and went on shaving.

CHAPTER SEVEN

Across the Atlantic

I

For a space I gazed at my mechanic in silence, and nothing was to be heard but the whisper of the razor on his stubby beard. He wiped the soap from the blade and turned.

"When do we start for Louisville?" he asked.

"As soon as we have had breakfast," I said as casually—he was not going to pull off any quiet surprise on me.

We were down at the seaplane-basin by nine, and after filling the *Merlin's* tanks took off just after the hour. We gave her plenty of gas and covered the eight hundred kilometers to Louisville in an hour and forty minutes.

It was useless attempting to get near the robbed banks, for the streets were thronged with people, packed tight and deep. I went right to the headquarters of the air police, where there was a chance that I might be known, and was lucky enough to find the local commander an enthusiastic supporter of the Aeronautical Research Society, of which I was an office-holder.

The raid on Louisville was simply the Wall Street and Newark affair on a smaller scale. The sleep had come upon the police and the watchmen at two o'clock in the morning, and the strong-rooms of the banks had been cut open by the same means as that used in New York. Gold to the amount of a million dollars had been taken from the four banks, with securities to an amount not stated, but these last had been found at the Post Office in two envelopes addressed to local hospitals. The hospitals also were the recipients of a box of radium each, smaller than, but otherwise identical with, those left in the New York Post Office.

Particulars of the Louisville Robbery

The robbed banks might roughly be put in groups of two: the National Bank of Kentucky and the Fidelity and Columbia Trust in Main Street, and the Citizens'-Union National and the Louisville Trust in Fifth Street. It might have been possible for the raiders to have effected their anæsthetizing with two bombs such as I had imagined had been dropped in New York, but though I looked for the smears of glass as best I could in the dense crowd, I was disappointed.

A feature of this raid was that the Post Office had been affected by the anæsthetic, doubtless because it stood across the way in Fourth Street from a large grocery establishment from which a quantity of comestibles had been abstracted. In this food-store, Messrs. Shapp & Zort, money had been left to pay for the goods as in the case of Schomberg's in Newark.

When we arrived, the news had just come through that a gasoline container down the Ohio to the west was showing a deficiency of fifteen hundred litres of aviation spirit. The sequence of coincidence was complete.

"Can you give me any information about the street cars that were running at the time of the raid?" I asked the air police commander.

"There are not many cars run on Sunday evening but the few that were out were stopped—notably one down Fourth Street to the levee," he replied. "The driver in falling took his hand off the safety lever, which of course automatically brought the car to a standstill."

"What about any automobiles?"

"We can only find three that were in the affected districts, and they seem to have been stopped in some way quite unfathomable."

"What sort of patrols had you at the time, commander?"

"Only one scout, who had been out towards the Cumberlands on patrol during the time of the raid. He came back in the ordinary way at half-past four, having seen nothing to report. In fact, he was filling in his sheet when the news came of the robberies. I immediately called out the other scouts, and three of them went up. I then radioed the news to all stations—a general call—but so far there is no trace of the raiders."

A Doped Policeman

"Could you find me someone who was doped?" I asked him.

"I think I could put my hand on a land cop," he said.

We went to the police station and found a man who had been on duty in the affected area during the night. His story was exactly similar to that of my New York friend, McGrath—no noise to startle, nor any smell—there might have been a faint luminosity, he couldn't say.

"Had you any gold about you while you were on duty?" I asked him.

"I have an old gold dollar I keep in my ticket pocket for luck," he said. "Why, sir?"

"Would you mind letting me see it?"

He went over to the side of the cot on which he had been lying when we entered the station dormitory, and took the dollar out of the little pocket in front of his tunic.

"Well, I'm durned!" he exclaimed. "The thing's gone rusty!"

"I expected it would be," said I. "Thanks very much."

My commander friend was rather astonished at what he thought was acumen on my part, and as we went down to the levee, I told him a few facts about the New York raid.

"This is a big thing, Mr. Boon," he remarked as we stepped out on the levee. "It's a national affair——"

I answered without much thought.

"I shouldn't be surprised if it became an international affair."

"International—hey?" He broke off as he saw the *Merlin*. "Say, Mr. Boon, is that your plane?"

Merlins for the Police?

"That's her. My latest model, the *Merlin*," said I, with some pride.

"She's the prettiest thing—and looks fast."

"She is fast. Fast as lightning." And I told him about her.

"Well, Mr. Boon," he said. "Hurry up and sell a copy or two to the air police. If all you think about these pirates is true, we can do with a few like her."

After a close inspection of the plane, we said good-bye, and Milliken and I took off up the river, heading for Pittsburgh. We wanted to see about our new engines.

It was one o'clock when we left Louisville and we made the suburb of the steel town shortly after two.

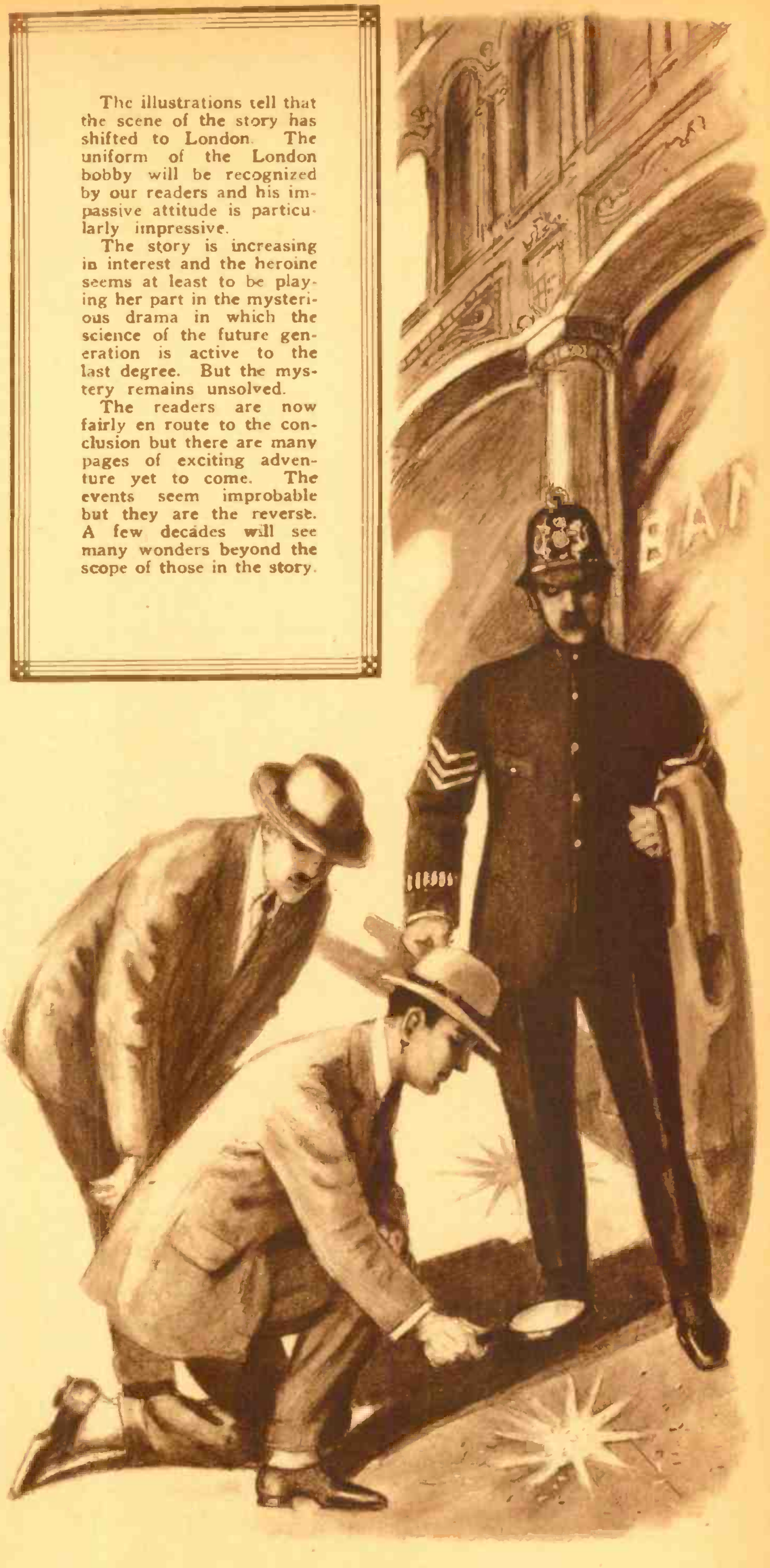
While we inspected the engines, a boy was sent out to bring us in a quick lunch, which Milliken and I ate as we made our inspection. The engines were splendid, and the charts of their tests showed a wide margin of efficiency. They were ready to be crated for their journey. I got an idea, and turned to Milliken

(Continued on page 416)

The illustrations tell that the scene of the story has shifted to London. The uniform of the London bobby will be recognized by our readers and his impassive attitude is particularly impressive.

The story is increasing in interest and the heroine seems at least to be playing her part in the mysterious drama in which the science of the future generation is active to the last degree. But the mystery remains unsolved.

The readers are now fairly en route to the conclusion but there are many pages of exciting adventure yet to come. The events seem improbable but they are the reverse. A few decades will see many wonders beyond the scope of those in the story.



"I hunted around the streets about the Bank in comparative quiet. The London Police are nothing if not efficient, and they had drawn around the district a cordon that was impassable. Only a few civilians were about the streets.

"I found four star-shaped splatters of powdered glass on the Exchange side of the Bank, and two in a sort of courtyard within the buildings. They were perfect in shape, and showed me what the smears I had found around Wall Street would have been but for the crowds that had trampled them about."

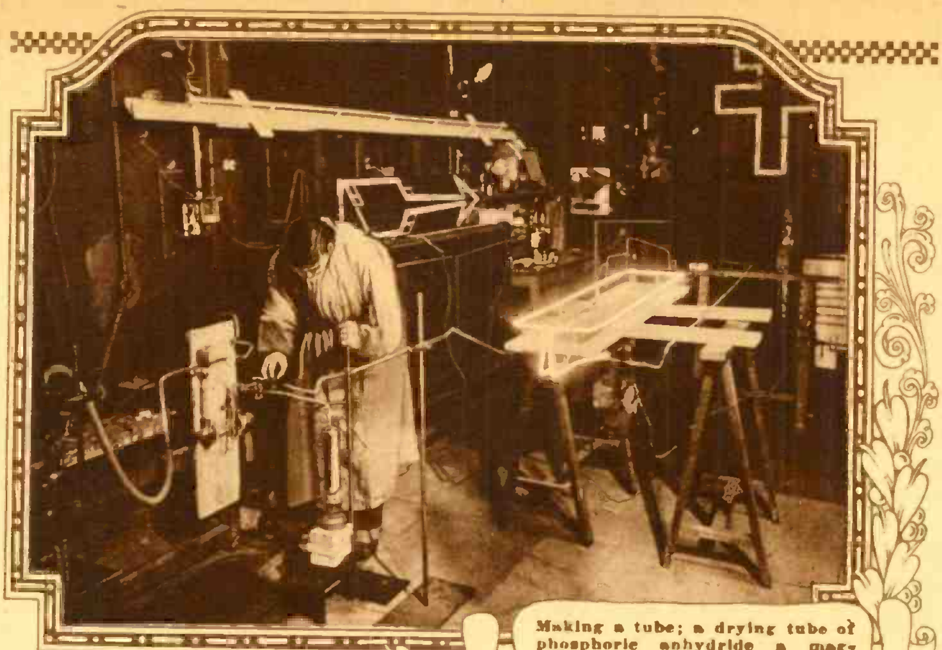
Risler Fluorescent Tubes

EXPOSED to a proper radiation, certain substances and especially sulphides of the alkaline earths at first become fluorescent, giving light as long as the excitation continues. Upon the cessation of this actuating radiation, they persist for a certain time in giving a lesser light, which has received the name of phosphorescence.

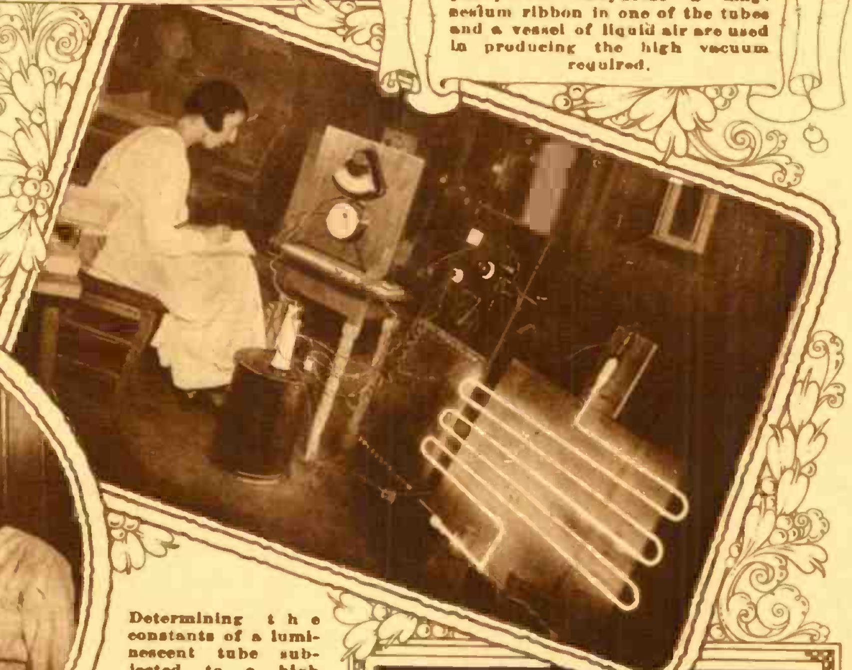
M. Jacques Risler has invented an original lighting system based on these two phenomena. In producing his fluorescent tube he spreads over the exterior surface of a gas-filled tube, in which the gas is at a very low pressure, or he introduces into the batch or material of the glass itself, various substances (zinc sulphide or calcium sulphide), to which traces of copper, bismuth and other impurities give a tinge of color, which may be yellow, green, orange or white, varying according to the salt employed.

Following up the investigations of Guntz, of Claude, of Moore and other physicists, inventors of mercury vapor pumps, of nitrogen, carbon dioxide and neon tubes, he sought to utilize as exciting radiations the gases emitted by metallic salts at their temperature of dissociation. This gave him luminous sources of velvety, shimmering clouds of the most artistic effect. For instance, gallium gave a beautiful violet fluoresence at its temperature of dissociation; sodium gives a yellow color; osmium a blue and thallium a green.

(Continued on page 417)



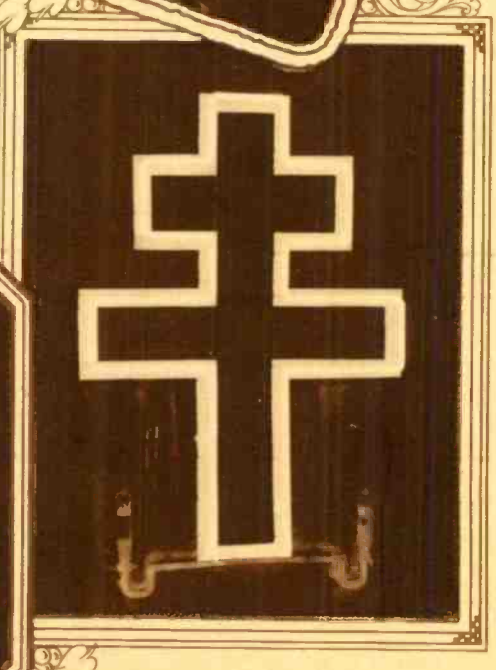
Making a tube; a drying tube of phosphoric anhydride a magnesium ribbon in one of the tubes and a vessel of liquid air are used in producing the high vacuum required.



Determining the constants of a luminescent tube subjected to a high voltage; the ammeter and voltmeter are seen in front of the observer. A transformer and a rheostat are also used to regulate the excitation.

A tube lighted up by a current passing through the human body; this tube contained carbon dioxide. It was coated with a pellicle of zinc sulphide.

Right: A fluorescent tube photographed by its own light.



The Geneva Cross made with the fluorescent tube.

Electric Cooking In Paris Restaurant

Right: Range for making sauces, with two heating elements and three-stage ovens. These and the other ranges are operated by electric heat.

Below: "Ripoche" system oven for preparing pastries. Each class of cooking is provided for in this great kitchen.

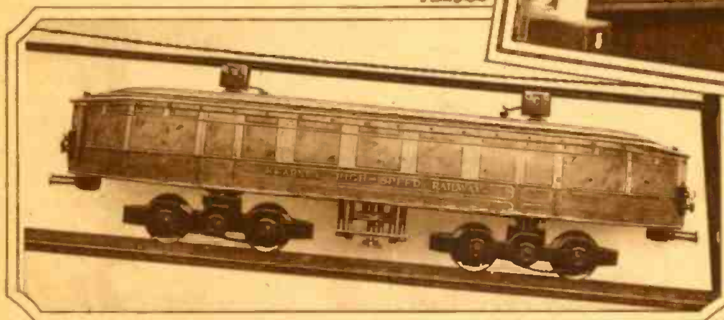
Above: The "communard," a generally useful range for preparing a great variety of dishes. The chef's staff have given it this name.

Left: Roaster and vertical grills, giving true roasting effect instead of the baking, to which our "roasts" are usually subjected. (See page 418)

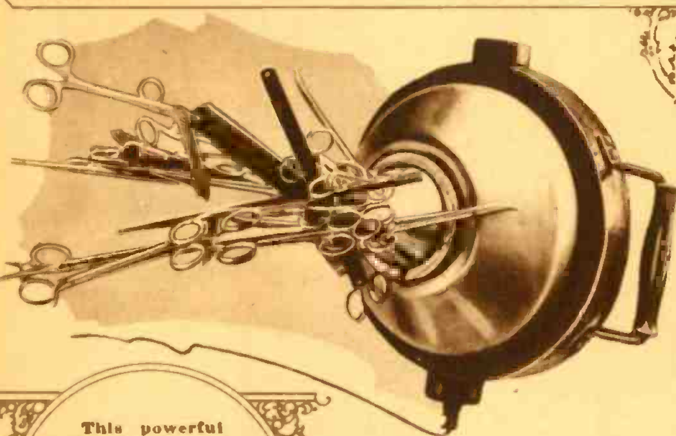
New Things Electric

The photograph at the right shows Mr. Kearney demonstrating his experimental model of a proposed mono-rail electric train. The model works perfectly and is claimed to show numerous advantages over the present types of electric railroads.

The photograph below shows the Kearney mono-rail train negotiating a steep upgrade. Note the stabilizing gyroscope under the car-body.



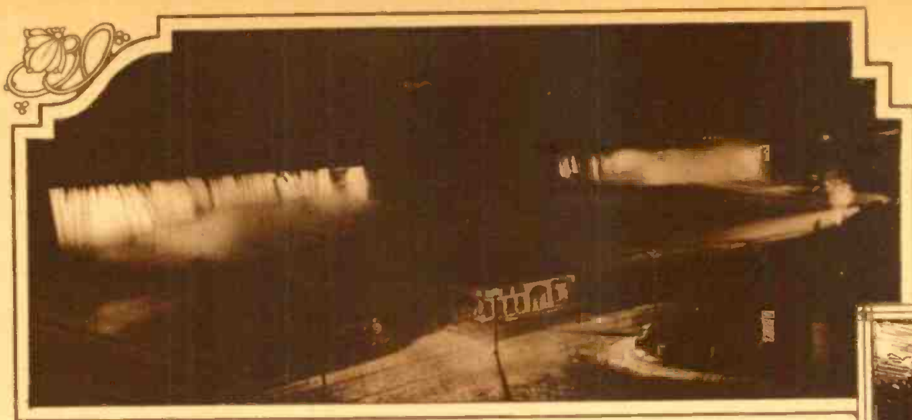
Electricity has invaded the shoe shining parlors with the result of making the labor easier and cleaner. In this instance electric motors actuate the shoe-shining brushes attached to a flexible shaft.



This powerful electric magnet used in the Cumberland Street Hospital, Brooklyn, is able to draw out a needle imbedded in a finger. The photograph above shows surgical instruments attracted by the magnet.

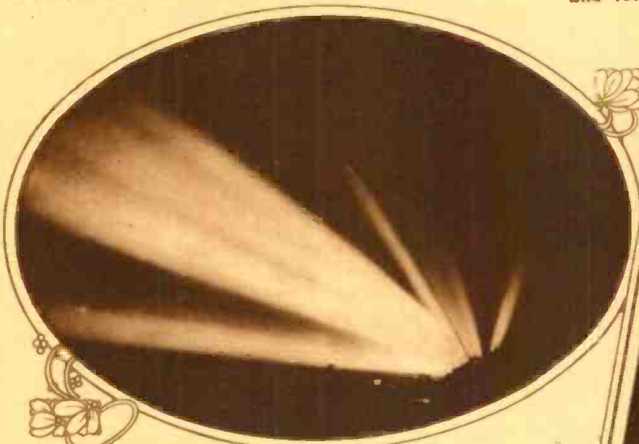
Left: The snow-covered cities of the Baltic region are employing this method of removing snow from the street. Electrically heated melters mounted on caterpillar trucks are fed with snow which is rapidly melted and removed as water through sewer systems.

Electric Lighting of Niagara Falls and its New Power Canal



General view of the Falls as illuminated by a bank of electric lamps. The dark spot in the center is Goat Island; the Canadian Falls are on the right and the American Falls on the left.

Bird's-eye view of the Falls; the Canadian Falls are wearing away the rock and forming a new gorge.

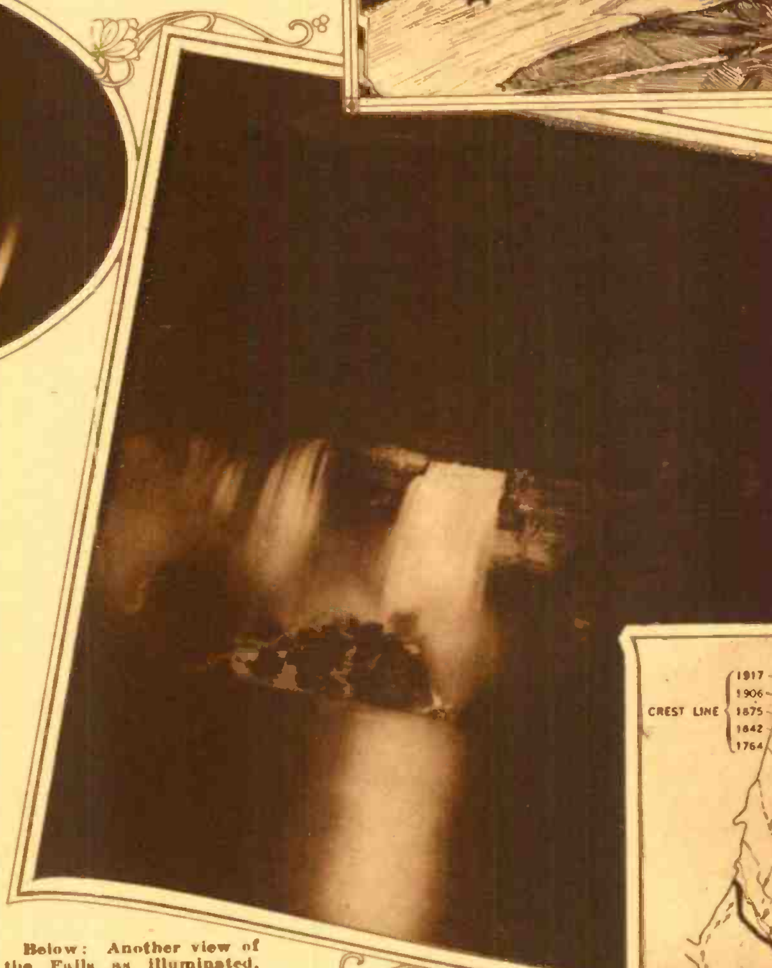


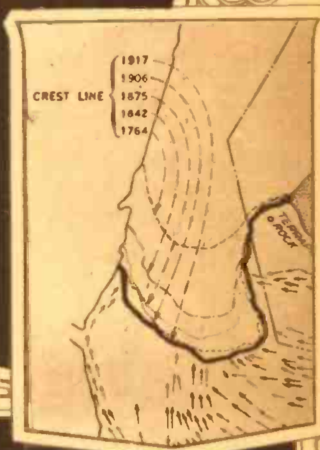
Above: The great light beams projected upon the Falls. It is found that there is no disagreeable theatrical effect produced in the illumination. This year it is going to be more brilliantly illuminated than ever.

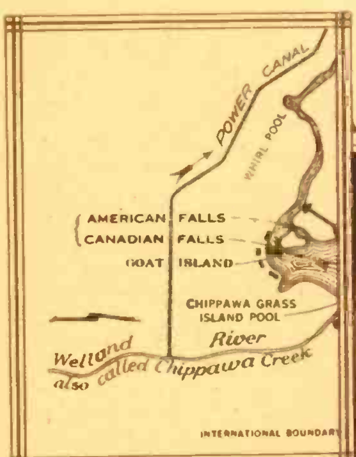
Right: A closer view of the Falls as illuminated, bringing out some features of the rock and trees of Goat Island.

Lower Right: The map shows Chippewa Creek, which formerly emptied into the Niagara River, but whose flow is now to be reversed, and which will be an intake for the new power canal, supplying the great hydro-electric plant situated below the rapids.

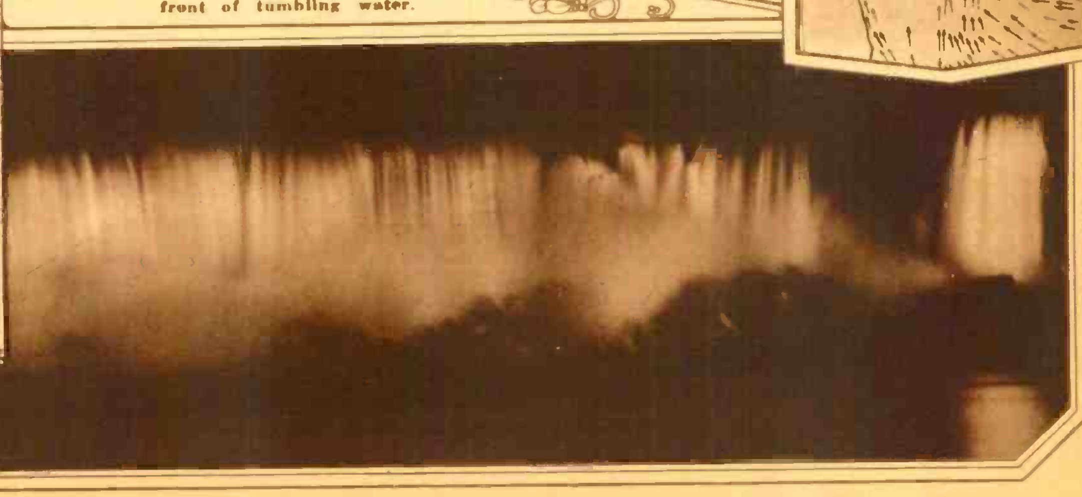
Below: The recession of the Canadian Falls; the edge is receding at the rate of about five feet a year; virtually a new gorge is forming and the Falls are said to be committing suicide. Eventually the recession may affect the electric plant.







Below: Another view of the Falls as illuminated, showing the impressive front of tumbling water.



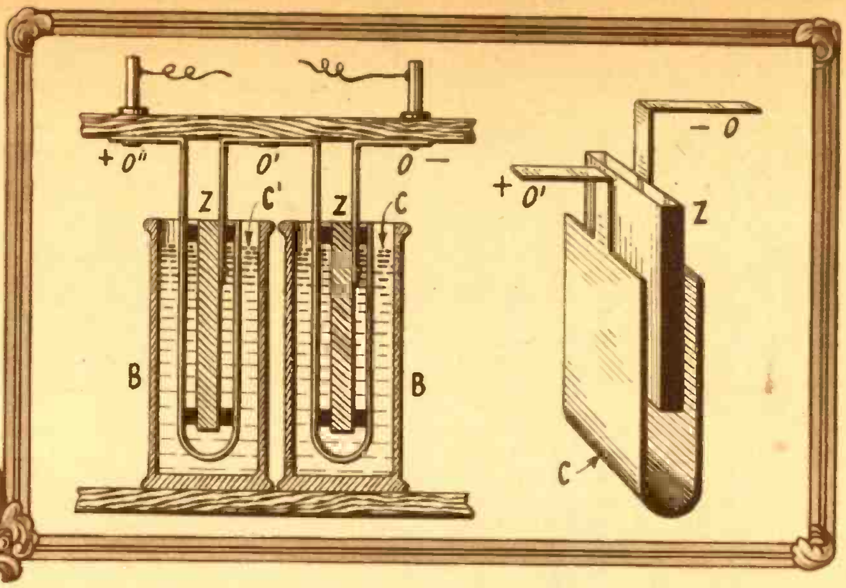
Note the work of fifty-three years in effecting the recession of the Canadian Falls. It is called the "Suicide of Niagara."

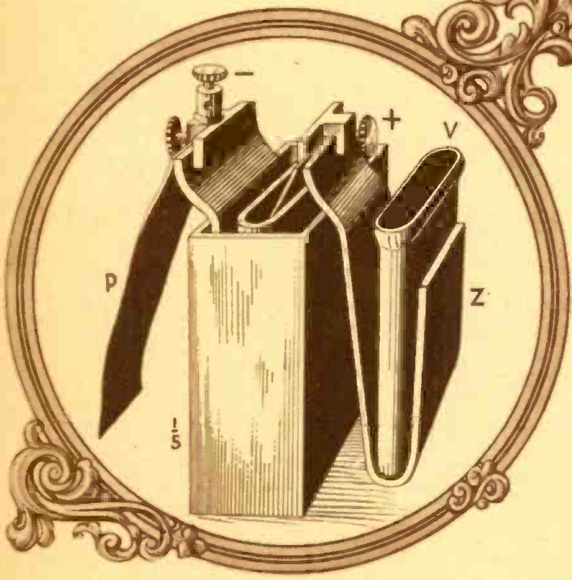
Historic Experiments

Number 6

Early Batteries After Volta

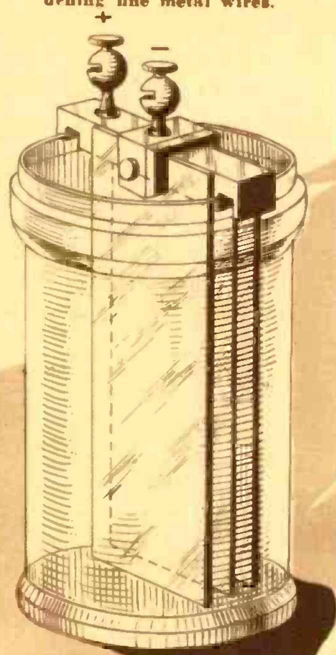
The Wollaston battery at right was first constructed in 1816 and was one of the best batteries of the period. Immersed in an electrolyte of dilute sulphuric acid, contained in a glass vessel, is a plate of copper folded around a plate of zinc and insulated from the latter. The elements are supported on a wooden bar by raising which the plates can be removed from the liquid.

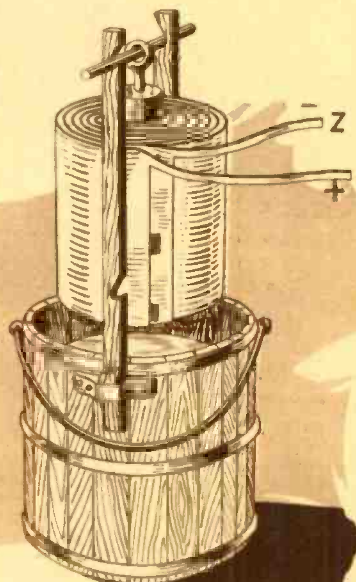


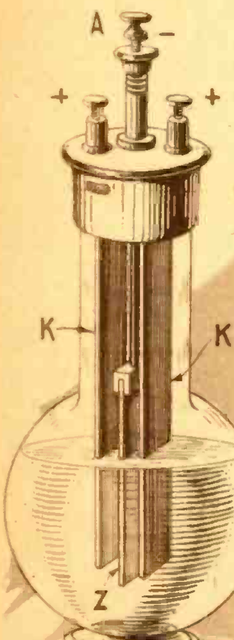


The Grove cell (1838) above consists of a U-shaped electrode of amalgamated zinc in dilute sulphuric acid and a porous cup containing a thin sheet of platinum immersed in nitric acid. The platinum is connected with the projecting portion of zinc in the adjoining cell.

The Offershaus helical cell (1821) at right consisted of long plates of zinc and copper separated by a network of rattan and rolled in a spiral immersed in an electrolyte of dilute sulphuric acid. At the moment of immersion, this couple gives an intense current capable of reddening fine metal wires.

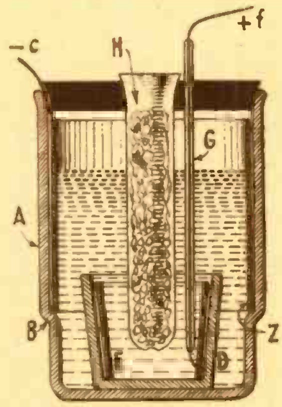






The Smee cell (1840), one of the most widely known batteries of the first half of the nineteenth century, employed amalgamated zinc and platinized silver as elements in an electrolyte of weak sulphuric acid. In some forms the platinized silver is replaced with platinized iron or a gauze of platinized silver instead of the plate.

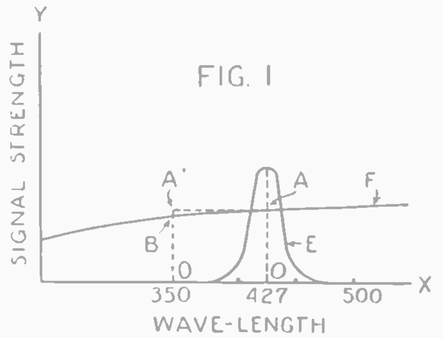
In the Poggendorff cell (1842) at the left, the amalgamated zinc electrode (Z) can be raised out of the electrolyte of potassium bichromate and sulphuric acid when the cell is not in use. The other electrodes (K, K) are of carbon. In certain forms air is blown into the liquid through a lead tube. The agitation so caused prevents the deposition of chromium oxide on the zinc.



The Meidinger cell (1859) employs a zinc cylinder (Z) as negative electrode in a weak solution of magnesium sulphate. In the smaller vessel (d) a copper or lead electrode is immersed in strong copper sulphate solution. The test tube (H), open at the bottom, contains copper sulphate crystals.

Disposing of the Static Problem

By Manfred Von Ardenne

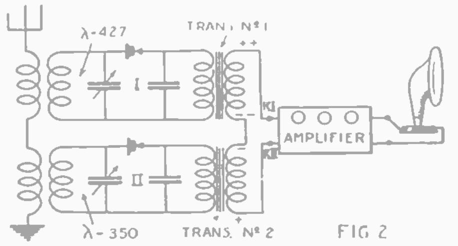


Curves showing the strength of static as compared with the strength of a radio signal. Note that as the receiver is detuned from the undamped signal wave, the strength decreases rapidly, whereas the strength of the static wave, which is highly damped, remains practically the same.

IN the development of radio technique, one problem is yet unsolved, which is the disposing of the static disturbances of the air. This problem has assumed a very great importance in wireless telephony as used by the public in general.

While the Morse signals can be received in adequate loudness with the present reception arrangements, and while the dash and dot alphabet is very little affected by static, the artistic use of a radio receiving set is disastrously affected by slight static disturbances.

If the radio distribution in its present form is to last, great advantages for the future of radio are to be anticipated by the diminishing or total abolition of static troubles. These atmospheric disturbances result from some kind of electric discharge, especially experienced in summer, due to lightning flashes and thunder storms. These



A differential circuit employing two crystal detectors for balancing out static interference. Circuit 1 receives both signal and static and circuit 2 receives static only, which static balances out that received in circuit 1 so that the signal alone remains.

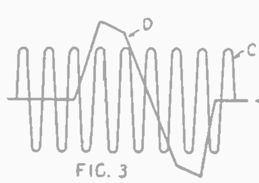
disturbances have a very wide range and represent very high potentials. The approach of a thunderstorm can be announced in advance by a receiving set, as the typical violent storm disturbances grow louder. But static is in no way limited to the periods preceding thunder storms; even in winter the receiving set is not noiseless.

We must accept the fact that, besides the visible discharges in the atmosphere, many irregularities extend up to the outer zone of our atmospheric ocean, to the so-called Heaviside layer. Interesting experiments show that a great portion of these disturbances occur simultaneously in America and Europe. To these unavoidable static disturbances, are added the reception of local discharges within a city. These are very powerful and upset reception more than natural static. They are occasioned principally by sparking in electric installations. A strike at the electric works, throwing the machinery into idleness, revealed to the author the accuracy of this conclusion. In especially great and regular measure these disturbances influence receiving sets within or in the neighborhood of an electric station. Motors in action and transformers are responsible for this type of disturbance. Again surges which play the same part on the power lines of street railroads are especially unpleasant. They work as an impulse and excite every tuned circuit to oscillation. These aperiodic disturbances can occur at the one and same moment from various sources. Herein lies the difference between them and the sharply tuned waves of the sending station, Fig. 1.

While we have assigned to the sending station in our example a wave-length of 427 meters, in a good selective receiving set, even if the circuit is a little out of tune, there is barely any audibility (curve E), and the disturbances (curve F), with greater discordance in the tuning, are as great or nearly as great. On this fact a new, and in comparison with present methods, a very excellent means (German Imperial Patent) is based, due to the author of the present paper, for getting rid of static, which will be here described.

The antenna shown in Fig. 2, firmly set up, yet adjustable in order to compensate for some inequalities of the receiving set, is coupled with two sharply discordant yet receptive circuits. One of the circuits is tuned to receive the waves of the transmitting station, and the other to take care of waves of slightly different length. In our diagram the upper circuit is tuned for the sending waves of 427 meters; the lower circuit is tuned to a wave of about 350 meters. With these two circuits two similar receivers are connected. The simplest case using crystal detector receivers is shown in Fig. 2, but very good results are obtained with two identical regenerative vacuum tube detectors with limited regeneration, so that oscillations cannot result in any case. In both receivers, on account of their identical construction (sensitiveness) as already noted, slight differences due to variations in the antenna coupling can easily be got rid of, and the disturbances can be heard in each with equal intensity and regularity. But only in the receiver tuned to the transmitting stations of 427 meters will the waves of the transmitting station be received. Instead of using two telephones, two transformers with equal number of turns are coupled to the amplifier. The transformers must be so connected with their detectors that the detected static currents oppose and neutralize each other and the signal current alone comes through. The transformers, see Fig. 2, are connected in series. The operation is in detail the following:

A series of undamped waves, C, which for an instant may be the carrier waves of music, are to be received. In order to make it clear the amplitude of these waves is greatly magnified in the diagram. This series of waves have a wave-length of 427 meters. The disturbance is represented by the series of lines D, in connection with which it is to be remarked that the disturbance in general is not so simple in character. In any case the disturbance is sufficient to affect the undamped series of waves and a disturbance in the re-



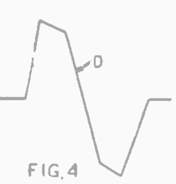
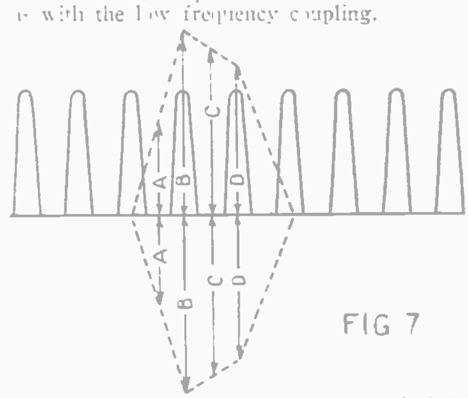


Fig. 3. The signal wave C and the static wave D received in circuit No. 1 of Fig. 2. Fig. 4. The static wave received in circuit No. 2 of Fig. 2. Note that the static waves in both figures are identical.

Fig. 5. Rectified signal and static waves received in circuit No. 1 of Fig. 2. Fig. 6 rectified static waves received in circuit No. 2 of Fig. 2. This indicates that the rectified static waves in both circuits are identical.

ception will result, Fig. 3; by using the two circuits of Fig. 2, circuit No. 1 with a wave-length of 427 meters, will receive both waves shown in Fig. 3, while the circuit No. 2, which is tuned to a wave-length of 350 meters, will only be affected by the disturbance D, Fig. 4. The train of waves, Fig. 3, will be rectified in circuit No. 1 by the detector and give the graph, Fig. 5, while the circuit No. 2 gives the graph of Fig. 6, from which it is perfectly clear that the positive amplitude of the disturbance A, B, C and D is opposed to an equal amplitude, which eliminates the disturbance and only leaves the train of rectified carrier waves undisturbed.

By the connection of this double receiver in the place of a normal receiving circuit, atmospheric and all similar disturbances are obviated, which have either none or a very slightly developed resonance curve. A telephone, or if intensification is desired, an audio amplifier, can be directly connected to the binding posts, K1 and K2. In experiments lately carried out by the author, he was able by an analogous circuit with a high frequency transformer to obtain the same effect with only a single receiver, even if in this case the operation is not so obvious as with the low frequency coupling.



Graph showing how the static wave is balanced out by differential connection of the two transformers of Fig. 2. The transformers are so connected that the static received in one balances the static received in the other.

The Power of Broadcasting

THE ordinary broadcast listener does not realize the enormous power used in broadcasting. Take, for example, a 1,000-watt broadcast station located in a densely populated section. It is estimated that 500,000 radio sets receive this station. Consider each set as equivalent to a regenerative detector and two-step audio amplifier, or a five-tube tuned R.F. receiver, in which case the electric energy input to the loud speaker may be considered as one-half watt, conservatively speaking. Then 500,000 receivers, each delivering one-half watt to the loud speaker, would give 250,000 watts, or 250 k.w. of electric energy.

Thus the initial one k.w. radiated from the broadcast station, with tremendous losses in transmission, releases 250 k.w. of energy in the receiving sets within its range. The layman may ask where does this energy come from. It is all supplied by the B batteries. This will clearly illustrate the enormous amount of B battery current used up by the great American public.

Constructing a Radio "B" Battery

By L. K. WRIGHT

MANY radio fans possess "A" storage batteries, but the number who utilize storage cells for the higher voltage battery are quite few, which is to be deplored, for no other source of current is so dependable, so free from hums or frying noises, as is the storage battery.

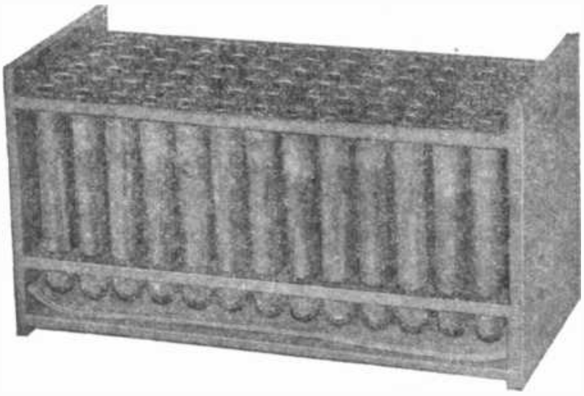
The small cells described hereinafter are each of two volts and the builder must determine what voltage the assembled battery is to deliver, and then determine the number of cells necessary. Each cell is made up of two lead plates, immersed in a sulphuric acid solution, and contained in a six-inch glass test tube of one inch diameter.

Obtain a quantity of 3/16-inch sheet lead and mark off the number of plates required, as in Fig. 1, there being, of course, two plates to each cell. The dimensions of the individual plates are given in Fig. 3. When the plates have been cut from the sheet and the edges smoothed with a rough file, they should be piled in a stack, and with the aid of two side boards and a clamp made into a solid bundle. The top plate should be marked out to accommodate two rows of ¼-inch holes, each row having 14 holes. The dimensions and spacing of the plate and holes are given in Fig. 3. Place the bundle of plates in a drill press and bore the 28 holes, as per Fig. 2. Then take a rough file and round the projecting lugs into 3/16-inch round rods, marking the tops of half of them with a cross to denote positive and the other half with a bar to indicate negative plates, as shown in Fig. 14.

The compound for *positive* plates is made of pure red lead, 100 parts by weight, and sulphate ammonium, 11 parts by weight. The latter chemical should be finely ground before adding to the red lead. Then mix into a thick paste with 26° ammonia. The paste hardens within five minutes, so mix only enough for a few plates at one time.

The paste is best applied to the plates with a wooden spatula, observing that no bubbles or voids are left (Fig. 5). Allow about 1/16 of an inch of paste to project from the holes in the plate, then place between several sheets of blotting paper and subject to several hundred pounds pressure in an old letter press for about 15 or more minutes (Fig. 6).

To make the compound for the *negative* plates mix litharge, 100 parts by weight, and sulphate ammonium, 6 parts by weight. Moisten to a thick paste with 26° ammonia, 10 parts by weight, and C.P. glycerine, 2 parts by weight. The glycerine and ammonia water should be mixed by shaking before adding to the dry powders. This compound hardens even faster than the positive compound and extra speed and precautions must be used in filling the negative plates. Should it be noticed that either compound is hardening, drying or becoming lumpy, it should be discarded, for after placing between blotting paper and putting under pressure, only properly conditioned paste will work. Pressure forces out the surplus moisture, fixes the pellet solidly in its hole and assures a plate which will function without scaling or dropping its paste.



A typical storage "B" battery showing the method of mounting the cells in a rack. Each cell is composed of a glass test tube with negative and positive plates and hard rubber spacer.

The negative and positive plates, after their removal from the press, are carefully stripped of the blotting paper, for any scaled or pulled pellets will condemn the plate. Patches or reinserted plugs of compound, or plates put back under pressure again must not be used, for they will fail after a short service. The plates are dried in the sun (Fig. 7) for several days, turning frequently, then the positive plates *only* are sulphated. This is done by making up a solution of C.P. sulphuric acid 1.00° (equal to 86 per cent. water and 14 per cent. acid at 60° F). Be sure to add the acid *slowly* to the water, and then let it cool before using. Then take up a positive plate in a wooden holder and dip it into the solution, withdrawing instantly. Wait a few seconds until gassing ceases and then dip plate again, allowing it to remain for three seconds in the bath. Dip again for five seconds, then immerse and allow to remain in the solution for 20 hours, not more.

Wash in running water for several hours and then scrub with a vegetable brush. Then allow the plates to dry in the sun as before. Plate compounds will, or should be, as hard as Portland cement after drying. When the plates are dry they are assembled by laying a positive plate down upon the table, applying three hard rubber separator strips (Fig. 9) 4½ inches long by 1/16x1/16-inch; one being placed on either side and one in the center. Then lay on a negative plate, lug faced the other way, and apply two rubber bands to hold the whole together. The lugs are fitted through a rubber cork (Fig. 12) which, besides having holes for the lugs, has a small one in the center, used for adding solutions and allowing gasses to escape.

The cork and elements are then placed in their tubes and the tubes are inserted in a case, which can be made to suit each individual's requirements. The tubes should fit through two thin boards, as shown in Fig. 13. Connections are made from opposite pole to opposite, depicted in Fig. 14, and may be accomplished by the use of the spring battery connector clips now on the market. The battery ends are connected to like poles of a direct charging current; the battery being charged at about two-thirds the normal rating for about 10 hours. *After* the current has been applied take a pipette and fill each cell with a 180° sulphuric acid solution (25 per cent. acid and 75 per cent. water). After charging, discharge through a resistance for about 10 hours and repeat the cycle twice more; then remove the electrolyte and discard it. Take the plates from the cells and wash them in running water, brushing them with a vegetable brush, and then reassemble in a 1250° electrolyte. Then the battery is ready for the real charge and should last as long or longer than the commercial products.

The charging or discharging of the cells should not be forced, nor 'hould the drying of the plates be hurried, otherwise the battery's power will be impaired.

The usual method of arranging the cells is to make up a box which is more of a square rather than a long narrow type, but in certain cases, such as where a case will be designed to be hidden behind the radio cabinet, the long narrow type may be desired.

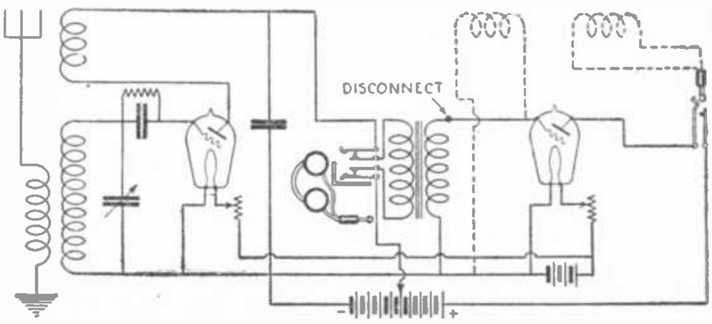
The specific gravities used above are degrees as shown on the ordinary battery hydrometer which are on the Beaumé scale. Do not let this battery get hot; use cold solution of acid.

Calibrating a Wave Meter by Harmonics

MANY articles have been printed recently telling of the construction and use of a wavemeter but few have given practical suggestions as to how to calibrate.

The Bureau of Standards uses the harmonics of a separate oscillator (of known wavelength) in plotting the complete scale. Most experimenters avoid this method because they think that it is complicated or involves extra apparatus. In reality it is simple and those who have one step of audio amplification are well fitted for the work.

The separate oscillator is made from the amplifier by connecting a coil and condenser in the place of the secondary of the transformer, and by plugging a tickler into the phone jack.



An accurate method of calibrating a wavemeter by harmonics. The audio frequency amplifier is temporarily used as an oscillator.

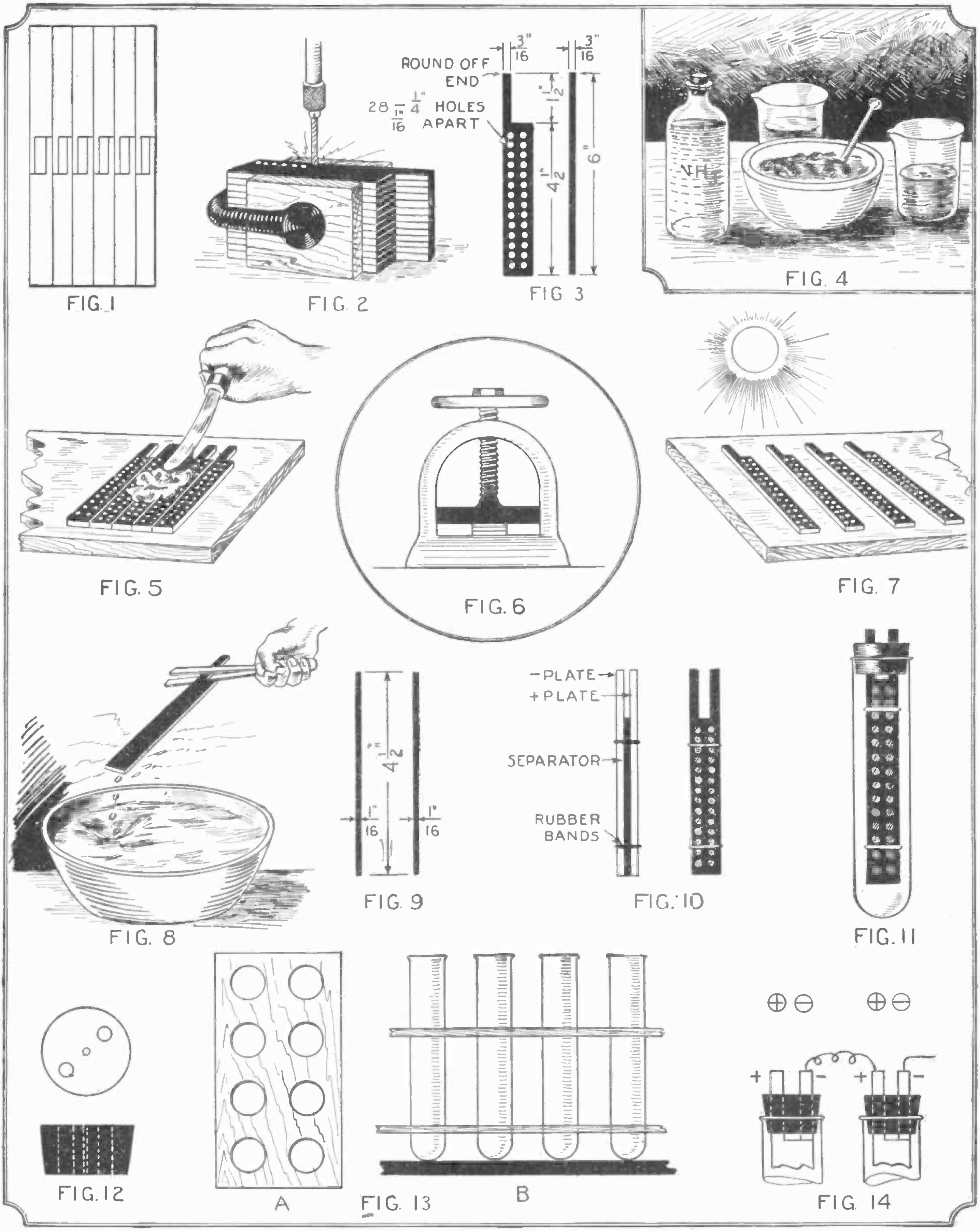
Plug the phone in the detector circuit and tune in some station of known wave-length as KDKA on 326. Adjust the oscillator to the same wave by the "zero beat" method. Then tune in the harmonic of the oscillator, calibrating the wavemeter by the click method at each.

Harmonics will be found at ½, 1-3, ¼, 1-5, 1-6, 1-7, etc., wave of the oscillator.

In this way I calibrated my wavemeter down to 25 meters, using fifteen harmonics of the oscillator. Contributed by

HARLEY IAMS, 6AHS.

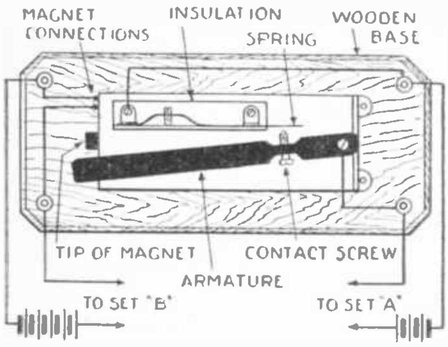
Constructing a Radio "B" Battery



The successive steps in the construction of a storage "B" battery. The plates are cut from a sheet, Fig. 1, stacked up and drilled, Fig. 2, to the dimensions of Fig. 3. The compound is mixed, Fig. 4, and spread into the plates, Fig. 5, after which they are clamped, Fig. 6, and dried in the sun, Fig. 7, and sulphated, Fig. 8. The spacers, Fig. 9, are placed between the plates, Fig. 10, and the unit placed in a test tube, Fig. 11, using cork, Fig. 12. The cells are placed in a rack, Fig. 13, and connected in series as shown in Fig. 14.

Awards of the $50 Prize Contest for Radio Experimenters

First Prize, $25.00	Second Prize, $15.00	Third Prize, $10.00
Geo. B. Engelhardt, 373 Ocean Ave., Brooklyn, New York	Arthur A. Blumenfeld, 1876 Belmont Ave., New York City	George Carlstrom, Twin Valley, Minn.



An automatic filament switch made from a telephone relay. The "B" battery current holds the switch closed.

First Prize
Automatic Radio Extension

By Geo. B. Englehardt

I USE on my radio an extension line over 100 feet in length so that the loud speaker may be placed in various rooms of the house. The line is equipped with jacks for the loud speaker plug. When a program is over, I do not have to walk all the way back to the set to turn off the filaments, but simply pull out the loud speaker plug and push it into the jack again. This automatically turns off the set and the horn is ready for future use.

An old telephone relay salvaged from a forsaken box or picked up from the junk pile of an electrical shop does the trick. It is first cleaned and oiled and then mounted vertically in such a way that the armature will stay over the core with only an extremely small pressure to hold it there, yet will definitely drop back when the pressure is released. The contact screw must be carefully adjusted. The circuit breaker contacts are connected in series with the A-battery as the diagram shows. The magnet winding is connected in series with the B-battery.

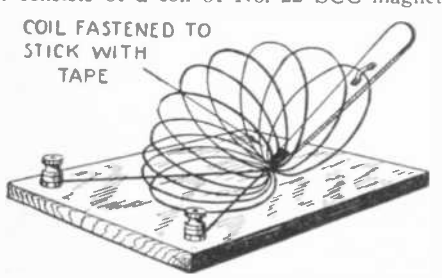
To start the set insert the loud speaker plug in one of the jacks, and push over the armature of the relay. This closes the A-battery circuit and lights the filaments, and the B-battery current passing through the relay magnet holds the armature closed. On removing the loud speaker plug, the B-battery circuit is broken and the relay armature is releasd. This automatically opens the A-battery circuit and the filaments are turned out. On replacing the loud speaker plug the silence of the horn is good proof of the operation of the relay.

Second Prize
The Simplest Tuning Coil

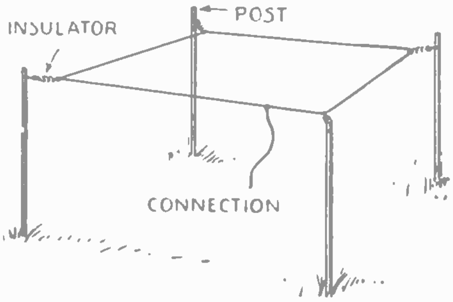
By Arthur A. Blumenfeld

THE illustration shows what may be called the simplest type of tuning coil. It consists of a coil of No. 22 SCC magnet wire wound to a diameter of 3½ inches. The last turn is attached to a board and the two ends are connected to binding posts. One end of the coil is fastened to a stick with tape as shown. The stick is hinged to the baseboard. When the coil is closed, the higher waves are reached. When open, the lower waves are reached. For broadcast wave-lengths the coil should consist of about 50 turns.

Not only is this type of coil the simplest to make, but it is very efficient, as there are no taps or condensers in the circuit. It is very good for crystal sets on account of its simplicity.



A tuning coil in which the inductance or tuning is varied by changing the spacing of the turns.



An experimental aerial which the author claims gives better results than a single wire one.

Third Prize
Two-Way Aerial

By George Carlstrom

HERE is a two-way aerial which I think is better than the ordinary single wire type. It is made by sinking four posts in a square and stringing the wire around them on insulators as shown in the illustration. The lead-in is connected to any convenient place on the aerial wire. The four posts should be separated from each other by a distance of about 20 feet. I have used this aerial with a 1,500-mile set and have received stations which I could never get on a single wire aerial.

$50.00 in Prizes

A contest for radio experimenters. There are three monthly prizes:

First prize ....$25.00 in gold
Second prize .....$15.00 in gold
Third prize ....$10.00 in gold

In order to be eligible for a prize the manuscript must deal ONLY with the experimental phase of radio, somewhat along the following lines: Radio *experimental* wrinkles. Short cuts for the *experimenter*. Simple devices to help radio *experimenters* in their work are wanted particularly.

This prize contest is open to all. All prizes are paid upon publication. If two contestants submit the same idea, both will receive the same prize. Address Editor, *Radio Experiments Contest*, c/o this publication. Contest closes on the 15th of each month of issue.

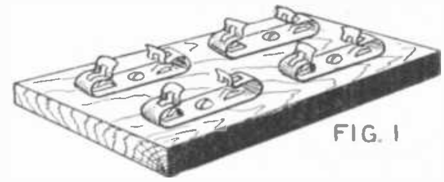


FIG. 1

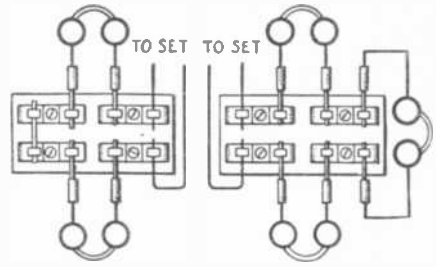


FIG. 2 FIG. 3

Multiple phone connection block made from Fahnestock clips mounted on a base.

Honorable Mention
Simple Phone Block

By Arthur A. Blumenfeld

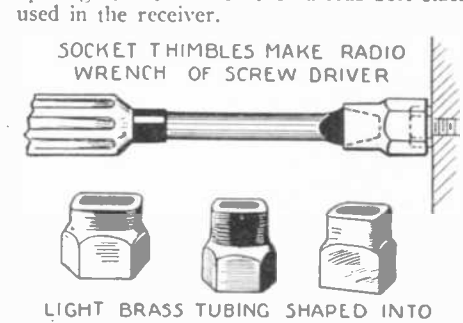
THIS simple phone block is made of a piece of wood and four double Fahnestock clips. Simply fasten the clips to the board and the phone block is finished. It should then look like Fig. 1. Fig. 2 shows how to attach two pair of phones, and Fig. 3 shows how to attach three pair of phones. If it is desired to add more phones, more Fahnestock clips should be used.

Honorable Mention
Socket Wrenches for Radio Work

By G. A. Luers

A NOVEL but most practical application of the screwdriver for use as a wrench is depicted in the illustration.

Small socket thimbles made from brass tubing, expanded to hexagonal shapes on one end and collapsed to seat the point of the screwdriver at the other, are especially advantageous for the various small bolts and nuts used in radio receivers. The construction which will be evident from the sketch, makes possible the insertion of the slender shank of the screwdriver blade in close places where the usual heavier wrench cannot be used. Obviously, it is possible also to use steel tubing for these sockets, but the steel is more difficult to shape. A set of sockets will include hexagonal and square openings to fit each of the various bolt sizes used in the receiver.



Simple socket wrenches made out of hex and square brass tubing flattened to fit the end of a screw driver.

The EXPERIMENTER Radio Data Sheets

By Sylvan Harris

WAVE-LENGTH OR FREQUENCY OF CURRENT IN A CIRCUIT

For the benefit of those who are more advanced in the study of radio, the ideas in this sheet will be given now, although they should properly come after the theory of inductance and capacity have been explained.

The frequency at which a current oscillates and the consequent wave-length in a tuned circuit depends upon the inductance, capacity and resistance in the circuit. The resistance does not affect the frequency very much, and for nearly all purposes its effect may be neglected. The relation is expressed in the following formulas. Those are given both for frequency and wave-length, although, considering what we have learned in data sheet 1-51, it will be preferable to use the relations involving the frequency rather than those involving the wave-length.

$$f = \frac{159.3}{\sqrt{LC}} \qquad \lambda = 1884\sqrt{LC}$$

The frequency, f, is in kilocycles per second, the wave-length is in meters, L is in microhenries and C is in microfarads. The product of L and C is always the same for the same frequency or wave-length, and is called the *oscillation constant*. Many radio calculations are greatly simplified by the use of this oscillation constant, since it can be expressed in the forms

$$LC = \left(\frac{159.3}{f}\right)^2 \text{ or } LC = \left(\frac{1884}{\lambda}\right)^2$$

Values of LC are given in the table in 1-31. The use of the table is very simple. Thus, suppose we want to find out how much inductance is required in a circuit to tune to 300 meters if the condenser used has a capacity of 0.0005 μf. The oscillation constant for 300 meters (see table) is 0.0253. Dividing this by the capacity we have 0.0253/0.0005 = 50 μh. A similar operation is followed if we know the inductance and want to find the capacity. This does not tell how to build the condensers or coils to have the capacity or inductance required. This is another problem and will be taken up later.

The EXPERIMENTER Radio Data Sheets

By Sylvan Harris

ELECTRON EMISSON AND SPACE CHARGE

IN Radio Data Sheet 3-2 the general idea of the emission which takes place in an electron tube was discussed, and in 3-3 was introduced the idea of the space charge in the tube. These ideas may be more easily understood by reference to the accompanying diagrams:

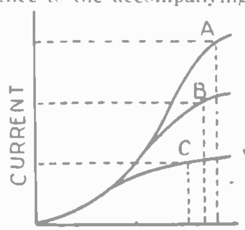


FIG. 1

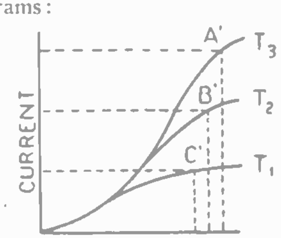


FIG. 2

These curves show how the current which passes through an electron tube containing an incandescent filament (or cathode) and a plate (or anode). The filament is heated by a current from a (the A-battery) battery, and another battery (the B-battery) has its positive terminal connected to the plate and its negative terminal connected to the filament, as in the diagram in 3-2.

Suppose there is a certain voltage maintained by the B-battery. This is V_1 in Fig. 1. As we start to light up the filament, the current from the B-battery gradually increases, absorbing the electrons coming from the filament. This continues until all the electrons coming from the filament are absorbed by the plate, by which time the space charge has attained its maximum strength. If the temperature of the filament is increased beyond this point, the plate current increases very little, if any, as shown by the curve approaching the horizontal.

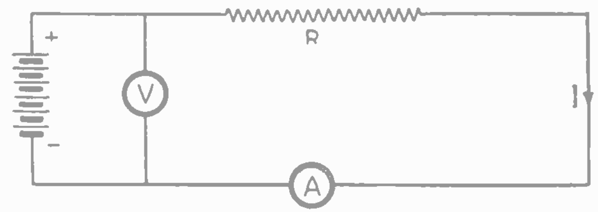
If, however, a higher plate voltage were used, say V_2, the plate current would be greater for the same temperatures. Fig. 2 shows the same relations plotted in a different way. This curve may be analyzed in the same manner. When the maximum current for a given temperature has been attained by increasing the voltage, the only way to increase the current further is to increase the filament temperature.

The EXPERIMENTER Radio Data Sheets

By Sylvan Harris

SIMPLE DIRECT CURRENT CIRCUITS

THE solution of simple D.C. circuits is relatively simple, and is based upon Ohm's law, stated in 1-3.4, *viz.*, I = E/R. In this equation I is the current flowing in the circuit, shown in Fig. 1. E is the difference of potential produced by the source of electrical energy (which may be a battery), and R is the resistance of the circuit; that is, the resistance of that part of the circuit external to the source of energy. If we use the practical units we must express I in amperes, E in volts, and R in ohms. If we use a fractional unit, such as the milliampere, the other two must be fractional units of the same order.



For the sake of illustration, all the resistance in the circuit is supposed to be concentrated at one place, although it is actually distributed in various amounts throughout the whole circuit. When resistances are in series, we add them together to obtain the total resistance.

A meter for measuring the current in the circuit is shown at A in the figure. Suppose this meter tells us that we have 10 amperes flowing. We also measure the voltage of the battery by connecting a voltmeter V across its terminals. Suppose this reads 30 volts. The resistance of the circuit is then, R = 30/10 or 3 ohms. This follows from the fact that the equation may be written, by the rules of algebra, in three ways, *viz.*,

$$I = \frac{E}{R}, \qquad E = RI, \qquad R = \frac{E}{I}$$

Therefore, when any two of the quantities are known, the other one can be calculated.

Although the conditions existing in D.C. (direct current or continuous current, it is often called) circuits are supposed to remain constant, they do not always do so. There are many things contributing to cause the resistance of the circuit or the voltage of the source of energy to change, which will be taken up at the proper time.

CUT ALONG PERFORATED LINES

The EXPERIMENTER Radio Data Sheets

By Sylvan Harris

SIMPLE D.C. CIRCUITS [Contiued]

IT was stated in 1-4 that when several resistances are connected in series in a circuit, the total resistance of them all is their sum. The same is true of the voltages when there are several sources of electrical energy connected in series in the circuit. Thus, suppose we have a battery of 45 volts connected in series with a generator of 110 volts. These are also connected in series with three resistances, which may be an incandescent lamp of 40 ohms, a rheostat of 10 ohms, and a long length of wire which has a resistance of 8 ohms.

The total voltage in this series circuit is 45 + 110 = 155 volts. The total resistance is 40 + 10 + 8 = 58 ohms. The current flowing in the circuit will then be 155/58 or 2.67 amperes. As another illustration, suppose that we are using a six-volt storage battery to light a UV-201A tube. This tube has been rated by the manufacturers to operate at five volts and carry a current of 0.25 ampere. The problem is to find how much resistance is required in its filament-rheostat.

From the rating we can obtain the resistance of the filament, *viz.*, 5/0.25 = 20 ohms. To obtain a current from the six-volt battery of 0.25 ampere a total circuit resistance of 6 ÷ 0.25 (6/0.25 or 600/25) or 24 ohms is required in the circuit. Twenty of these ohms are already in the filament so we have to use 24 — 20 or 4 ohms in the rheostat. In other words, to be sure that we will not burn out the tube we must be sure that we can get at least 4 ohms resistance in our rheostat. The nearest to this that is available in the radio stores is the six-ohm rheostat, which is the proper one to use. This, of course, applies only to the case where one tube is controlled by the rheostat. A 15 or 30 ohm rheostat is usually used with one tube so as to give a finer degree of current control.

Similar calculations can be applied to the steady current flowing in the plate circuits of the tubes. Suppose we have a B-battery voltage of 90 volts, and from the characteristic curves we learn that the plate resistance of the tube is 10,000 ohms. The plate current is then 90/10,000 or 0.009 ampere. This is the same as 9 milliamperes.

The EXPERIMENTER Radio Data Sheets

By Sylvan Harris

A SIMPLE RECTIFIER

IN Radio Data Sheet 3-2 it was explained that a current could flow from the plate of an electron tube to the filament of the tube only when the filament is incandescent and the plate is charged *positively* with respect to the filament. The diagram shows such a two-element tube connected in electric circuit carrying an alternating current.

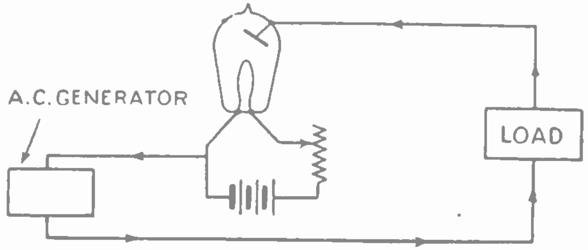


FIG. 1

The electric circuit shown includes a generator of the alternating electric current and a load or receiver of electric energy. Assume the filament to be kept incandescent by a special connection. Suppose at a certain instant the voltage in the circuit is such that the direction of the current will be as shown by the arrows. Current will flow through the tube because the plate will be positive with respect to the filament and the filament will be incandescent.

When, however, the generator voltage reverses (in the direction opposed to the arrows), the filament will be positive with respect to the plate. If the plate happened to be emitting electrons, current would flow from the filament to the plate, but since the plate is not heated, it is not emitting electrons. Therefore, no current will flow through the circuit when the filament is positive.

We have applied to the circuit an alternating voltage, A, Fig. 2, and have obtained a flow of current, B. Since the current has been prevented from flowing in a certain direction, we have rectified it.

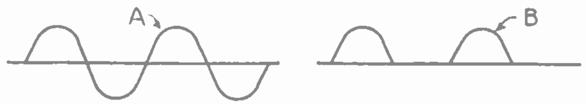


FIG 2

The EXPERIMENTER Radio Data Sheets

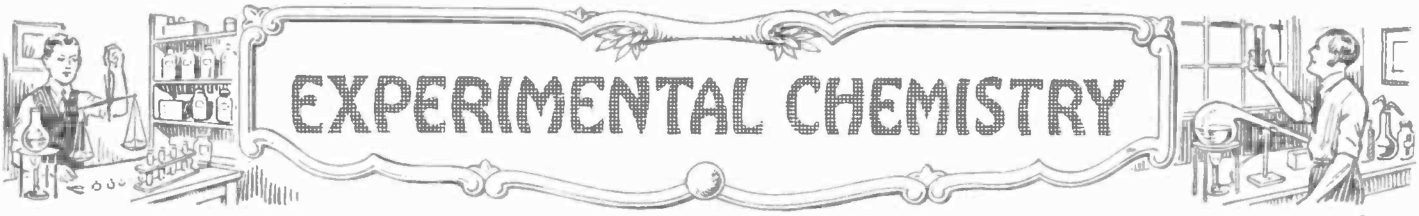
By Sylvan Harris

TABLE OF OSCILLATION CONSTANTS

The use of this table of oscillation constants is explained in radio data sheet 1-30.

Meters	Kilocycles	L × C	Meters	Kilocycles	L × C	Meters	Kilocycles	L × C
100	3.000	0.00282	550	546	0.0852	800	375	0.1801
110	2.727	0.00341	555	541	0.0867	805	373	0.1824
120	2.500	0.00405	560	536	0.0883	810	370	0.1847
130	2.308	0.00476	565	531	0.0899	815	368	0.1870
140	2.143	0.00552	570	527	0.0915	820	366	0.1893
150	2.000	0.00633	575	522	0.0931	825	364	0.1916
160	1.875	0.00721	580	517	0.0947	830	361	0.1939
170	1.764	0.00813	585	513	0.0963	835	359	0.1962
180	1.667	0.00912	590	509	0.0980	840	357	0.1986
190	1.579	0.01015	595	504	0.0996	845	355	0.201
200	1.500	0.01126	600	500	0.1013	850	353	0.203
210	1.429	0.01241	605	496	0.1030	855	351	0.206
220	1.364	0.01362	610	492	0.1047	860	349	0.208
230	1.304	0.01489	615	488	0.1065	865	347	0.211
240	1.250	0.01621	620	484	0.1082	870	345	0.213
250	1.200	0.01759	625	480	0.1100	875	343	0.216
260	1.154	0.01903	630	476	0.1117	880	341	0.218
270	1.111	0.0205	635	472	0.1135	885	339	0.220
280	1.071	0.0221	640	469	0.1153	890	337	0.223
290	1.034	0.0237	645	465	0.1171	895	335	0.225
300	1.000	0.0253	650	462	0.1189	900	333	0.228
310	968	0.0270	655	458	0.1208	905	331	0.231
320	938	0.0288	660	455	0.1226	910	330	0.233
330	909	0.0306	665	451	0.1245	915	328	0.236
340	883	0.0325	670	448	0.1264	920	326	0.238
350	857	0.0345	675	444	0.1283	925	324	0.241
360	834	0.0365	680	441	0.1302	930	323	0.243
370	811	0.0385	685	438	0.1321	935	321	0.246
380	790	0.0406	690	435	0.1340	940	319	0.249
390	769	0.0428	695	432	0.1360	945	317	0.251
400	750	0.0450	700	429	0.1379	950	316	0.254
410	732	0.0473	705	426	0.1399	955	314	0.257
420	715	0.0496	710	423	0.1419	960	313	0.259
430	698	0.0520	715	420	0.1439	965	311	0.262
440	682	0.0545	720	417	0.1459	970	309	0.265
450	667	0.0570	725	414	0.1479	975	308	0.268
460	652	0.0596	730	411	0.1500	980	306	0.270
470	639	0.0622	735	408	0.1521	985	305	0.273
480	625	0.0649	740	405	0.1541	990	303	0.276
490	612	0.0676	745	403	0.1562	995	302	0.279
500	600	0.0704	750	400	0.1583	1,000	300	0.282
505	594	0.0718	755	397	0.1604	1,100	272	0.341
510	588	0.0732	760	395	0.1626	1,200	250	0.405
515	583	0.0747	765	392	0.1647	1,300	230	0.476
520	577	0.0761	770	390	0.1669	1,400	214	0.552
525	572	0.0776	775	387	0.1690	1,500	200	0.633
530	566	0.0791	780	385	0.1712	1,600	187	0.721
535	561	0.0806	785	382	0.1734	1,700	176	0.813
540	556	0.0821	790	380	0.1756	1,800	166	0.912
545	551	0.0836	795	377	0.1779	1,900	157	1.015

CUT ALONG PERFORATED LINES



Making Chemicals from Minerals

By Raymond B. Wailes

1. Making potassium permanganate, stirring the proper mixture with an iron rod as it melts. 2. Pulverizing the pyrolusite previous to the fusion. 3. Evaporation, as of potassium permanganate or sodium silicate, as described in the text.

MOST minerals are insoluble in reagents, such as water; otherwise, they would dissolve in rainfalls unless under ground. The depth of the deposits is what prevents rock salt from being dissolved. But fusion with suitable reagents forms entirely different compounds with many of them, these compounds then being used in solution form. Such is the method by which several of the processes described herein are carried out.

Potassium permanganate can be made by the experimenter from pyrolusite or manganese dioxide by employing several chemical operations. The first is to digest the powdered mineral in water after weighing it out. It is then dried. Mix together the same weight of potassium hydroxide sticks and half as much potassium chlorate in an iron crucible and heat till melted. Now add the powdered pyrolusite mineral a little at a time. Stir with an iron rod (Fig. 1). Heat for about an hour, cool and digest with almost a liter of water. The solution will now be green. Now boil the solution in an evaporating dish and at the same time pass carbon dioxide gas into the green solution until it has changed to a purple color (Fig. 4). Filter through an asbestos filter. Wash what is left upon the asbestos filter and allow filtrates and wash water to cool and evaporate slowly on a water bath. Crystals of potassium permanganate will form. Bottle them, corking well. Label.

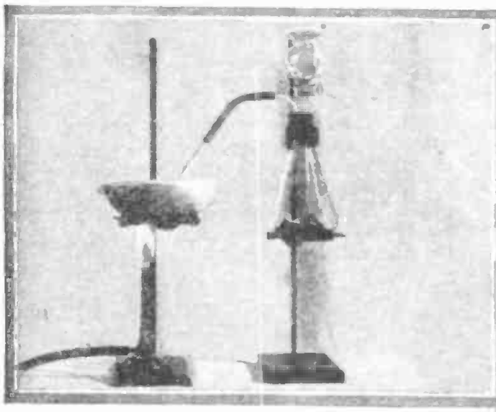
A simple oxidation experiment can be performed by heating lead monoxide (litharge) upon an iron plate with a Bunsen burner (Fig. 2). Turn the powder over as often as possible. The yellow litharge will be converted into red lead, a higher oxide of lead in the course of several hours.

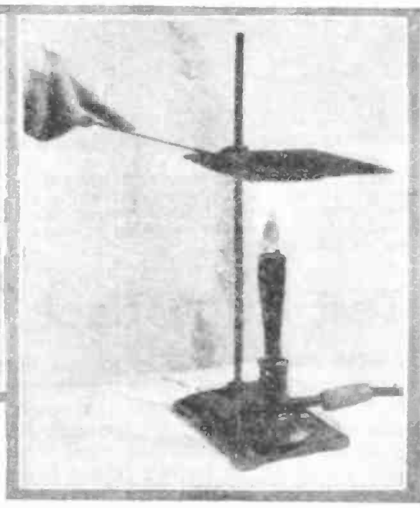
The strontium mineral, celestite, is found in rocks; it is strontium sulphate. Pulverize this and mix with a little more than its weight of sodium carbonate, add water and boil. A good proportion is 100 grams of celestite, 150 grams of dried sodium carbonate (washing soda) and 500cc of water. Filter, after boiling for half an hour. The strontium is now in the form of the carbonate (strontium carbonate) and *remains on the filter paper,* as it is insoluble. Add to this precipitate, after washing thoroughly with water, dilute hydrochloric acid, drop by drop, until no more effervescence takes place. The strontium carbonate will dissolve in the hydrochloric acid and run through the filter paper to be caught in a clean beaker. Wash the filter, allowing the filtrate to also pass into this beaker, which then contains a solution of strontium chloride. Evaporate this filtrate until it almost crystallizes and then allow to cool, when the crystals of strontium chloride will appear. If nitric acid is uesd, strontium nitrate, used for red fire in pyrotechny, will be produced.

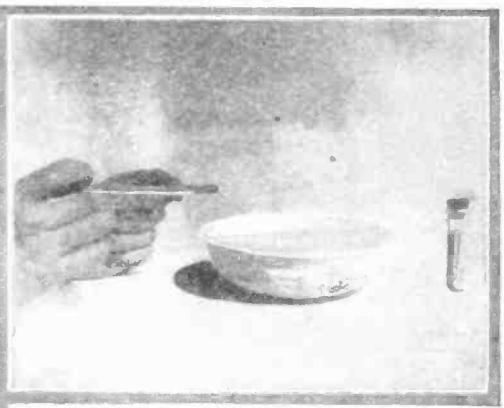
Boric acid can be made from borax by simply boiling a solution of borax in water and adding hydrochloric acid, drop by drop, until an acid reaction occurs, which can be ascertained by touching a drop of the solution to a strip of blue litmus paper (Fig. 3). Cool the solution, when crystals of boric acid will separate out.

Trouble is sometimes had in filtering hot saturated solutions of chemicals. A length of rubber tubing wrapped around the funnel with hot water circulating through the tubing will prevent cooling and crystallizing (Fig. 6).

Wood ashes contain "potash" (potassium







4. Passing carbon dioxide gas into the solution for making potassium permanganate. 5. Heating lead monoxide upon an iron plate with constant stirring, producing ultimately the higher oxide, red lead. 6. Testing a boric acid solution for acidity; it must be almost exactly neutral.

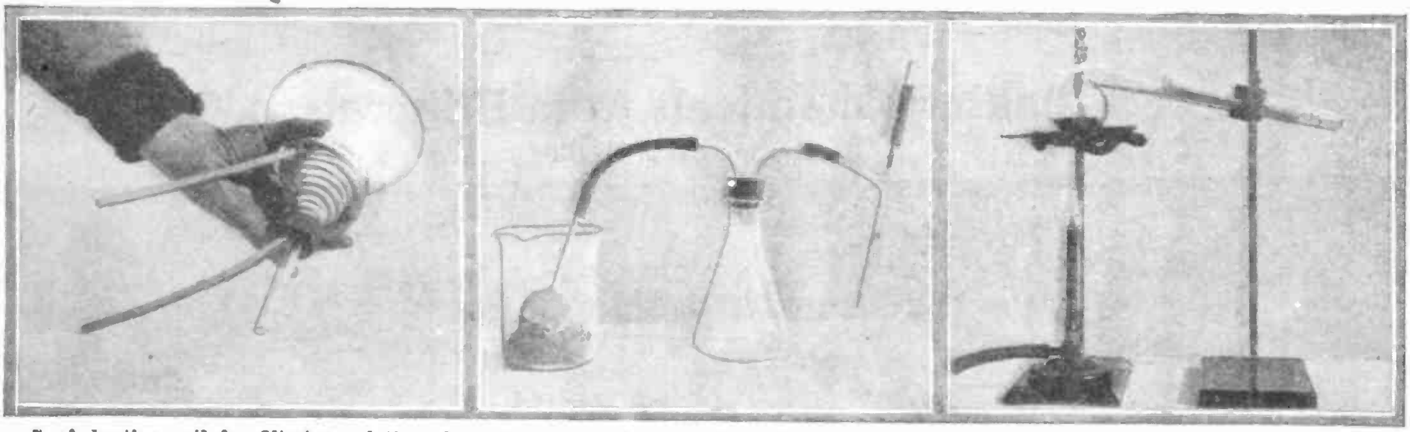
carbonate). When lime is added to the recovered potash, calcium carbonate (a form of marble) is precipitated and potassium hydroxide is found in the filtrates.

To make a dilute solution of potassium hydroxide from wood ashes, shake the ashes

tion C is important. The ejector tip should be varied until best results are secured.

Now evaporate the solution from the empty flask and catch more in the same way if needed. Crude potassium carbonate will crystallize out. Heat to redness if black

added if desired. Heat until effervescence ceases, add 100cc of water when cool and then boil. Now cool and filter. Wash the filter paper and let the washings run with the first filtrate. Now evaporate the whole filtrate until a somewhat thick syrup forms,



7. A heating coil for filtering solutions hot. Hot water circulates through the tubing. Block tin tubing is best. 8. Using a jet aspirator for rapid filtration; a thistle tube takes the place of the ordinary funnel. 9. Expelling mercury from cinnabar by simple heat.

with hot water and pour the mixture into the beaker of Fig. 10. Water should be running through tube I, which is drawn out to a jet and protrudes at E into the tee tube. A constriction C should be made in the T tube with a Bunsen burner. It can be seen that water squirting out through the drawn-out ejector tube E will suck in air through the side-arm of the tee tube, and at the same time the solution of the wood ashes in the beaker will be sucked through the sand about the thistle tube T which has its mouth covered with a double layer of cheese-cloth tied on. From the thistle tube the solution goes into the empty catch bottle

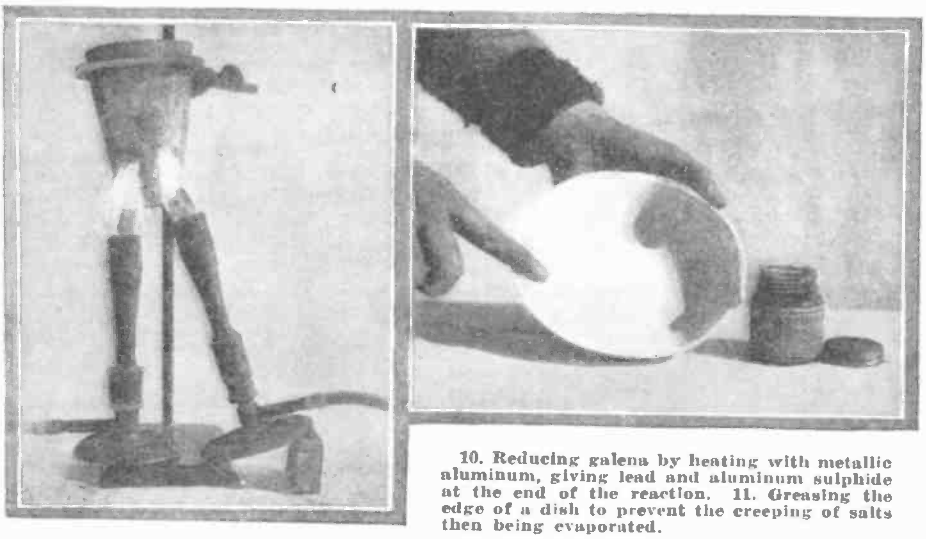
where it is held. This is a simple method of filtering with a suction. The constric-specks appear. When cool, add unslaked lime and water, boil for a short while, allow to settle, pour off the dilute potassium hydroxide and bottle it for future use.

Mercury metal can be distilled from the natural mineral, cinnabar, using a retort as shown in Fig. 8. The sulphur will be driven off and will probably catch fire and burn, but this will not matter. The mercury will volatalize and then condense in the test tube. Be very careful to permit none of the mercury vapor to escape into the room. It is poisonous if inhaled.

Water glass solution can be made by fusing 40 grams of sodium carbonate with 5 or 10 grams of white "bird" sand in an iron crucible. A *bit* of charcoal can be which is commercial water glass. The crucible fusion can be hastened by stirring as was done in the pyrolusite experiments (Photo 9).

Galena is an ore of lead, in combination with sulphur in the form of lead sulphide. If powdered galena is mixed with one-tenth its weight of powdered aluminum (granulated) and heated in a clay crucible (Fig. 6) aluminum sulphide and metallic lead will form, the latter being poured away from the regulus of aluminum sulphide while molten. Stopper the aluminum sulphide mass tightly in a bottle after making, for it will combine with the water in the air and give off offensive hydrogen sulphide gas. The same liberation of this gas takes place if a bit of the aluminum sulphide is dropped into water (Fig. 4).

Double salts crystallize beautifully. Ammonium-copper sulphate is an easily prepared chemical illustrating this property. Take 100 grams of copper sulphate and 50 grams of ammonium sulphate and dissolve the whole with stirring in 350cc of water to which one or two drops of sulphuric acid have been added. Allow to settle and pour off the clear solution into an evaporating dish (Fig. 5). It is well to rub a little grease or vaseline around the rim with the finger to prevent creeping of the salts. Allow to crystallize, which will produce crystals of the double salt, ammonium-copper sulphate. The vaselined rim prevents the solution from creeping up and over the sides of the crystallizing dish.



10. Reducing galena by heating with metallic aluminum, giving lead and aluminum sulphide at the end of the reaction. 11. Greasing the edge of a dish to prevent the creeping of salts then being evaporated.

Test Tube Rack

THERE are many varieties of test tube racks, some good and others not so good, but from the standpoint of ease of construction and general efficiency I have seen few that excelled the one described here.

The test tube rack is formed from a length of No. 12 or No. 14 B.S. gauge copper or brass wire, the length depending upon the size of the test tubes and the number.

A wooden dowell or anything about the same size as the test tubes may be used to form the loops, after which the wire with its circular loops may be fashioned in semi-circular form or in the conventional straight form. *Contributed by* MARCUS LORRIN.

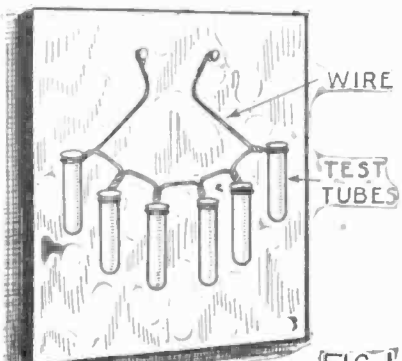


FIG. 1

Left: An ingenious wire test tube holder to be affixed to the wall by two screws.

Right: The same idea carried out differently, this time using a baseboard as a support.

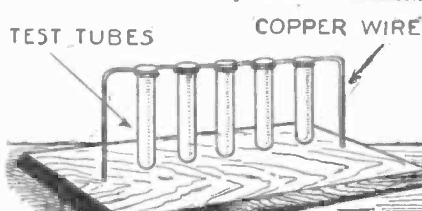
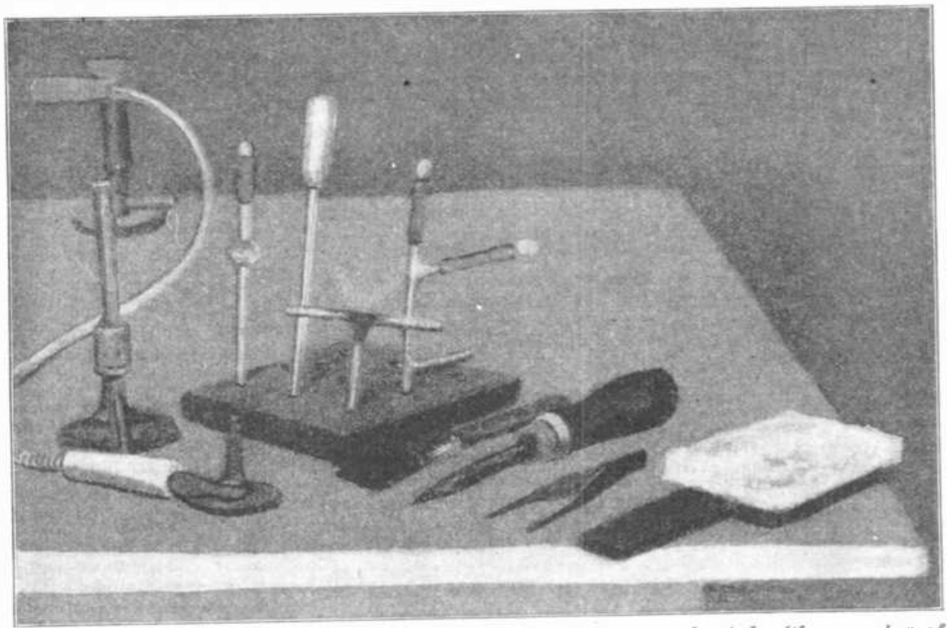


FIG. 2

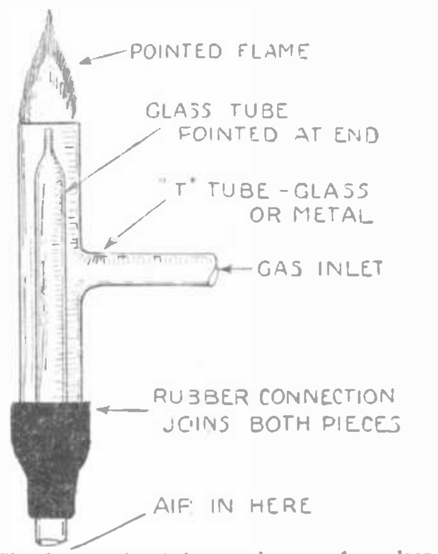
Experimenter's Glass Blowing Tools

By Raymond B. Wailes



View of an amateur's glass blowing outfit; note the board perforated with a number of holes, for holding the hot tubes while they are cooling. The burner tube is not yet connected to the gas supply. Other tools described below lie on the table.

HAVE you ever tried to do glass blowing? Perhaps you can recall the first piece of glass working, among the simplest of all known to the art, that of sealing two glass tubes together. This should not have bothered you and perhaps your finished piece did not crack apart when cold. Next the tee piece was probably tried, using the ordinary Bunsen burner. Here is where you probably failed. Efforts in other glass manipulations probably met with disaster, mainly because of lack of the proper tools to work with, and want of experience. This little article tells of the tools which the amateur glass worker should have in order to better his knowledge along this art.

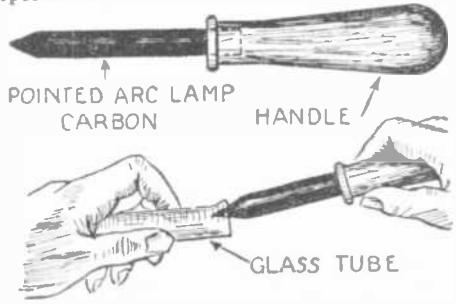


Simply constructed gas burner for glass blowing, with central air supply, the reverse of the ordinary Bunsen burner.

The most important item of the glass worker or glass blower is the burner, or lamp as it is called. Professional multi-tip burners fed with gas and air under pressure are probably out of the question in fitting up a small bench for amateur glass working.

Perhaps the simplest burner which can be used with considerable success in glass working is the micro-burner. This is primarily adapted to bacteriological work. It gives a pointed flame on the ordinary city gas pressure. The burner stands about three inches high and costs about a dollar. This little burner, a Mekker or an ordinary Bunsen burner, has enabled the writer to turn out tees, ells, crosses, internal seals, straight welds, etc., with ease. Yes, the micro-burner should be in every experimenter's hands if he is looking for a simple glass-working burner.

A burner which gives a pointed flame and which can be made by any experimenter is shown here. It consists of a glass or metal tee tube which carries internally a straight glass tube pointed at the end concentric with itself. A rubber tubing connector joins both pieces together. Gas led through the side opening burns with a hot and pointed flame at the end as shown. The diameter of the tip of the drawn out inner tube should be varied, likewise the distance of this tip from the end of the tube, until the best effect results. The reason for the hot flame can be seen by picturing a cross section of the flame at the end. Air fills the inner portion, and is surrounded by a layer of gas which in turn is surrounded by another layer of air—the air of the atmosphere of the room. Thus two oxidizing mediums are present and act upon the gas, making combustion more local and therefore more intense. This home-made burner with its pointed flame can be used for many glass working operations. It is really a home-made micro-burner. It can be held by the ordinary ring stand burette clamp, or a special holder can be made for it.



A piece of arc-light carbon pointed at the end is carried by a wooden handle and is used for expanding the ends of tubes.

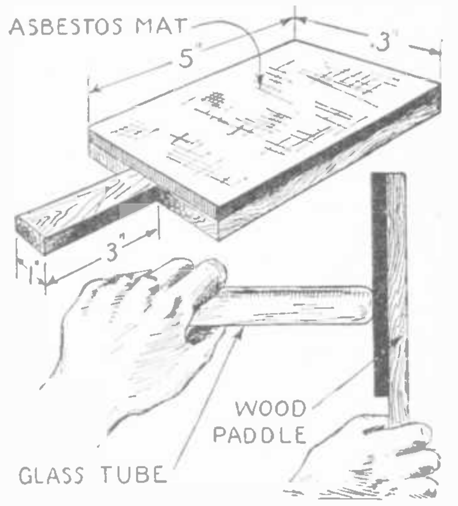
Glass Working Tools

A handy tool for flattening the closed and rounded ends of glass tubes is made from a wooden paddle by fixing a sheet of asbestos to it as shown. The asbestos prevents burning of the wood and spoiling of the tube. This paddle pressed against the softened, rounded end of a glass tube enables the operator to flatten the end so that the tube will stand upright. Of course, the annealing operation, that of smoking the glass after the work is done, should in this and all cases be practiced by the amateur. When the piece is cold, the soot can be brushed from it by means of an ordinary paint brush which should be included in the glass working equipment.

A pair of forceps comes in handy for pulling out softened ends of glass tubing.

A tool for flaring out the ends of glass tubing can be made from an electric arc light carbon by filing one end down to a point and thrusting the other end into a wooden tool handle. In operation the pointed end is slightly warmed in the flame and inserted into the softened end of the tube to be flared.

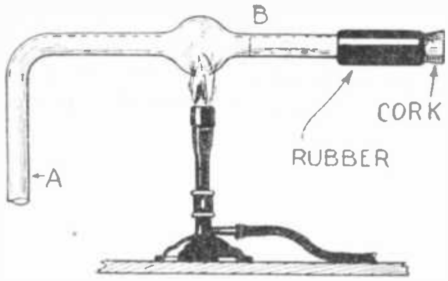
Little tips made from a 1-inch length of rubber tubing having one end closed by a cork are useful in temporarily closing an end of a tube while blowing. These tips are slipped over an end which is to be temporarily closed for the purpose of blowing at some spot along the tube.



A wooden spatula faced with thin asbestos is used for flattening the ends of tubes while they are hot.

A useful kink which will pay for itself many times over is shown in one of the illustrations. This consists of blowing a little expansion bulb near the end of a tube. For instance, a simple gas generator consists of an Erlenmeyer flask with a thistle funnel and a delivery tube carried by a two-holed stopper. The delivery tube is usually bent at a right angle, this right angle being connected by rubber tubing to any desired vessel for precipitating or other purposes. If the glass right angle is of ¼-inch diameter tubing, a 5/16-inch inside diameter rubber tubing cannot be slipped over it with tightness. A little expansion in the glass tube half or quarter of an inch from the end will easily enable the larger rubber tubing to be slipped singly over the smaller glass tube. To make this bulb, heat the spot where the bulb is desired to be formed, using a longer tube than desired and rotating the tube the while. Now when just soft press the ends of the tube together slightly, still rotating. This thickens the wall of the glass tube at the softened spot. Heat slightly again to soften and blow into the tube so that the bulb will form, rotating while heating and blowing after removing from the flame. When cold, the surplus tube can be cut off at B with a three-cornered file. The end should now be rounded in the flame (fire polished) to remove the sharp edge.

A handy support for finished work is made from seven-eighths of an inch dressed wood about six or eight inches square. This should be peppered with various sized holes from one-eighth to half an inch in diameter, not boring clear through. Hot glass tubes, finished work, etc., can be thrust into one of the holes so that the piece can air cool without touching any object whatever. This rack is a decided asset for the experimenter.



Blowing an extension a little way back from the end of a tube; it is afterwards cut off at the point B and rounded in the flame.

The writer has used the tools described herein for several years and knows that they will be very useful to fellow amateur glass-workers. But remember, skillfulness can only be acquired by practice and not absorbed from text. The assertion has ever been made that a glass-blower has to have the art in his very being.

Experiments in Spontaneous Combustion

By Earle R. Caley, B.Sc.

THERE are actually a certain number of serious fires due to spontaneous combustion. The most usual source of these conflagrations are rags or waste that have been saturated with vegetable oils or paint and thrown in some place where the circulation of air is slow. The oil saturating these substances are oxidized by the air and in doing so have their temperature raised. This heat generated in this manner remains in the interior of the oily cloth or waste and the temperature rises more and more, as the air slowly oxidizes the oil. Finally, the oily waste attains a temperature high enough to burst into flame, often with serious results.

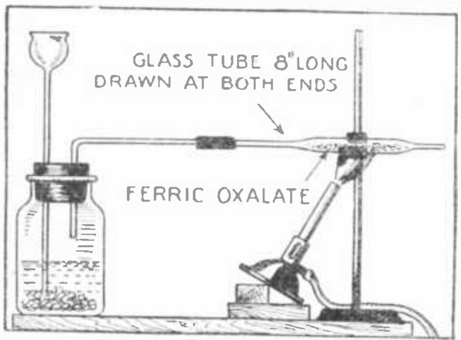


FIG. 1

Ferric oxalate ignited in a hard glass tube gives metallic iron so finely divided that it will catch fire and burn to magnetic oxide in the air.

Many other substances besides oils ignite spontaneously in the presence of air. Phosphorus is a well-known example. Some of the most striking and unusual experiments on spontaneous combustion may be performed with metals. We do not usually think of iron as a substance that ignites easily in air. Iron oxidizes or rusts easily in air, but this is a slow, cool process. If the iron is finely enough divided this rusting or oxidizing process occurs so rapidly that the iron becomes red hot and burns.

Experiment I

Our ordinary sources of heat are from various forms or compounds of carbon. No one who has ever had to start a hard coal or coke fire would ever think that carbon could be prepared so that it will ignite of its own accord when exposed to the air. This can easily be done, however.

A small quantity of lead tartrate is placed in a short length of hard glass tubing sealed shut at one end. The tube is then heated strongly by a Bunsen burner as long as any smoke or flame is emitted. While still hot the open end of the tube is sealed shut by heating with a blow-pipe flame. The sealed tube is then allowed to cool down. On breaking open the tube with a file and allowing the black powder to fall through a height of six or seven feet it will be seen to burn.

The combustion here is due to the combined effect of a fine powder of lead and carbon. In case lead tartrate cannot be readily obtained a mixture of equal parts of finely powdered brown sugar and burnt alum treated in the same manner will exhibit results nearly as good.

Experiment II

A piece of ordinary yellow phosphorus when exposed to air ignites after a short time. By dissolving a small piece of yellow phosphorus in a small stoppered bottle full of carbon disulphide, a liquid is obtained that will ignite when poured out on any surface. A good way to show it is to make a flag out of thin paper, attach to a stick and pour the solution over it. As it dries it will burst into flame. This is due to the finely divided phosphorus which is left by the rapid evaporation of the volatile solvent.

Experiment III

The apparatus shown in Fig. 1 is used for the preparation of metallic iron so finely powdered that it ignites when dropped through the air. A piece of hard glass tubing about eight or ten inches long is drawn out at both ends in the manner shown. Enough thoroughly powdered dry ferric oxalate is then placed in the tube to lie along the bottom and fill the tube about one-third full. A hydrogen generator, consisting of the usual wide-mouthed bottle filled with a delivery and thistle tube, is connected to one end of the hard glass tube. Granulated zinc is then placed in the generator bottle and diluted hydrochloric acid poured down the thistle tube.

The generation of hydrogen should then be allowed to take place at a good rate for a few minutes before the reduction of the iron salt is attempted. After this time the glass tube is heated with a Bunsen burner

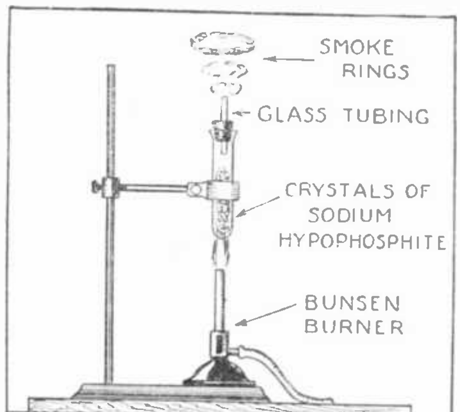


FIG. 2

A very simple way of producing small amounts of the spontaneously combustive phosphoretted hydrogen by simple ignition.

until all the salt is reduced, which can be easily told by the uniform black appearance of the residue in the tube. when the proper point is reached. When this point has been reached and while the hydrogen is still slowly passing through the tube the drawn-out ends are sealed shut with a blow-pipe flame. The tube may then be allowed to cool down. If this tube be broken and the powdered iron allowed to fall through the air it will become red-hot and burn, due to rapid oxidation. The best results are obtained on damp days, when the air has a high degree of humidity.

Experiment IV

Certain gases, on coming into contact with air, ignite spontaneously. The most common of these is hydrogen phosphide. The most easily carried out experiment to show the combustion of hydrogen phosphide is

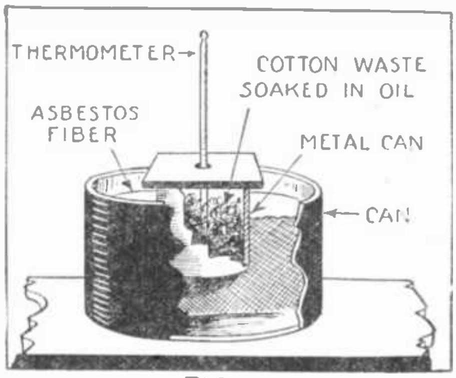


FIG. 3

Thermometric test for the heating developed in oily waste, oily rags and the like; the source of many conflagrations.

performed by means of the simple apparatus of Fig. II. A test tube is nearly filled with crystals of commercial sodium hydrophosphite and capped at the top with a single hole rubber stopper carrying a short length of glass tubing. On heating the test tube hydrogen phosphide will be evolved from the salt and on coming into contact with the air will ignite with a brilliant flame. Usually, when the air is quiet, vortex smoke rings of the combustion product, phosphorus pentoxide, will be formed.

Experiment V

The simple apparatus of Fig. III may be used to show the rise of temperature when oily waste is placed in a confined space. It is seldom that actual combustion will result in this experiment, but a very considerable temperature rise will invariably be recorded. A small metal can, having a greater height than width, is placed in a somewhat larger can or wooden box and the space between them packed with dry waste or rags or, better still, if obtainable, asbestos fibre.

The interior can is filled loosely with rags or cotton waste that has been soaked in a little boiled or raw linseed oil, the excess of which has been squeezed out. An ordinary thermometer is placed, with its bulb down, in the oil-soaked cloth. Readings taken from time to time will clearly show the progressive increase of temperature, due to the retention of the heat caused by slow oxidation.

Laboratory Manipulation

By T. O'Conor Sloane, Ph.D.

Various laboratory appliances are shown here. Above on the left is shown the capillary siphon which delivers water drop by drop, while on the right what is known as a separatory funnel is shown, which can be adjusted to do the same thing. Below these two are shown water supply systems which maintain an approximately constant level of water in a vessel from which water can be taken or evaporated.

SOMETIMES very slow, continuous pouring is required, and what is known as the capillary siphon may be used, although it is very seldom employed in ordinary laboratory work. A piece of wire or a glass tube or rod is bent into the shape of a siphon and it is wound with lampwick. This is placed in the vessel whence the fluid is to be drawn after it has been thoroughly moistened with water. The outer end must, like a siphon, be lower than the level of liquid in the vessel. Drop by drop the solution will fall from the lower end, and in this way a slow, continuous delivery of fluid will be kept up. There would seem to be no difficulty if a bit of asbestos cord and a glass rod bent to a siphon shape in adapting this system even to strong acid.

One case of pouring in a laboratory is where it is desired to give a constant supply of wated to a water bath, or any vessel in which evaporation is being conducted. A large bottle is fitted with a double perforated cork which should be by all means of India rubber. A glass tube, bent to form a siphon, passes through one of the holes in the cork, reaching down close to the bottom of the bottle, and the other end reaches to about the same level. Through the other aperture in the cork a straight tube is inserted and this is thrust down until its bottom is on a level with the desired level at which the water is to be maintained in the other vessel.

The heights of everything are so adjusted that the mouth of the evaporating dish or water bath or other vessel will be half an inch or so higher than the bottom of the straight tube. As the water boils away, when its level sinks below that of the bottom of the straight tube it will siphon water out of the large bottle and bubbles of air will pass in through the straight tube, unless the water rises above its level. It will be understood that to start it into operation the siphon tube must first be completely filled with fluid. This is principally applied to water baths and the like, not often to evaporation of chemicals.

A simpler method is to use a bottle with a single aperture and cork, through which the tube of about the diameter of a lead pencil passes. The end of this is immersed in the vessel in which evaporation is to take place. As long as the level of the water is above that of the bottom of the tube, no water can escape, but if the level falls below the tube, air will enter through it into the interior of the bottle and a small amount of water will escape. In this way by intermittent action a great quantity of water can be supplied as the other water evaporates.

If a double bend is given to the tube, constituting what the mechanics call an off-set, the bottle can then be placed to one side of the source of heat, so as not to be affected thereby.

Sometimes a separatory funnel may be used for slow delivery of water. This is simply a glass funnel with an accurately ground stopcock at its apex or neck. The stopcock may be turned so that the water will leave it practically drop by drop, but it has the disadvantage that it is not automatic in its regulation, and the rate of flow will vary, getting constantly less and less as the level of water in it sinks.

The chemist uses funnels for filtration, but seldom for pouring from one bottle into another. Yet he will never let a drop run down the outside of a flask or bottle.

It sometimes seems as if the chemist's wash bottle were an index of his technique. It would be easy to give pictures of how not to make a wash bottle. What we show here is how it is properly constructed.

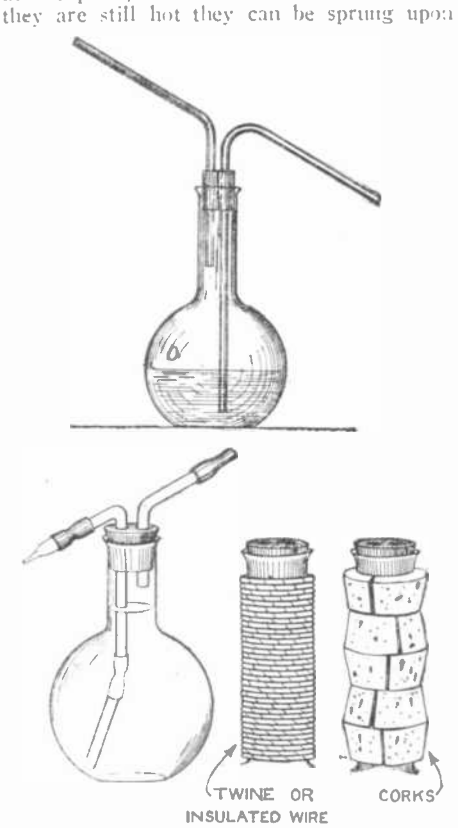
The short tube through which the operator blows should have a smooth round bend and need not go more than half an inch through the cork. Sometimes boiling water is to be used; if so it is impossible to employ a wash bottle unless it is arranged as the illustration shows, with a piece of rubber tubing thrust on to the inlet tube.

If the water is boiling violently in the wash bottle, steam will issue from the one tube. To use it, it is then taken in the one hand, with finger and thumb of the other hand the little rubber tube is squeezed tight, and after it has cooled a few seconds it is placed to the mouth, and by blowing there will be no danger of hurting the operator. When blowing ceases, before taking the mouth away, the tube should again be pinched. Without these precautions rather nasty scalds will occur.

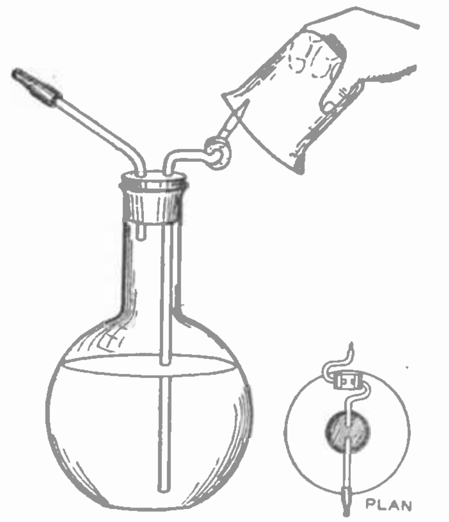
If the bottle is boiling vigorously, when the rubber tube is squeezed between finger and thumb, water may issue from the jet. This should be kept in mind so that water will not be squirted over the desk. The first outflow may be received directly in the funnel or in a beaker or even on the floor, where a little moisture does no harm.

If water is boiling in a wash bottle it cannot be taken in the hand because the neck will be so hot. The hand may be protected by folding a towel very neatly and wrapping it around the neck. This of course is only a temporary arrangement. A pad of cotton may be made, placed tightly around the neck and wrapped securely with string. This forms an excellent protection.

Another way is to take two or three large corks, cut and file out holes that will fit the neck of the bottle, cut them through in one place, boil them in water, and while they are still hot they can be sprung upon



Wash bottles are shown here; the upper illustration shows one incomplete and ready to have its tip drawn to a fine point, while below it is another fitted with India rubber connections, which prevents the glass tube from breaking, and enables the tip to be moved about with the finger. Two methods of protecting the hand from the heat of steam which may be evolved by boiling are also shown.



An arrangement for enabling the tip of a wash bottle to be turned up and to hold its position there. The drawing explains it very clearly and the plan gives the layout.

the neck of the bottle without breaking. After they have cooled off they can be secured by tightly tying with cord. Wire seems more permanent but is not very good as the current of hot air from the burner may heat it so as to make it uncomfortable for the operator.

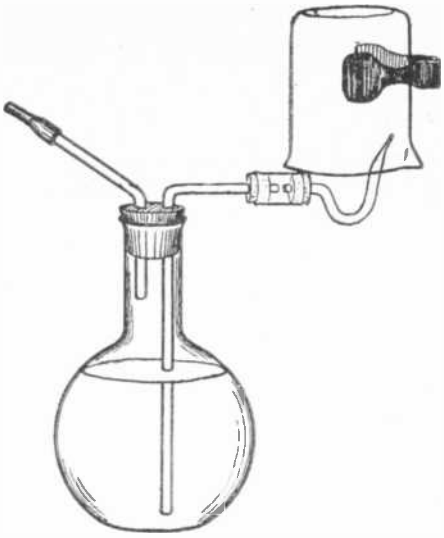
If the wash bottle is light enough a towel may be placed around the neck with both ends free and by holding the two ends as if it were a sort of handle the bottle can be manipulated very nicely.

Sometimes heavy gutta percha or rubber insulated wire is wrapped around the bottle. If this is done it is advisable to put several layers of muslin or some fabric under the wire, as the insulation of the latter is not a very good insulator.

The outlet tube of the wash bottle should be in three pieces; a few inches of the lower end should be separate and attached by a rubber tube. The object of this is to introduce flexibility so as not to break through the bottom if the cork is pushed in too quickly. The outlet jet should also be cut off and attached by a short piece of rubber tube, so that it can be bent about in different directions with the finger.

Another way of arranging the outlet jet of the wash bottle is shown in the illustrations which speaks for itself. A short tube of large diameter has a perforated cork at

How to hold test tubes and small flasks with a towel or even with a folded wisp of paper. Such a wisp of paper is an excellent test tube holder.



A simplification of the former construction but not so practical.

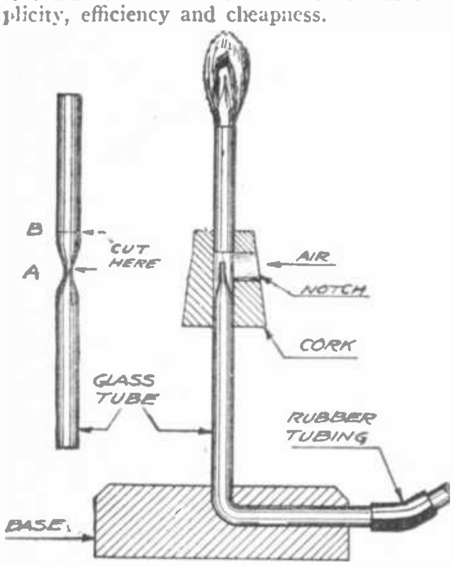
each end through which the two tubes are thrust. The effect of this is that the jet tube can be bent up or down as desired and will hold its place.

The system of holding the wash bottle by a towel just placed once around the neck or it might better be said three quarters around the neck can be used for test tubes with folded paper and is an excellent way of holding them.

Efficient Bunsen Burner

By Hugo Allessandroni

WHILE carrying on for a school a chemical experiment for which a hot flame was required, I constructed an excellent Bunsen burner remarkable for its simplicity, efficiency and cheapness.



A Bunsen burner constructed essentially of glass tubes and corks, which as an extemporized appliance has been found to give excellent results.

Procure a glass tube; heat the center in a flame gradually to avoid cracking the glass and draw it to a thin shape so as to produce a fine hollow point. Scratch carefully with a file and break it. Break away also the point of the other tube.

Now burn or file a hole large enough in a cock to fit the tube, and on the side cut a notch extending to the hole. Bend the glass tube with the point at right angles in the flame and saw a slot in a wooden block for the tube to fit in snugly, fastening it with sealing wax.

Put the parts together as shown in the diagram. Adjust the air mixture by sliding the upper tube up or down.

This burner will be found invaluable around the home, laboratory and shop for a countless number of purposes, especially in the field of radio.

Laboratory Heating Oven

By Frank B. Moore

A HEATING oven is a very useful article in the chemical experimenter's laboratory, and the high cost of the ones manufactured by regular chemical supply houses prohibits their purchase by the average experimenter.

Here is one which may be constructed for less than one dollar and which will prove quite serviceable.

The requisites are an ordinary soap box (wooden) about 18 inches in length by 13 inches in width. Of course, the size of the box will depend upon the needs of its constructor. However, the above dimensions will be found to be large enough for most uses, for heating flasks, beakers, etc.

To make the wood box somewhat fireproof, it is given a few coats of good varnish, then when dry, two coats of red lead mixed with water glass (sodium silicate).

The inside is covered with some heat insulating cement, such as fire clay, plaster of Paris, etc.

Two porcelain heating coils are procured (if possible from some old heater) and secured in the bottom of the box—or rather to its sides—one coil in one end of the oven, and the other coil in the opposite end, so as to give an even distribution of heat throughout.

It must be understood, however, that this oven is not subjected to much heat, the temperature not greatly exceeding 212° Fahr.

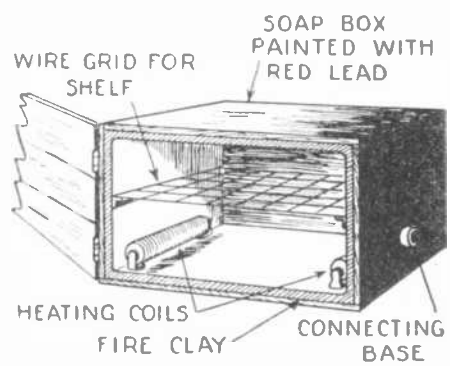
The heating coils must be connected in series with the 110 volt A.C. or D.C. line.

A circuit breaker may also be connected on the line so as to break when a short circuit occurs, etc.

A thermometer may be mounted through the top of the oven so as to indicate the exact temperature reached.

When all this has been done, the door of the oven is put on. It may be made of galvanized sheet iron or wood "treated" the same as the body of the oven.

Various other changes may be made to suit the constructor's taste.



A chemist's air bath or drying oven made of a discarded soap box. Here electricity provides a great improvement on the old-time gas heated oven.

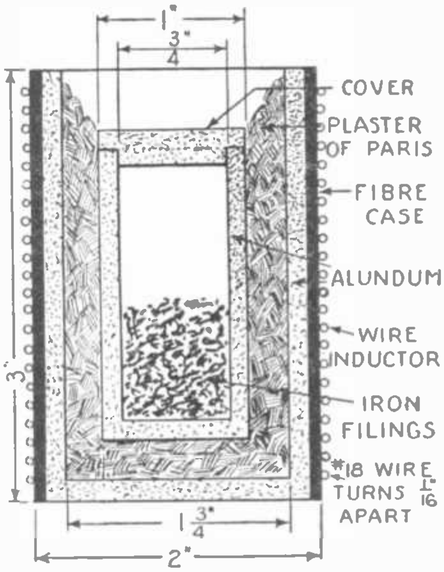
To the practical chemist the air bath or oven, as it is called, indifferently, constructed as above, appeals strongly. The Editors have had much experience with air baths in the past and these were made entirely of metal and were heated by a Bunsen burner. But the one described has a great advantage in that it is of wood, which is a non-conducting material, and there is no turning of gas on or off, because it would be a simple matter to determine the amount of current required to produce different temperatures. Drafts of air blowing against the wooden box would have no effect and there would be no troublesome regulation of a Bunsen burner to be attended to with constant reference to a thermometer inserted through an aperture in the top.

Model High Frequency Furnace

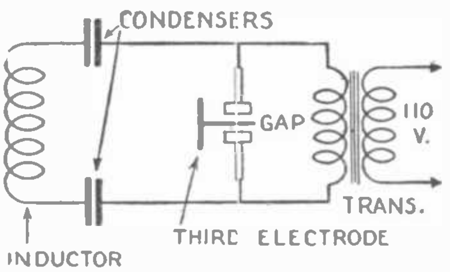
By Raymond Francis Yates

MANY experimenters have heard and read a great deal about Dr. Northrup's high frequency furnace, but few know that it is possible to utilize this principle in the laboratory for the heating of an appliance of laboratory type. During a recent experiment the writer required an electrodeless furnace that would bring about a fair degree of heating without danger of oxidizing the materials under treatment. Since the Northrup furnace can be closed up and sealed air-tight, it naturally presented itself as a logical heating appliance to use. Believing that other experimenters might be faced with the same problem at some time, the writer decided to present this data in an article that would allow anyone in possession of the few simple instruments needed to set up the furnace.

It will first be necessary to obtain an alundum crucible of the dimensions shown in the diagram if metal is to be heated. The writer would not advise the use of a larger crucible, since a great deal of time will be required to bring about a fair degree of heat using an ordinary radio transformer. This crucible is set into a still larger one and the intervening space is filled with plaster of Paris. This double wall is used for purposes of thermal insulation. Otherwise, beyond a certain point the heat would be dissipated almost as rapidly as it could be produced.



The cross-sectional view of this experimental high frequency furnace shows the central crucible of alundum which contains the material to be fused surrounded by plaster of Paris used as a heat insulator. A coil of wire surrounding the furnace induces eddy currents in the metallic content of the crucible and these currents generate the required heat.



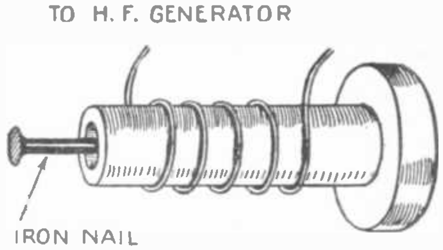
The diagram shows the circuit of a small experimental high frequency furnace which can be constructed readily by any amateur experimenter.

A cover should also be made for the inner crucible and this should be provided with an extension of plaster of Paris so that very little heat will escape by this avenue. Due to the very coarse grain of the alundum it will be found possible to make the plaster of Paris adhere perfectly if a little pressure is used. It might also be advisable to heat the finished crucible gently to drive off the excess moisture from the plaster of Paris. If this is done too quickly the plaster of Paris may crack under the strain. Too high a heat will destroy the adherence and consistency of the plaster.

A fibre tube which will easily slip over the entire furnace or crucible assemblage is wound with No. 18 bare copper wire, the turns being spaced about one-sixteenth inch apart. If a lathe is at hand it would be a good idea to groove the fibre with a large lead-screw thread, to prevent the wire from losing its position. Two brass terminals are secured in the fibre tube, which hold the ends of the high frequency coil and of the leads from the two high tension condensers used.

The apparatus is now ready for work. The transformer shown is one of the high voltage types used for spark transmission in radio telegraphy. It may have a voltage anywhere between 5,000 and 10,000 volts, and it may range in power anywhere from 1/8 to 1 kilowatt. The greater the power the more rapid will the heating be, and a 1 K.W. transformer will heat almost twice as rapidly as a 1/2 K.W. The spark gap used is provided with a third terminal, which is placed between the points of the regular electrodes. This can be carried out by placing a small piece of bent brass in position as shown. The condensers used are of the glass plate variety and of the same capacity that is employed in radio for the various transformer powers. Two of the same capacity will be needed. It will be seen that they are connected in series with the spark gaps and the high frequency coil.

The reader must understand that this furnace does not heat by the ordinary method. The high frequency coil does not become red hot and communicates no heat to the crucible as might be supposed. The high frequency coil should remain quite cool—cool enough to touch. When a conducting substance is placed inside the crucible (iron filings are good to demonstrate the principle), high frequency currents are induced in the metal, and the metal like an unlaminated core of an A.C. coil becomes heated. Nor should the experimenter expect the metal to become red-hot immediately the transformer is switched on. Half to three-quarters of an hour, and possibly an hour, must pass before the charge in the crucible will be re-



This simple arrangement of a porcelain insulator wound with a few turns of wire surrounding an iron nail, illustrates the principle of the high frequency furnace. Eddy currents induced in the nail rapidly cause it to be heated.

(Continued on page 416)

Ohm's Law and Electrical Power Law

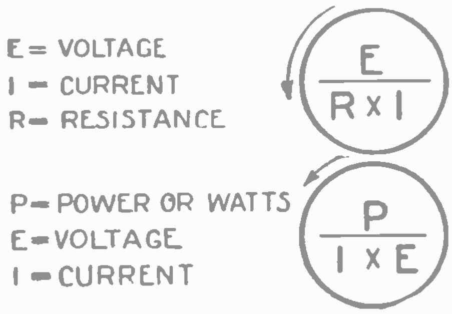
By A. B. Lyons

ON page 693 of the October issue of PRACTICAL ELECTRICS there is given an easy method of remembering Ohm's Law.

I am giving here a somewhat different version or statement of how to remember the law of power also.

Remember the (1) as "Erie." The letter above the line divided by any one below the line gives the other the two below the line multiplied together give the letter above.

The second is "Pie." All that is necessary is to remember that the first letter always goes above the line; the method of using No. 2 is the same as for No. 1.



The arrow indicates that one is to start at the top letter and go around contra-clockwise.

I hope this suggestion will prove of benefit to some of the readers.

Ohm's law, I=E/R and the power equation P=I x E are readily remembered with the aid of the diagram shown at the left. To aid in recalling these diagrams, you need only think of the word Erie for the first of these laws and the word Pie for the second.

How to Make a Ring Armature Dynamo

By Hans Konwiczka

WE have described the construction of a very good dynamo of moderate size. We now come to the dynamo with ring armature.

The first requirement is a very compact horseshoe magnet which any blacksmith or machinist can make by following the drawings. We also need 300 or 400 feet of cotton covered magnet wire about 40

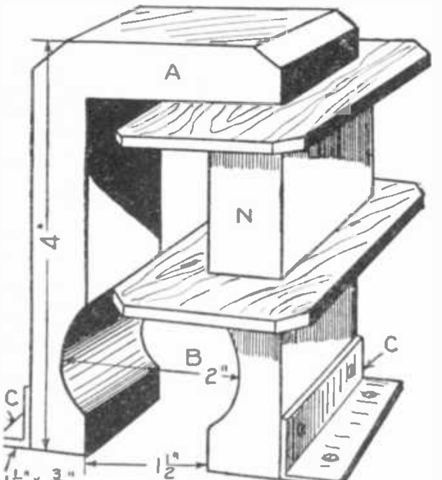


FIG. 18

The field poles shown above produce a strong and uniform magnetic field with very little losses. The piece is made of soft iron and can be readily bent and filed up into shape by the amateur experimenter.

mils in diameter, and also about 80 feet of the same quality of wire of 25 mils diameter, this, however, uninsulated. We also need some sheet brass, a good half pound of thoroughly annealed iron wire, 10 or 12 mils in diameter, some cigar box wood, a piece of round rod, or doweling a little over three-quarters inch in diameter and various screws, as well as four binding posts.

The main elements of the dynamo are the following:

1, the Electromagnet; 2, the Armature; 3, the Commutator; 4, the Brushes; 5, the Baseboard; 6, the Drive Wheel.

1. *The Electromagnet*

A magnet is bent up out of a bar of iron 1¼ inch wide and five-eighths inch

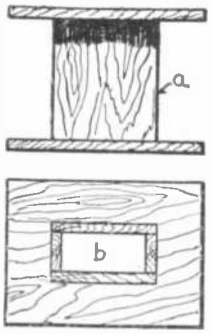


FIG. 19

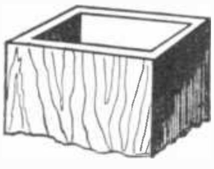


FIG. 20

The field coil is wound on this wooden spool, which is designed to fit over the rectangular pole pieces.

thick. It must have legs four inches long, separated from each other a little over 1½ inches (Fig. 18). In each one of the legs, three-eighths inch from the end, a groove (B) is filed out, which forms two arcs of a circle of two inches diameter, as indicated by the dotted lines. The magnet must be very nicely filed up in this place. To each end a brass angle (C, C), the same width as the iron, is soldered or screwed. This angle serves to screw the magnet down to its base. Before this piece is soldered on, each leg has to receive a wooden bobbin (N). These bobbins are made out of cigar box wood as shown in Figs. 19 and 20. The wood is to be as thin as possible, about three-thirty-seconds inch thick, and glued up into shape as shown. Fig. 19a gives a side view of the bobbin. Fig. 20 shows how the pieces are to be glued together. Fig. 19b shows how the flanges are glued to the body. When both are ready, they are wound full with S. C. C. magnet wire 40 mils thick, exactly as we did for the round bobbins in the other machine. The same length of wire must be used on each bobbin, and care must be taken that the windings are in the opposite direction, one from the other. Some eight inches of the ends are left free for further connections. We now have to wind the armature.

2. *The Ring Armature*

We have already described the winding of a small ring armature so that we only need say a few words about it. Two coned mandrels (a, b) with flanges (c, d) upon the ends are required. The smaller diameter of the core is thirteen-sixteenths inch and the larger diameter fifteen-sixteenths inch. The flanges are made of the cigar box wood two inches in diameter. Three notches (Fig. 22) (e) are cut out. The two halves are screwed together or otherwise secured and are wound full of the same iron wire thoroughly annealed. The wire must make a ring seven-sixteenths inch thick as shown. As we wind, it receives coating after coating of shellac in saturated alcoholic solution. The wires of the core are fastened together by three binding wires passing through the groove, which enables us to apply it readily. On separating the two halves of the mandril we have our iron ring ready for winding.

The core is now wound as shown in Fig. 23 with our magnet wire, each winding about one-half inch wide, and all thoroughly impregnated with shellac, and as we put on the windings we can remove the binding wires one by one as they are reached. Three layers of wire 24 mils in diameter go into each of the six coils, which must be very accurately placed. Each of the divisions will take 13 feet of wire. To facilitate the winding the 13 feet of the magnet wire are wound on a stick as there is no easy way of winding a ring armature.

The first coil which we wind will give us the exact length of wire for the others. Temporary binding wires are used to keep the coils compact and prevent them from spreading. The grouped ends of the coils are twisted together so as to bring them all into series, the first end of one being

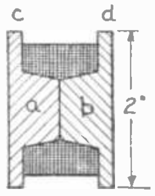


FIG. 21

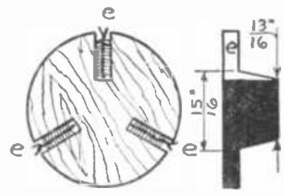


FIG 22

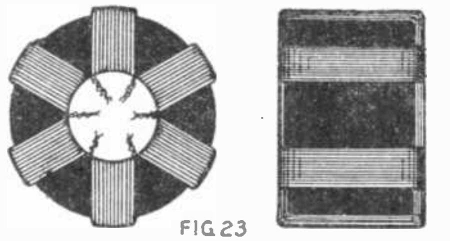


FIG 23

An ingenious method of making an iron ring for the amateur is shown in Figs. 21 and 22. A coil is wound with annealed iron wire around a spool formed of two coned mandrels. After the iron ring so formed is fastened by three binding wires, the mandrels are removed and the ring is ready to be wound as shown in Fig. 23.

connected to the last end of the other, giving a closed circuit all the way around.

3. *The Commutator*

This consists of a perfectly round piece All the winding must be in a uniform direction. This completes the armature. And next comes the commutator, which is of wood 2¼ inches long, and of such thickness that the armature will fit tightly on it. It can be cut from a piece of doweling of the right diameter The hole for the shaft must be exactly in the middle, as otherwise the armature may rub against the magnet, which is absolutely not permissible. Fig. 24 shows the commutator. Six little strips of thin copper or brass plate, copper being the better, numbered from 1 to 6 in the drawing, each one inch long and about one-quarter inch wide, are screwed down with even spacing. The

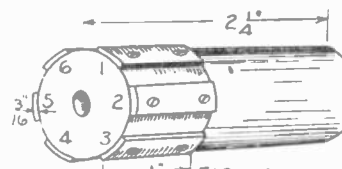


FIG 24

Six strips mounted on a wooden cylinder as shown above comprise the commutator of this simple dynamo.

length of the shaft on which it is carried is four inches, and one-quarter inch on the right- and left-hand ends is turned down to constitute the bearings. The shaft (X), which may be made of brass or iron wire in the neighborhood of one-eighth inch diameter is driven through the commutator.

On the other half of the commutator where there are no brass strips the armature is driven so as to bring the ends of its windings to correspond with the six little plates. The ends of the wire are scraped free of insulation and the beginning of one winding and end of the other are attached to the same plate. Do not attach both ends of the same section of winding to one plate. The bearings for the armature and commutator (ZZ) are made of heavy brass plate one-sixteenth to three-thirty-seconds inch thick. The height of the bearing for the shaft must be a little over one inch from the base

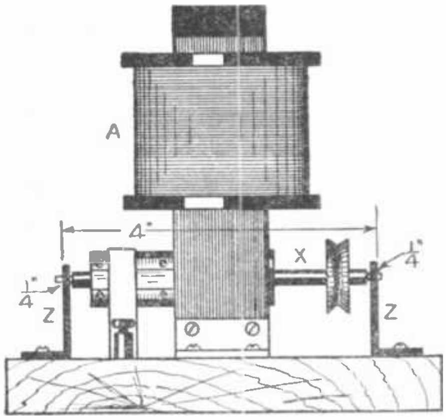


FIG. 25

The illustration above is a side view of the assembled ring armature dynamo. The commutator and one of the brushes are seen at the left.

and the bent piece at the bottom is five-eighths inch long; the width of the pieces is about one-half inch.

4. *The Brushes*

These are simply strips of thin brass or, still better, sheet copper three-eighths

The large and small brushes.

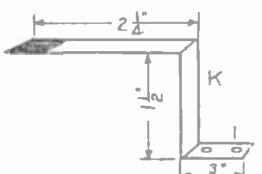


FIG. 27

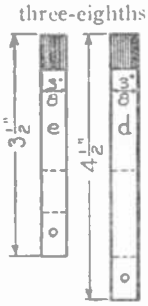


FIG. 26

inch wide, the ends of which are cut into a comb with a scissors. One of the brushes (d) (Fig. 26) is about $4\frac{1}{2}$ inches long and is bent as shown in Fig. 27. The upper horizontal part is two inches long; the vertical part is $1\frac{1}{2}$ inches long; the bent part for the screws is $\frac{3}{4}$ inch long. The second brush is $3\frac{1}{2}$ inches long and bent as shown in Fig. 28. The portion that is bent for constituting the foot corresponds to that of the other brush.

5. *The Baseboard*

The baseboard is 5 inches long, $5\frac{1}{4}$ inches wide and about $\frac{3}{4}$ inch thick all of mahogany or walnut, if it can be used, which will give the apparatus an elegant appearance. The constituent parts are now mounted on this base as shown in Figs. 25, 29 and 30, and the magnet (AA) is screwed down to the baseboard by the angles (cc). We can put the bearing standards (Z) for the armature. This must fit accurately in the field of the magnet without touching it. Now the brushes are screwed down as shown, so that one is in contact with the top and the other with the bottom of the commutator, the comb-shaped portions resting thereon; (f) and (f) represent the terminal binding posts. A driving pulley, Fig. 30 (E) is carried by the shaft

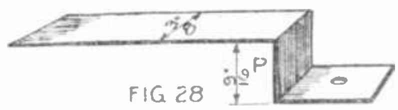


FIG. 28

A detailed view of the brush C, shown in Fig. 29. Note that the end of brush which bears on the commutator is cut into small comb-like strips.

for the driving belt. The following are the connections:

To the brush (C) the nearest end of the magnet winding is connected, the second end goes to the binding post (d); this is for carrying the current to the desired appliance. The other lead from the appliance just mentioned comes back to the binding post (d') connected to the brush (B), but if we want to make an electric motor out of our machine a different connection is requisite. For a motor we must connect the beginning of the magnet winding as well as the brush nearest thereto to the source of the current; then the other end of the winding is connected with the second brush, and this again with the other lead from the circuit.

6. *The Drive*

This corresponds exactly to what we have shown for the preceding article, Figs. 16 and 17. Naturally, a sewing machine with its flywheel is of considerable advantage as it will give a high speed of rotation with little exertion. The machine should

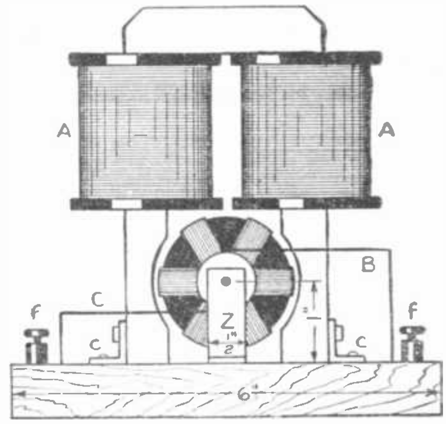


FIG 29

This front view of the generator shows the extreme simplicity of its construction. All parts are readily accessible for repairs. The brushes, B and C, are merely copper strips extending from the terminals to the commutator.

give 6 volts potential difference. It will light several small lamps.

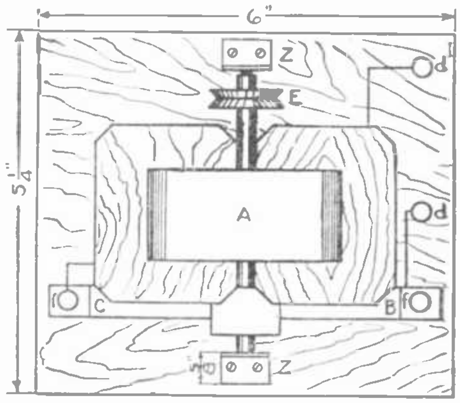


FIG 30

This top view of the generator shows the connections for the series type of dynamo. The "load," from the appliance which is to be supplied with current is connected to the terminals d and d1. The generator can be supplied with current and runs as a motor.

Brackets for Receivers

By Philippe A. Judd

THE average amateur would not think of throwing his variable condensers or rheostats down upon the table—or any old place—when he knocks off listening in for the day, but that is precisely what he does with his head phones. And, with the exception of his vacuum tubes, receivers are the most delicately constructed instruments he has in his set.

To say nothing of the damage accruing to the caps and shells, the greater part of the residual magnetism is driven from the permanent magnets by such rough handling. Needless to say, this less greatly reduces the efficiency of the phones.

After breaking several phone caps through careless handling, I conceived the idea of a bracket, as shown in the illustration. At the time, the bracket was being used for its original purpose—supporting a lamp and shade over my receiving set (B). I soon had it, minus shade and socket, rewired with the phone cords. A hole was drilled and tapped in the center of the head band to take the end of the bracket arm (A).

This type of bracket is very flexible and allows the headset to be easily adjusted to anyone operating the set. It also has a tendency to support the phones when on the head, which is not at all disagreeable

to the wearer. The phone cords are out of the way at the back of the head.

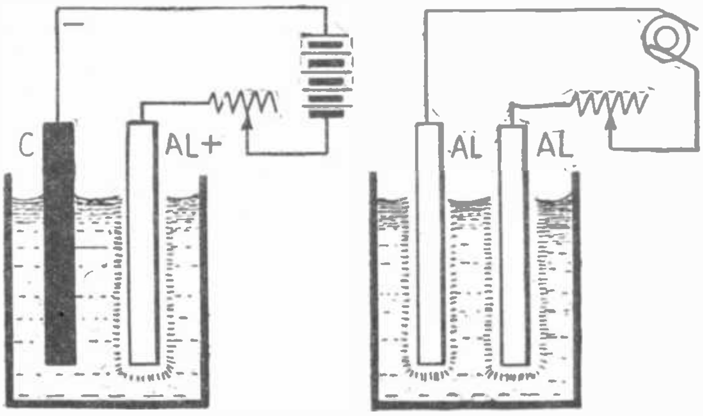
When removing the phones it is only necessary to swing the bracket arm up and backward, as shown by the dotted lines, in which position it will remain until again needed. Thus the headset is always ready for use, is out of the way, and is in a position to avoid damage.

To prevent excessive jarring of the head-set, which results from careless handling, the experimenter can convert the adjustable arms of a "wall" lamp into a head-set support of the form illustrated above.

It must not be assumed that this bracket is exclusively for radio operators. It will be found a most convenient accessory to the house-telephone, leaving the hands free to write down messages or telegrams, which operation involves confusion if one hand has to hold the receiver to the ear of the listener. In every family complaints are heard of the discomforts of head-sets. They are heavy, the hair is disarranged by their use, unless it is bobbed. The bracket shown here obviates these troubles for radio or telephone.

Light by Electrolysis

By WILLIAM GRUNSTEIN, E. E.



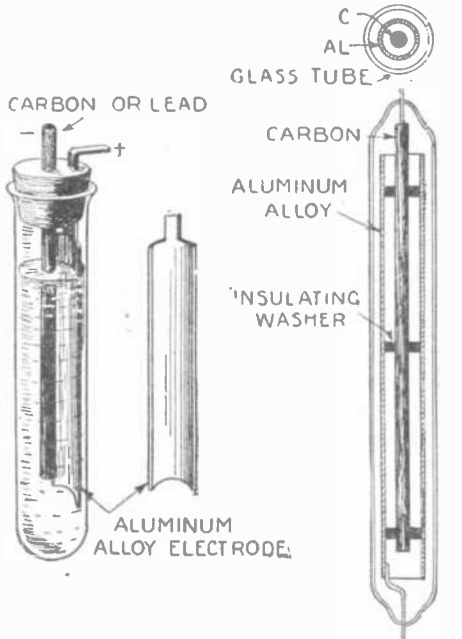
With the proper voltage applied to the terminals of an electrolytic cell, the positive electrode of which is aluminum, the surface of the latter will glow with a dull light. A similar effect can be produced with two aluminum electrodes supplied with alternating current.

ELECTRICITY has been utilized in a number of ways for the production of light, but all of these methods entail large energy losses through heat radiation so that even in the most efficient electric lamp, only a small percentage of the energy dissipated is converted into light. This is not surprising when we recall that in most methods of electric lighting, light emission is achieved through incandescence, necessitating a very high temperature of the light source. This high temperature is attained by the conversion of a large part of the electrical energy into heat.

The great loss entailed by the present means of electrical illumination has directed the attention of experimenters to the development of so-called cold light, that is, light whose source is at a very low temperature. All apparatus devised for this purpose has, however, proved unsatisfactory, either because the light-source was inadequate or could be constructed only at a prohibitive cost. One recent method, developed at the laboratories of the Westinghouse Electric Co., by John Coulsen, deserves special attention because of the novel features involved and because it shows promise of successful industrial application. Its novelty, however, rests on application merely for this light-source is essentially the familiar electrolytic rectifying cell.

In this epoch of radio most people are familiar with the electrolytic rectifier. No detailed description is required to recall this apparatus to our readers. It is exceedingly simple in construction, comprising a cell containing an electrolyte in which an aluminum and a carbon electrode are immersed. If these electrodes are connected to a direct current supply making the aluminum the anode or positive electrode, the current through the cell gradually reduces until it reaches a constant and almost inappreciable value. The aluminum electrode will be noticeably coated with a dull gray film. If the polarity of the electrodes is now reversed, the current will suddenly increase to its previous maximum value. This peculiar characteristic, of which the film is the visible manifestation, renders this cell unilaterally conductive.

Why this cell rectifies is not definitely known. According to one theory of its operation, when the aluminum electrode is made positive a thin layer of gas is formed around the electrode. This layer has a very high resistance and the current is thereby reduced. When, however, the aluminum is negative the gas layer is suddenly removed, and the cell becomes conductive.



A very simple form of the "electrolytic lamp" can be made of a test tube using a carbon rod and an alloy of aluminum as electrodes. A more efficient form consisting of a sealed glass tube enclosing a cylindrical aluminum electrode and an axially located carbon electrode is shown at right. The tube is filled with electrolyte before sealing.

If with the aluminum electrode connected to the positive terminal of a direct current, supply the voltage applied to the cell is raised, the aluminum plate will begin to sparkle when the potential reaches a certain value. If it is raised beyond this, the film will completely break down and electrolysis takes place. This sparkling is very bright and takes place over the entire surface of the electrode. It consists of small spots of light appearing and disappearing almost immediately. The light so produced, however, is very feeble and unsteady. Preceding this sparkling stage a hardly perceptible glow appears on the aluminum electrode. This glow can be much improved by the use of an alloy of aluminum, manganese and copper as anode. The electrolyte may be citric acid, or ammonium citrate, carbonate, borate or bitartrate or any other compound commonly used in rectifying cells. In operation, the film is first formed on the aluminum alloy electrode. To assure a uniform deposit of this film, it is advisable to regulate the temperature and current during this film forming period.

After the film is formed the electrode is connected to the positive terminal of a battery of from 100 to 400 volts, the other terminal being connected to a carbon or lead electrode. When such high potential is applied to the electrolytic cell the gas layer around the anode becomes ionized and a glow, giving a considerable quantity of light appears on the anode. In applying the voltage, the circuit is closed with a low potential across the cell and this potential is increased gradually until the glow voltage is reached. If the current density is increased beyond this point the sparkling effect referred to above will result.

The light from a single cell can be increased by the use of alternating current and two aluminum-alloy electrodes, upon which the films have been formed as described above. The two electrodes will now glow alternately, making the cell operate on both alternations of the current and without increasing the current consumption, twice the illumination can be obtained by the A. C. as by the D. C. cell.

An effective glow lamp of this type can be constructed by using a large test tube

(Continued on page 418)

Coat Button Insulators

THE use of collar buttons and snap fasteners for switches is well known, as well as safety pins for sockets and potatoes for transformers! It would be a shame if somebody didn't invent a use for overcoat buttons, the bone or ivory variety. So I have put this idea to work.

Buttons for insulators (so easy everybody will say, "Why didn't I think of that before?"), and it works swell. Hoover has nothing on this. They can be used on parlor aerials (not now!) and any other place where not too large an insulator of this kind is objectionable. Buttons can be put together and fastened with sealing wax and then can be used when wires come through wood.

Contributed by PERCIVAL MORRIS.

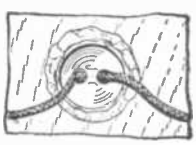


FIG 1

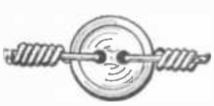


FIG 2

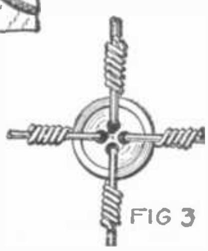


FIG 3

Coat buttons used as insulators for connecting two or more ends of wires, suggesting other electrical uses.

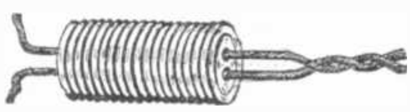


FIG 4

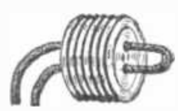


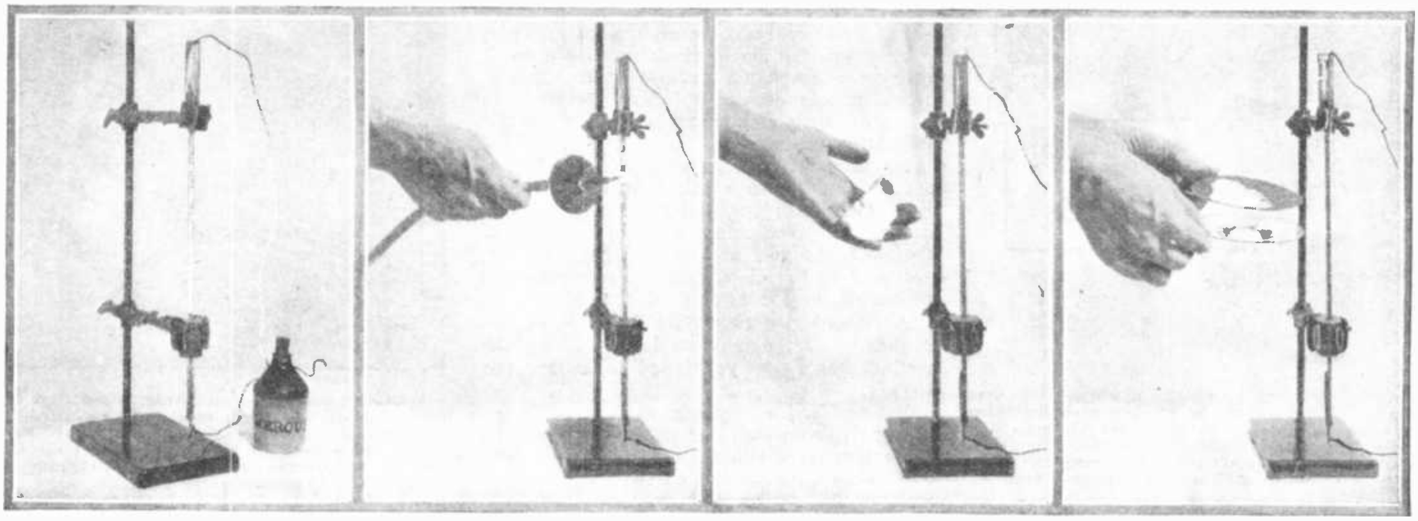
FIG 5

FIG 6

Various uses of the coat button, this time several are bunched together so as to make adequate insulators and inlets for wires.

Making a Mercury Vapor Ultra-Violet Lamp

By Raymond B. Wailes



A very simple but powerful ultra-violet lamp such as that shown at the extreme left can be constructed with a capillary quartz tube filled with mercury. A Bunsen flame applied to the tube evaporates the mercury and causes a break in the electrical circuit. An arc is started which has the characteristic mercury vapor color, and emits ultra-violet light, which will cause phosphorescense in such common substances as the white of boiled eggs and ivory soap. A piece of glass cuts off the ultra-violet rays as shown on the right.

THE press has frequently told us of the wonders of quartz glass which is transparent to the short and invisible ultra-violet rays which are in the sunlight. Then, too, some of the characteristics of ultra-violet light or rays have been expounded. For instance, it is these rays which cause the bloom or fluorescence of some machine oils, cause sunburn, stimulate plant growth, etc. Many other interesting effects of ultra-violet light have been known but which can only be perceived by the aid of a suitable ultra-violet lamp itself.

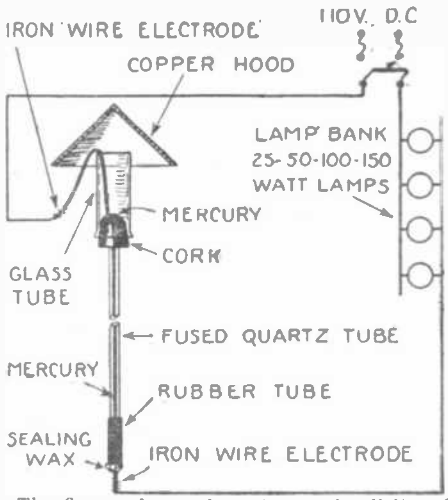
The little mercury vapor ultra-violet lamp described here is very easily made from an eight inch length of fused silica tubing, or fused quartz tubing, as it is sometimes called. The tubing used had an internal diameter of 1 millimeter, or about one-twenty-fifth of an inch. The lower end has affixed to it a short length of rubber tubing which carries the lower electrode which should be of iron wire. A drop or two of sealing wax will keep the wire in place.

The tube is filled with mercury. This can be accomplished by pouring in some of the metal until the tube overflows. The air space below the mercury should now be heated with a Bunsen burner. The air will expand and bubble past the mercury which will fall back into place when the flame is removed. This operation should be repeated until the tube is entirely filled with mercury, and all air bubbles expelled. It is necessary at the last filling of mercury to actually boil the liquid metal in the tube, the resulting boiling being sufficient to vaporize some of the metal which will carry off the remaining trapped air bubbles.

A short length of glass tubing, half an inch in diameter can be mounted at the upper end of the silica tube by means of a cork or a red rubber stopper, this type withstanding higher temperatures than black rubber. Radiating fins of copper can be affixed here, if desired, likewise a copper conical hood might be added, placing it in an inverted position at the mouth of the tube. Any mercury vapors, which are poisonous, which might tend to escape into the atmosphere, will amalgamate with the copper hood. This vaporization of the mercury should not be scoffed at, for recent observations have proved that mercury vaporizes at room temperature!

An iron wire electrode should be used as the top electrode, passing just below the end of the cork or stopper which holds the half inch diameter tube. It projects into the mercury of the quartz tube. Copper wire can be used but it will soon amalgamate with the mercury, the amalgamation penetrating to the very center of the wire and contaminating the mercury. Iron is preferable.

The finished lamp should be connected in series with several incandescent lamps which are in parallel with each other, say, two sixty watt lamps. The arc is now started by holding a small flame about one inch from the top end of the tube. The mercury will become heated, will boil, and the resulting mercury vapor will conduct the current, a brilliant arc ensuing. Direct current should be used; the arc cannot be kept glowing with alternating current. The 110 volt system is very satisfactory. The brilliancy of the arc



The figure shows the extreme simplicity of the mercury vapor ultra-violet lamp. A copper hood placed over the upper end of the tube prevents, by amalgamation, the escape of noxious mercury vapor.

can be increased by placing more incandescent lamps in parallel. As each additional lamp is screwed into its socket, an increase in brilliance can be noted.

The knack of starting the lamp by means of the gas flame will soon be acquired. The arc should not be "struck" near the center of the tube, for the pressure of the mercury column above it will exert an extinguishing effect upon it, and suppress the vapor formation. With a one-sixteenth inch inside diameter quartz tube the arc should be struck at about one and one-half inches below the upper end of the tube.

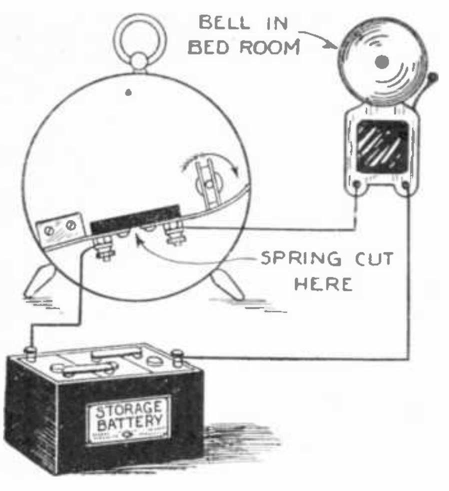
It is useless to try to use a glass tube for the lamp. A silica tube a foot long and 1 millimeter internal diameter costs slightly less than two dollars. Owing to its remarkably low thermal expansion coefficient, it will not break when the hot blue Bunsen burner flame is spotted upon it for the purpose of starting the arc. Then, too, if a glass tube were used and the lamp operated, it would be very deficient in the ultra-violet rays, which are not transmitted by glass.

One lamp of the writer's consumed about half an ampere with a 50 watt lamp in series with it, the voltage across the arc lamp being forty volts.

Many substances fluoresce, or glow, when the rays from the lamp are allowed to fall upon them. The following substances exhibit this property of fluorescence when isolated, or exposed, to ultra-violet radiations: Aesculin; amidophthalic acid; luminous sulphides of barium, strontium calcium and zinc; eosin; fluorescein; gelsemin; magdala red dye; barium platino cyanide; quinine salts; paviine; rescorcin blue; rhodamin B (dye); chlorophyll; uranium or canary yellow glass; some oils as lubricating oils; vaseline; willemite; fluorspar; turmeric; uranium salts; kunzite (a variety of spodumene mineral). Mr. L. J. Buttolph of the Cooper-Hewitt Electric Company, who has done much research on ultra-violet lamp manufacture, has found that the following substances are also fluorescent, or shine, when exposed to the ultra-violet rays: Ivory soap; white of boiled egg; pearl buttons; finger nails; real teeth; pearls; some diamonds; freckles; white paper.

Fig. 4 shows how the rays are cut off by glass. A quinine tablet is crushed in water and a drop of sulphuric acid (dilute) added to render it soluble. The resulting solution is placed in an open vessel such as a watch glass. When held near the arc of the lamp which is in operation, an intense bluish fluorescence or glow will be given off. This, however, instantly ceases when a sheet of glass such as another watch glass is held between the quinine solution and the arc. Here, the ultra-violet rays coming from the mercury arc pass through the quartz tube of the lamp but are cut off by the glass.

Many experiments are possible with the use of the mercury vapor ultra-violet lamp described. Such effects as ionization of glass, chemical decomposition, bleaching of colors, etc., can be performed with it.



An alarm clock located in a warm room was connected to a bell in an upstairs bedroom through a storage battery and through the spring contacts illustrated above. When the alarm started the winding key completed the bell circuit, thus ringing the bedroom bell.

Electric Alarm

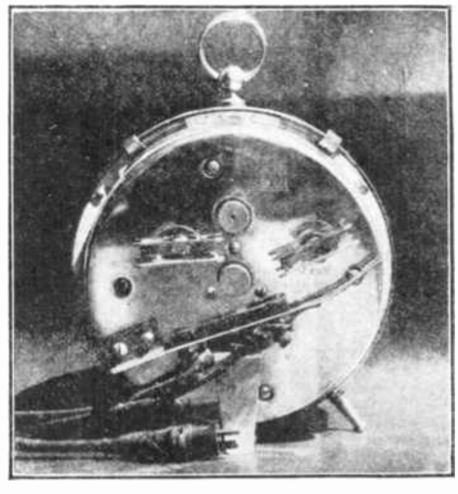
By Glen McWilliams

WHEN the cold air in an unheated upstairs bedroom seemed to interfere with the alarm clock twice one week, causing a mechanic to lose several hours' work, it was decided to place the clock in a warm room and run wires to an electric bell in the bedroom.

As none of the known methods of connecting an alarm clock and electric bell were satisfactory, the attachment shown was made in a few minutes from a piece of spring brass and a scrap of hard rubber, fastened to the clock with two screws, and connected in the circuit as shown.

As the device closes the bell circuit periodically as the winding key revolves, the method has never yet failed to arouse the sleeper.

We received a very neat model of this apparatus from which our photo was made by our artist. A well made apparatus is the best exponent of the quality of the instrument.

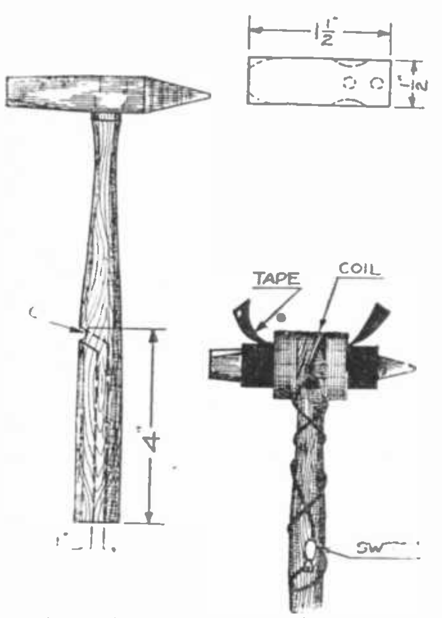


When an ingenious mechanic found that the operation of his alarm clock was retarded by the excessively low temperatures of his bedroom he devised the "remote control electric alarm" illustrated above. The diagram of connections is shown at left.

Electro-Magnetic Hammer and Screwdriver

By Walter C. Healy

ONE often finds in hammering small nails, brads or tacks, that it is exceedingly hard and tiresome to first press them into the material and then to apply the hammer. One also finds while using small screws or while trying to start larger ones in awkward places that it is very trying to have them slip from his grasp and either fall upon the floor and get lost or else drop into some inconvenient place.



Much trouble can be saved in hammering small nails or tacks, by converting the ordinary hammer into the electro-magnetic type shown above. A switch mounted on the handle enables the operator to attract or drop the nails conveniently.

To correct these difficulties I have constructed an electromagnetic hammer and a screwdriver of the same sort. They are superior to the permanent magnetic tools of this type because in a permanent magnetic hammer if you should happen to get too many tacks or other small nails on it they have to be removed one by one, which is not in the least desirable. The same applies to a permanent magnetic screwdriver. When a certain screw has to be dropped into some specific place the magnetism cannot be shut off, whereas in the electromagnetic instruments the magnetism can be applied or withdrawn at will simply by the pressure of the user's thumb. Other good qualities of these handy tools are numerous, but I will not take the time nor space to tabulate them, but get to the construction of the tools themselves. Anyone with even a slight knowledge of electricity will be able to produce a very efficient finished article with the commonest tools at a nominal sum. The following materials will be needed for the hammer:

Any ordinary hammer that has a wooden handle (a rivet hammer is best); a piece of springy metal (a corset rib serves the purpose well) 1/2 inch wide and about 15 feet of annunciator wire; 12 inches of insulating adhesive tape; 3 very small brass or copper screws, and 10 feet of thin double-stranded lamp cord.

Drill a 1/4-inch hole 4 inches long through the handle of the hammer, as shown in Fig. 1, also making a 1/4-inch outlet for the lamp cord at (O). Place the piece of springy metal in a vise and file into shape as shown in Fig. 2, so as to make a comfortable thumb-switch. Drill two holes the size of your screws in the base.

Place strips of tape the length of the hammer-head with their sticky side up, on the top and sides of the head, Fig. 3.

Wind annunciator wire over taped hammer-head, leaving about one-quarter of the head protruding on either side. Draw and stick the ends of the tape together to hold the wire firmly in place, Fig. 3.

Screw thumb-switch on handle of hammer in a place convenient for your thumb to reach, also place contact screw directly beneath the thumb-switch. Hook up as shown in Fig. 4.

Attach to one or two dry cells and the hammer is ready for use. I would advise taping the handle from the top at least as far as the thumb-screw in order to conceal the lead wires and at the same time hold them in position.

The materials necessary for the screwdriver are the same as those for the hammer, with the exception that a common wooden-handled screwdriver is used in place of the hammer listed.

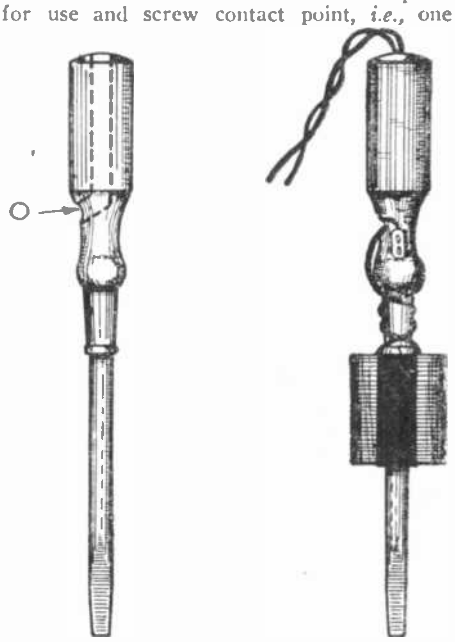
To make the magnetic screwdriver:

Drill a 1/4-inch hole through about two-thirds of the handle, making a 1/4-inch outlet at (O), Fig. 1.

File the springy metal to shape shown in Fig. 2, then bend it as shown in Fig. 3 and slot it, Fig. 2. The slots can best be made by first drilling two small holes the size of your screws and then using a hack-saw or a file to lengthen them. (By using several hack-saw blades on one frame a very accurate slot can be made.)

Tape and wind the same as for the hammer, fastening the whole coil to the handle by means of either another piece of tape or by jamming the free ends of the tape already used inside the ferrule of the screwdriver, Fig. 4. A combination of both these methods will prove very satisfactory.

Screw thumb-switch in a convenient place for use and screw contact point, *i.e.*, one of your brass or copper screws, so that it will touch the thumb-switch when the switch is moved forward, Fig. 5.



A small coil mounted on a screwdriver as shown above will greatly facilitate the work by holding the screws to the screwdriver until the former is in place and well centered in the aperture.

Hook up in the same manner as you did the hammer, Fig. 4.

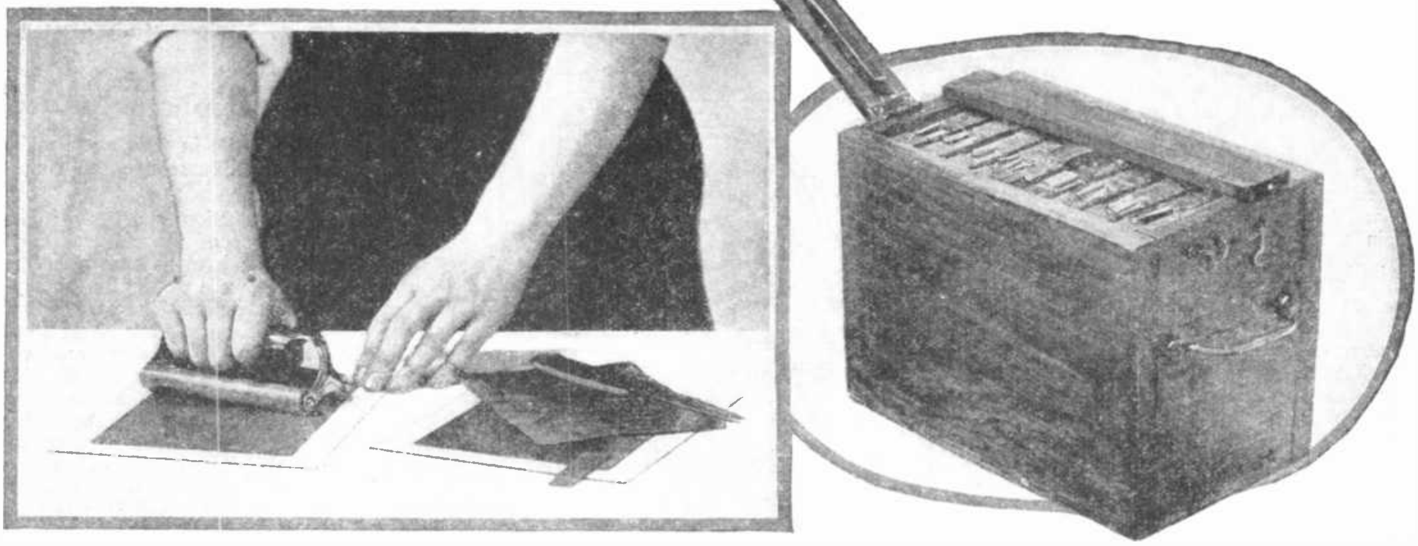
Tape the handle, from the coil, at least as far as the thumb-switch.

To use the screwdriver simply attach it to one or two dry cells. The current can be turned on and left on by pushing the thumb-switch forward and turned off by reversing the motion.

This switch can also be used on the hammer if wanted, although I do not think you will find it preferable to the other.

How to Make a High Voltage Condenser

By PAUL F. CHENEY



Though experimenters have frequent need of a high tension condenser few succeed in constructing one that will satisfactorily sustain high potentials. The condenser shown at the right is a carefully designed and readily constructed apparatus. Photographic plates with the emulsion removed are used together with heavy tin foil which is first carefully smoothened or squeegeed as shown at left.

EXPERIMENTERS who are wont to delve in realms of high frequency and high potential electricity, often experience trouble in securing a condenser of suitable capacity that is neither too expensive nor too liable to be broken down. Mica condensers are undoubtedly the best, but their price is usually above the average home worker's pocketbook. Glass plate condensers come next but unless they are carefully made, and correctly connected, they are most apt to puncture under the great strain. The author knows from past experience, for before the condenser which is to be described was constructed, eight glass plate units had been smashed in rapid-fire succession.

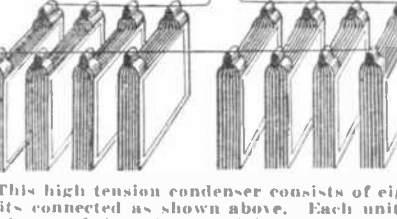
In choosing glass for the plates of a condenser of this type it is necessary to select that which is free from lead and as nearly free from air bubbles and flaws as possible. The author chose photographic plates because of their uniform quality and thickness. By using diplomacy you can get the old plates from your local photographer for almost nothing. The eight by ten inch size is the best for all-around requirements, but the five by seven inch plates will do very well for small condensers. These latter may be had for as little as a cent apiece.

As the emulsion on these plates is conductive, it must be removed. This can most easily be done by allowing them to soak over night in a strong solution of lye. In the morning they may be rinsed and dried and the work of coating them commenced.

Heavy tinfoil is the cheapest material for coating the plates, and fairly satisfactory, but copper foil in any but the smallest condensers is well worth the difference in price. Two pieces of foil, each six by eight inches, on the opposite sides of an eight by ten photographic plate, give an approximate capacity of .001 microfarad. Foil on the two sides of a five by seven plate gives a capacity slightly less than one-half of this figure. Knowing the capacity of a single plate, units can be built up to any size desired.

The first thing to do in preparing the foil is to squeegee it in contact with a glass plate by the use of an ordinary photo-print roller. Get out all the little wrinkles as far as possible, working from center outward, for the little air spaces between the foil and the glass of the condenser plate are often the scene of minute discharges that are a frequent cause of breakdown. Next cut out as many pieces of foil as will be necessary for the entire condenser.

A good insulating varnish that has been well thinned out is excellent for fastening the foil to the plates. Spread it on with a brush, not too thick, remembering that



This high tension condenser consists of eight units connected as shown above. Each unit is made up of five plates and has a capacity of .005 mfd. This arrangement facilitates "trouble hunting" and replacement.

the adhesive is just a means to an end, and that the greatest desirability is to get the foil as close to the glass as is physically possible. Squeegee the foil well and be sure to get it in the center. On the large plates never leave less than an inch space on each side, for otherwise they will brush heavily and disrupt in short order. Try to get the metal plates exactly opposite each other.

If the condenser is to be of large capacity it is best to group the plates in units of, say, five or ten plates each. This facilitates handling and replacement if a plate becomes broken. The author will outline a method of procedure in this line which has proved very satisfactory.

Cut a number of copper foil strips, each an inch wide and four inches long, to correspond with the number of foil-plates. Lay one of these on the plain glass plate, about an inch from the left upper edge and projecting an inch over the top, and upon this lay one of the coated plates. If the voltage, which is to be used with the condenser, is in excess of five thousand, it is a good plan to smear the space between the edge of the foil and the edge of the glass with vaseline. If this is done to each side of every plate, it will help greatly to prevent brush discharge.

Upon the upper side of the first coated plate, to the right, lay another one of the copper foil terminal strips, corresponding to the first one, but on the opposite side. Next, directly above this, lay the second coated plate. Upon this lay the third copper foil strip, to the left and in alignment with the first. Any number of plates may be added to this, in the same manner, to secure the desired capacity. Five eight by ten plates so arranged give a capacity of .005 mfd., which is a desirable grouping for a unit. A layer of friction tape will bind the plates on the unit tightly together and will help keep the vaseline from oozing out.

When over eight thousand volts are to be used, it is necessary that you connect two banks of condensers in series. However, when we connect two condensers in series, we cut the capacity in half which means that the capacity of each bank must be just twice as great as the capacity desired.

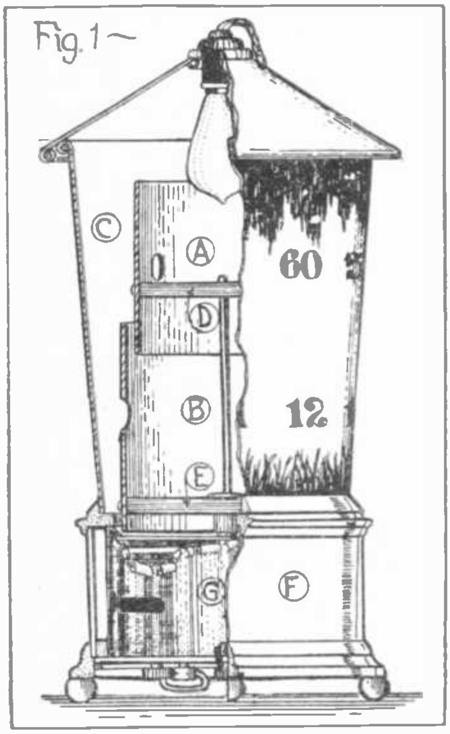
The photograph shows a condenser of .01 mfd. capacity, having two banks of four .005 mfd. units each, connected in series. This condenser has proved its worth after hours of continuous running, connected to a high frequency resonator in conjunction with a one-kilowatt, fifteen thousand-volt transformer.

If the constructor of this condenser is not familiar with photographic plates, he will probably find that they are much thinner than he anticipates, and also that in consequence of this thinness they are very easily broken in manipulating. Therefore, in squeegeeing, it is important that they should be properly supported; if placed upon an irregular wooden top table they will inevitably break. It is well to have a sort of pad underneath it, which again must not be too soft; a folded newspaper will be found quite adequate for the purpose, or a heavy cloth such as a bath towel folded a number of times.

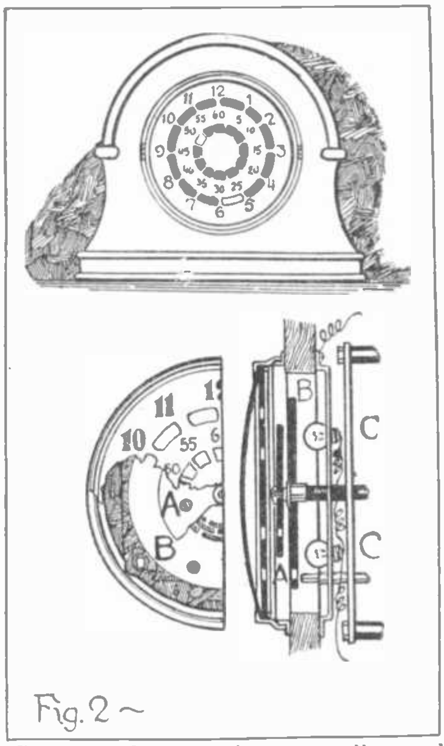
An old recipe for ironing a pocket handkerchief so as to avoid wrinkles was to begin in the middle to apply the iron. In this way by working around in a rough spiral or in a series of radiating strokes all wrinkles were supposed to be pressed out to the edge and to disappear into space, so that the handkerchief came out perfectly flat. By using the fingertips, starting at the center, the tin foil can be put on in the same way, by pressing it down with spiral strokes, working the wrinkles out to the edge.

Unusual Clock Dials

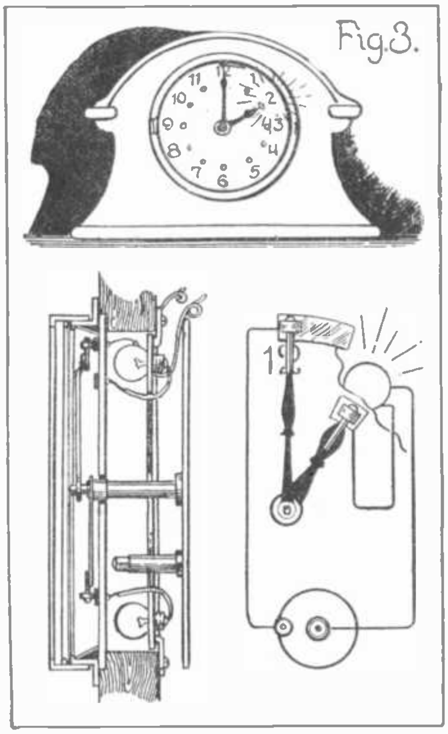
IN Fig. 1 you will find an old friend in new raiment. The alarm clock (G) has been made innocuous by the removal of its bell and hammer, and is seen hiding its loss within the dark interior of the lamp base (F). Its hands have also been removed and the center pinion lengthened. The hands have been replaced by the wooden crossbars (D) and (E), which support the two light cylindrical shields (A) and (B). These each have a small hole, so located as to allow a beam of light from the bulb to be thrown upon the parchment lamp shade (C) which has the hours and minutes painted upon its outer circumference. The spots of light thus made indicate the time. The winding and setting keys protrude through the bottom of the base.



This neat timepiece is constructed of an old table lamp in the base of which an alarm clock has been placed. The shafts of the clock carry opaque cylinders in each of which a small hole has been cut. The light projected through this aperture falls on the translucent cylindrical lamp shade.



By means of two rotating opaque discs, each provided with a small aperture through which a beam of light falls on a translucent dial, the usual clock hands are eliminated, the time being indicated by the position of the two spots of light.



In this clock the electric circuit of a small lamp is closed by the hands every time the clock marks the hour. Behind each number on the dial a small lamp is placed, the latter becoming illuminated when the hour hand reaches it.

The second illustration shows another electrified clock. In this case the hands have decamped in favor of the opaque disks (A) and (B). The dial has also been altered and now occupies a position immediately behind the glass. Both the disks and the dial are perforated, as shown in the diagram, so that the light from the miniature lamps (C) may shine through to tell the hour. The clock is wound in the usual manner.

The third figure illustrates a timepiece that writes finis at the death of each hour by becoming lit up, and then retires into its pristine darkness until another hour has come to an end. Here the hands serve as switch levers which close and then open the lamp circuit at the hour, as they crawl slowly around their endless path. Twelve small lamps occupy the space behind the translucent dial, one for each hour. The diagram shows the wiring details plainly.

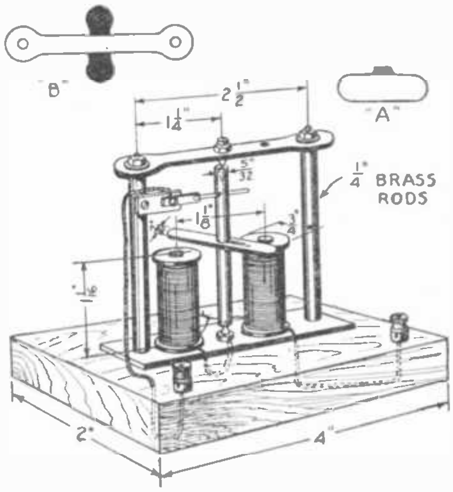
Contributed by PHILIPPE A. JUDD.

Motor from Telephone Ringer

THE first thing to do in starting to make this motor is to disassemble the ringer entirely.

The frame construction consists of the two round brass rods of the ringer, which stand upright on the base as shown in the diagram. The rods were originally the supporting rods of the ringer. The base is that part on which the brass rods are riveted, cut down to the size shown in the diagram. Suspended between the brass rods is the portion of the ringer holding the armature. This becomes the bearing. (B) shows the bearing of the ringer with dark portions removed. The shaft (S) is a small, round iron rod easily obtained and placed between the bearing. A 3/32 hole is drilled in both ends of the shaft.

The best way to find the exact center of the rod is to place a small collar over the rod so that part of the collar projects above the rod and then make a small mark on the rod by tapping a center punch inside the collar. These holes permit the screws which



An old telephone ringer has been dissembled to be reconstructed in a small motor. The illustration shows the details of its construction. Its armature is a thin iron strip and its commutator is a pin passing through the shaft and making intermittent contact with a copper strip on the shaft.

held the armature of the ringer to be inserted into the shaft and thus form the journals. The small nuts on these screws, which are used as lock nuts, are also used as lock nuts on the motor. The armature (A) was also used as the armature on the ringer. The portion, indicated in black, is removed and the armature is soldered on the shaft as is shown in the diagram.

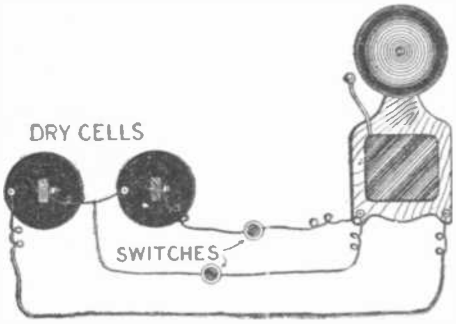
On the shaft above the armature is the commutator for "making" and "breaking" the circuit by hitting the "brush." It is made of the wire which carried the hammer, which hit the bell. The brush is made from spring brass. The fibre, which holds the brush and insulates it, is held to the frame by a 4/32 screw. A wire is run to the fibre down to the binding post from the screw which holds the springs. The coils are rewound with No. 22 wire.

Contributed by WM. VAN ROSENBERGH.

Two-Way Door Bell

THIS bell has two push buttons, one for the front door and the other for the rear.

(A) is a bell, (B, B) are two dry cells, (E) is the connecting wire and (C) and (D) are the front and rear push buttons, respectively.



Simple arrangement for making a door bell give different sounding rings according to which button is pushed, so that the sound discloses whether it is the rear or front door that the call comes from, or which of any other two places, according to the disposal of the buttons.

When (C) is pressed it completes the circuit, using two dry cells, which gives a strong, clear ring, indicating that someone is at the front door.

When (D) is pressed i completes the circuit, utilizing but one cell, which gives a weaker sound, and indica es that someone is at the rear door.

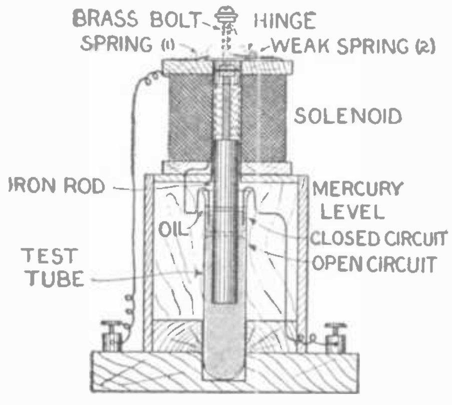
Contributed by FRED HALL.

Mercury Circuit Breaker

THIS circuit breaker has a positive action and the contact points will always make a good connection when in the circuit.

A solenoid is mounte over a test tube containing an iron rod and mercury. Sufficient mercury is used to keep one end of the iron rod floating about one-fifth inside the solenoid. A few drops of oil on top of the mercury will reduce sparking.

A brass bolt is threaded into the iron rod. It has a washer held in place by a



Very ingenious mercury switch which operates as a circuit breaker; when the current gets too strong, the core is drawn up into the solenoid, lowering the level of the mercury and opening the circuit.

nut on one end to keep the rod from tilting. A hinge on top of the solenoid is held down by a spring (1), but when enough force is applied to the hinge to raise slightly, the spring slips off and the hinge lifts up readily.

When a normal amount of current is flowing in the circuit the iron presses against the hinge lightly, but when the current becomes stronger the rod presses against the hinge hard enough to make the spring (1) release its hold on the h nge, the rod jumps upward, lowering the level of the mercury to a point below the contact points, thus breaking the circuit.

A small spring (2) on the hinge pulls it back so that when the rod falls back the head of the bolt catches on the hinge and prevents the rod from dropping down into the mercury. The dotted lines show position after it has opened the circuit.

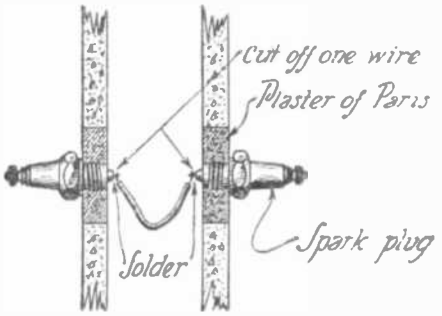
Contributed by GORDON L. REED.

Spark Plugs as Terminals

A GOOD way to use up old spark plugs is as terminals, when you want to pass a wire through walls, safely, neatly and efficiently.

To do this you cut off the wire which is attached to the side, Fig. 1, of the plug, then make a hole through the wall. Solder a wire about 10 inches long to the central wire on the inner end of one spark plug, pass the wire through the wall and solder the other end of the wire to the other spark plug; place plugs in position, then put on plaster of paris to finish up and hold in place.

Contributed by J. P. SHERIDAN.



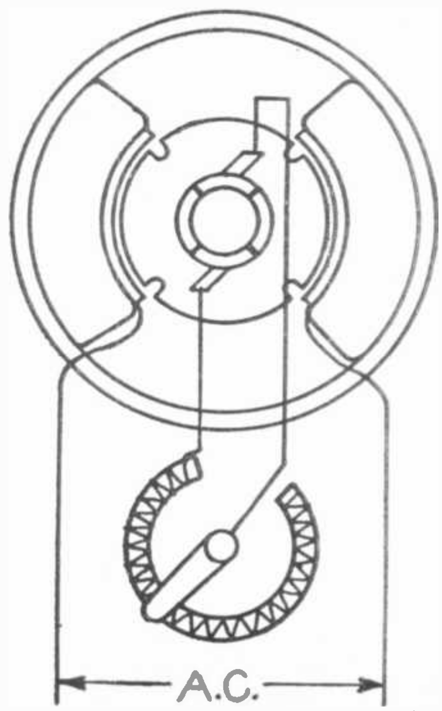
Very nice use for spark plugs for carrying wires through a partition; the heads of the plugs giving good connections on each side.

Repulsion Motor

WHERE only alternating current is available, a shunt-wound battery motor is rather useless.

Such a motor may, however, be easily adapted for use with alternating current by simply changing a few connections.

Disconnect the field coils from the armature and short-circuit the brushes through a rheostat. The alternating current is, of course, applied only to the field of the motor. The armature rotates by induction, forming an induction motor.

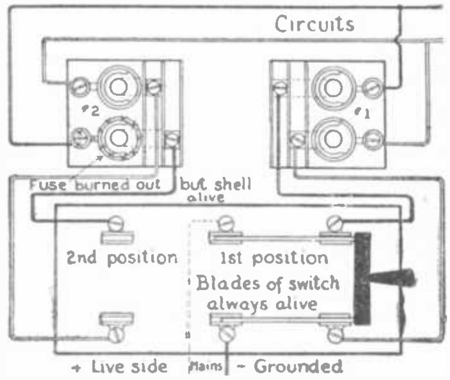


A shunt-wound motor has its connections changed so as to become an induction motor, in a certain sense, of the squirrel cage order.

Switch Connections

I SHOULD like to offer some suggestions on the article in the Junior Electrics (page 328) on fuse connection, by George Edwin Howard.

You will find if you look over the dia-

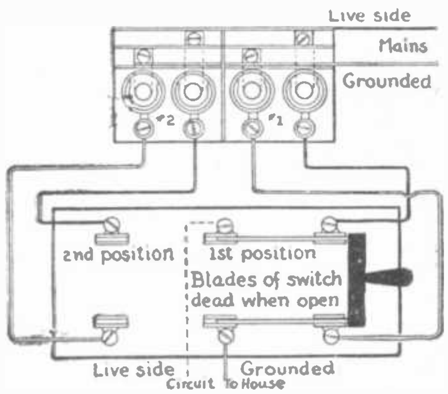


The switch connection given in one of our recent issues is criticized by this writer and this drawing illustrates how the blades of the switch are always alive, which may certainly be considered a defect.

gram that, first of all, the switch, a knife-blade type, will have the blades always alive, even when open, which, of course, is dangerous. The National Board of Fire Underwriters recommend in Rule 24, Section C, that, when practicable, switches must be so wired that the blades will be "dead" when switch is open.

Usually service switches are located in the basement, and quite often in a place where the person operating the switch stands on a very good ground, which makes it imperative to prevent a possible accidental contact.

This hook-up or wiring diagram only gives an added fuse, without regard to safety, for in the inclosed schematic diagram No. 1 (a copy schematic of the one printed in your magazine, possibly a little more elaborate) you will see that the added fuse serves more as a hazard, because the current feeds back, so that in attempting to remove the fuse in No. 2 you will find that the shell has become alive, and is dangerous to handle.



Alternative arrangement of the switch, by which when opened the blades are dead, thus getting rid of the objection to the connection given by our other contributor.

All fuse blocks (and sockets) must be connected so that the positive or live side is in the center, with the shell side connected to the grounded side of he current.

I have enclosed my version of the article, "Fuse Connection," in diagram No. 2. As you will see the fuses are ahead of the switch and the fuse socket shells are not livened up by the change-over. Thus the fuse may be readily removed without danger from accidental contact. The switch blades also are dead when open.

Contributed by WALTER L. KEEFE.

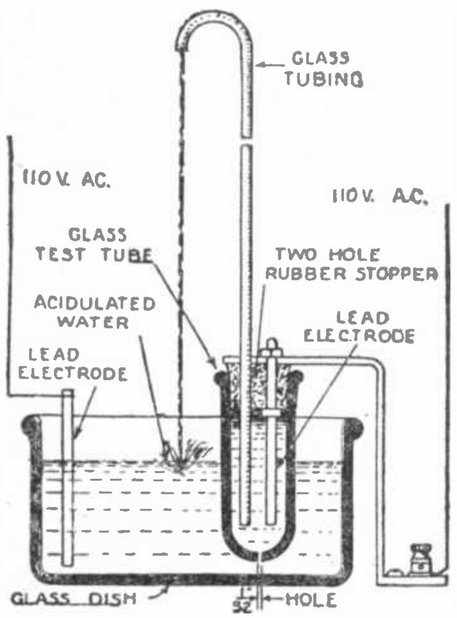
Electric Pump Experiment

AN electric pump with which I have experimented is illustrated here. It will interest your readers as it may have the germ of a practical and commercial device for lifting liquids electrically. I have raised water that has sulphuric acid mixed with it to a height of ten feet with such a device and I do not know the limits of its capacity to lift liquids.

The construction of this simple pump for laboratory experiment is as follows: Melt a hole about $\frac{1}{32}$" diameter in a glass test tube 4" long and ⅞" diameter, then procure one two-hole No. 5 rubber stopper; place a lead electrode in one hole and in the other a glass tube bent as shown in the illustration to suit the height it is desired to lift the liquid. Mount them as shown in a dish containing acidulated water, then place a lead electrode in the dish; connect the electrodes to a source of 110 volt alternating current. Upon switching on the current a hissing, sputtering sound will be heard and the water will rise in the glass tube and flow out of the top.

The operating principles of the pump seems to be the results of a series of explosions occurring in the aperture at the bottom of the test tube and forcing the water upward.

Contributed by JAMES W. DOUGHERTY.



This electrochemical pump can be constructed out of the simplest materials. By means of it the acidulated water used as electrolyte can be pumped as high as ten feet. The action seems to be due to explosions in the test tube.

Telescoping Test Tube Condenser

THIS easily constructed condenser may be used to increase the wave-length of your set if it is connected across the aerial and ground.

In my own set I do not get the higher wave-lengths such as are used by KSD and KYW, unless I use in the circuit, the condenser described.

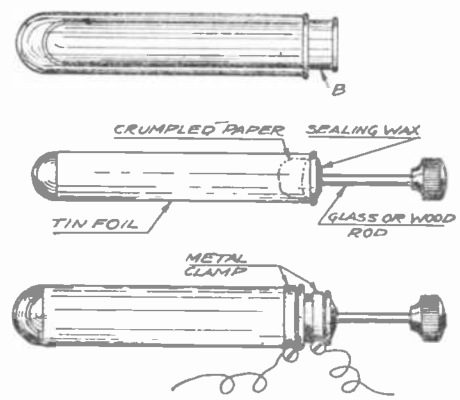
Secure two test tubes, one small enough to fit snugly into the larger, yet to slide easily in and out when desired. Cut two rectangular pieces of tinfoil just large enough to reach around the tubes. Paste them smoothly to the outer surfaces of the tubes. This is made clear by the diagrams.

In the end of the smaller tube, place a wad of crumpled paper. Against this place a round stick, a bit of thin dowel rod is good for this, or even a wooden skewer. If you can secure a short length of glass rod or tubing, so much the better. Pour melted sealing wax around the stick or rod to hold it firmly in the test tube. A knob of wood or hard rubber is fastened to the end of the rod to improve its appearance.

A narrow strip of metal, copper, brass, or zinc, is clamped around the end of each tube and in contact with the tinfoil. To the bolts in these clamps are connected the insulated wires which are to be connected to the set.

To increase the wave-length of your set about fifteen meters connect the wires to the aerial and ground as shown. In order to vary the capacity, slide the telescoping inner tube in and out of the larger.

Contributed by CLYDE E. VOLKERS.



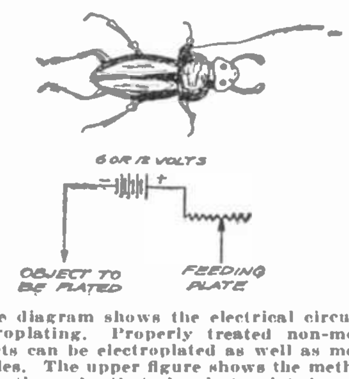
Two test tubes and two sheets of tinfoil make an excellent variable condenser. Adjustment is effected by sliding one test tube inside the other, telescope fashion.

Electroplating Metallic and Non-Metallic Objects

By THOMAS W. LIPPET

ONE of the most neglected phases of electricity in the experimenter's laboratory is the plating of conducting and non-conducting objects, by the use of an electric current.

The object should be suspended by a thin copper wire before the final dip. This wire will serve two purposes, one to protect it from being handled, as finger prints will produce blemishes, and to carry the current. If the article to be plated presents a smooth, finished or polished surface, the deposit will be "bright." If, on the contrary, the surface has a rough mat appearance, the deposit will have a dead lustre. The article should be put into the plating solution as soon as it is taken from the cleaning solution, as the surface will oxidize when exposed to the air.



The diagram shows the electrical circuit for electroplating. Properly treated non-metallic objects can be electroplated as well as metallic articles. The upper figure shows the method of connecting a beetle to be electroplated.

Cleaning Solution

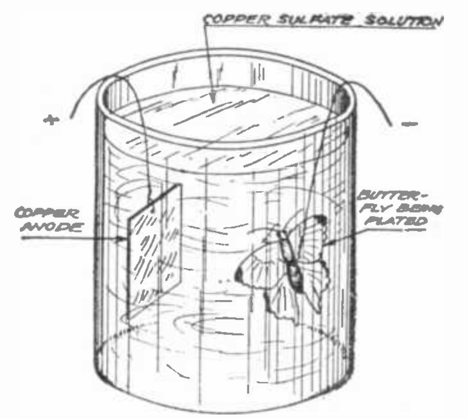
	Parts of water	Nitric acid	Sulfuric acid	Hydrochloric acid
*Objects to be plated				
Copper and brass	100	50	100	2
Iron (cast)	100	3	12	3
Zinc	100	..	10	..
Silver	100	10	..	..

The solutions to plate the different metals come next. To plate copper you use a solution obtained by the production of a double salt, such as cyanide of potassium and cyanide of copper. A good alkaline solution is prepared by dissolving 8 oz. of copper sulfate in 1 qt. of hot rain water. When this is cool add liquid ammonia until it assumes a rich blue tint. Dilute this with an equal amount of rain water, and add potassium cyanide until it assumes the color of old ale. This can be filtered and used in small quantities. This solution can be worked cold but the rate of deposition is increased and the deposited copper is of improved quality when heated to a temperature varying from 110° to 130° F.

To plate with nickel a double sulfate such as nickel and ammonium sulfate is used. The solution should be heated and kept free from dirt, dust etc.

To plate with silver the bath is to consist of potassium silver cyanide prepared by precipitating a solution of silver nitrate with potassium-cyanide and redissolving the washed precipitate in another potassium cyanide solution.

In all these solutions the auxiliary apparatus used is a porcelain or glass container. A glass jar is to be preferred. The direct current is supplied by a storage battery, but if a quicker deposit is wanted, two storage batteries connected in parallel and controlled by a rheostat will do very well. The object



An arrangment for copper-plating a butterfly in a bath of copper sulphate solution. Before insertion in the copper-plating bath, the butterfly was, by a chemical treatment, covered with a thin film of gold rendering it conductive without destroying its texture.

to be covered is connected to the negative electrode and is called the cathode. The anode is the feeding plate and is connected to the positive post.

These plates must be placed close together but care must be taken that the cathode and the anode do not touch.

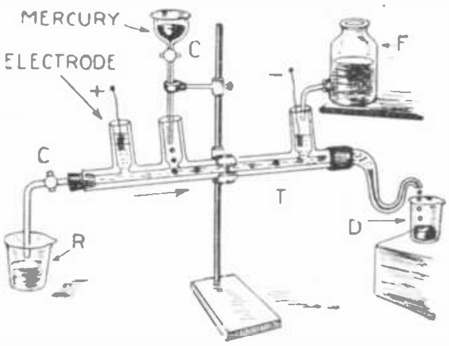
We now come to the electro-plating of flowers, insects, etc., and rendering non-conducting substances conductive. The greatest difficulty is to get a film of a conducting material over the object and this should be attempted only by those who have had some experience. One way to do this is to coat it with powdered graphite, but the texture is covered and the beauty impaired by the graphite.

A much better way is to prepare a mixture from the following ingredients: Wax or tallow, 1 oz.; India rubber, 1 dram; asphalt, 1 oz.; spirits of terpentine, 1½ fl. oz. These are mixed together by melting them and 1 oz. of a solution of phosphorus in bisulfide of carbon in the proportion of 1 to 15 is added. The articles are dipped in this solution and then dipped in a weak solution of silver nitrate until the black appearance of silver is seen. Then it is dipped in a weak solution of chloride of gold. It is now covered with a thin film of gold and can be plated like any other metallic object.

Electrified Mercury Drops

THE electric current can be made to do some queer things with mercury, especially in the form of drops, not to speak of the mercury arc lamp. A little experiment shown here and recently performed by investigators of surface tension effects might be amusing to some readers.

Mercury was allowed to drop from a separatory funnel (C) into the tube (T), which contained dilute sulphuric acid. The acid was kept in motion by being fed from reservoir (F), the outlet of the acid being equipped at (R) with a regulating means. A current applied through the side tubes as shown, caused the mercury drops to move UP the tube (T), against the force of gravity. The mercury exuded at (D) and was returned to (C) and used again.

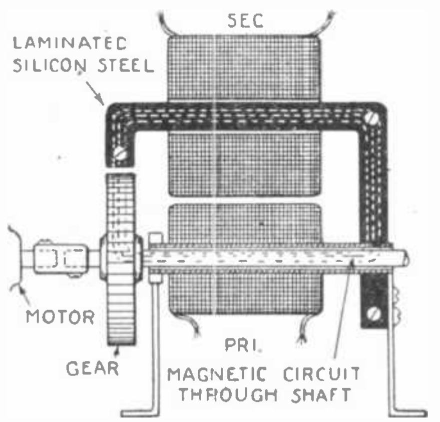


In this spectacular experiment small drops of mercury are made to travel up an inclined capillary tube filled with dilute sulphuric acid. The tube is connected to an electric battery and the mercury drops travel in the direction of the current.

Rotary Transformer

FOR experimental work where small currents of varying frequencies are required, the unit illustrated herewith incorporates the virtues of simplicity, compactness and flexibility, as well as ease of construction.

The rotor may be formed of laminated punchings or a toothed gear wheel may be substituted. As is apparent from the diagram, the shaft of the rotor and the rotor itself are included in the magnetic circuit. While a solid iron shaft is not best for the purpose in mind, nevertheless some efficiency is sacrificed for the sake of simplicity in construction and assembly.



This simple but very effective frequency transformer induces in the secondary of the transformer a current of variable frequency, the variation being accomplished by the change in magnetic path caused by the rotation of a gear, or large toothed wheel. The shaft of this gear forms the core of the primary coil.

The primary coil is wound directly on a brass tube which also serves as a bearing for the rotor shaft. The upper portion of the core is formed of regular transformer iron.

The secondary is wound on the upper leg and may consist of a winding of any desired ratio with respect to the primary.

In the event that a toothed gear is employed for the rotor, it may be found best to anneal the gear in a gas flame, cooling it in air.

The frequency will depend upon motor speed and interruptions of the magnetic gap by the rotor teeth.

The design is somewhat similar to that applied in an ordinary alternator where field and armature are stationary, and the core made to rotate.

Several applications of the unit are obvious and it will prove useful in any experimenter's list of apparatus. Use has been made of a similar device for furnishing current for class code practice, employing proper voltages for the circuit and apparatus.

Contributed by J. BRONT.

The Battle of the Colors

is the subject of a most interesting article. With a few drops of aniline color the most wonderful and astonishing color combinations can be thrown on the screen, and they are mystifying and puzzling to the onlooker. Read all about it in the April issue of SCIENCE AND INVENTION.

Interesting Articles Appearing In April Science and Invention.

Hearing Iron Molecules Move.

Electric Phonograph Motor.

The Larmor vs. Heaviside Layer.
By Dr. Joseph M. Howard.

Single Control Receivers.
By Leon L. Adelman, A.M.I.R.E.

A Four Tube Distance Getter.

A Multi-Range Wave Meter.
By Sidney E. Finkelstein, A.M.I.R.E.

Illuminated Flashers

BEAUTIFUL effects of spark discharges can be obtained with flash plates or even bodies of a new type.

The partly metallic varnish is prepared by mixing commercial bronze powder, such as aluminum, iron, copper, brass, etc., with shellac varnish.

The flash plate base is then coated with this varnish, using a fairly stiff brush, as shown in Fig. 1. To produce a still better effect, some bronze powder should be dusted upon the plate while the varnish is still tacky. The base for the flash plate may be either cardboard or glass; if the former is chosen, the cardboard must be thoroughly dried by heat before the varnish is applied. Connection with the discharger balls or the terminals of the spark coil secondary is made by two paper fasteners driven through the cardboard. (Fig. 1.)

Fig. 2 shows the appearance of such a flash plate in darkness.

If a glass plate is to form the base of the flash plate, small brass rings can be cemented to the sides of the plate, and the connection to the spark coil, etc., is then made from these rings.

Names, initials, designs, etc., can be shown on such flash plates by painting the glass plate or the cardboard sheet with clear shellac varnish. When the varnish is still tacky, the outline of the name, etc., is dusted in with bronze powder, so that the sparks will show the name. The varnish in this case contains no bronze, but merely serves as a binding medium between glass plate and the powder dusted on it.

This system of producing flashes is not confined to flat surfaces alone; glass or rubber balls can also be coated with the metallic varnish and lit up by a discharge. Such a flash ball is shown in Fig. 3; it is suspended from a silk thread, and the discharge takes place between two arms fitted with brass balls.

Glass tubes may be coated with bronze varnish and lit up by sparks; in this case the coating may be placed inside the glass tube to prevent damage to it. Such an internally coated flash tube is prepared as follows:

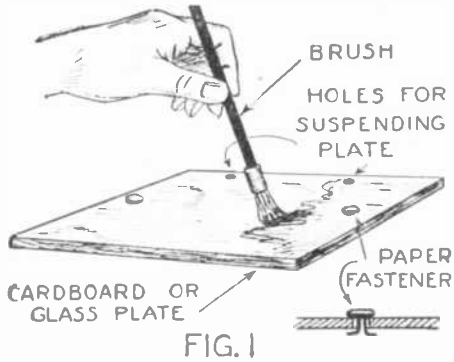
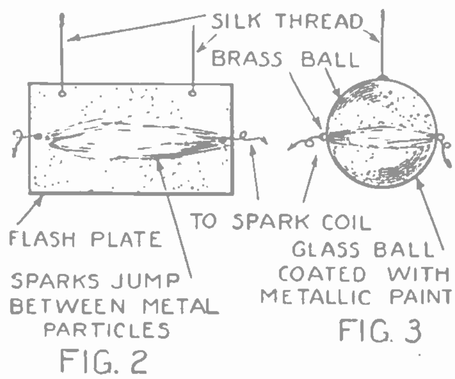


FIG. 1

By coating a glass plate with a mixture of varnish and metallic filings, a spectacular scintillation is produced. When this coating is brought in contact with the terminals of a spark coil, the sparks will jump between particles of filings.

One end of the tube selected is plugged with a cork, and a small quantity of shellac varnish is poured into the tube. Then the other end of the tube is also closed with a cork and the tube is twisted and moved about until the whole of the inside has received a coating of varnish. The corks are then removed and the surplus varnish is poured away. The tube is shifted about until no more liquid drops from it.

When the varnish has partly set, which will not take long, bronze powder is placed in the tube and by rotating and inclining the latter, the inside of the tube is coated with the metal dust. When completely dry, the ends of the glass tube are closed with cork stoppers, and wires are led into the tube through these stoppers. The inner ends of the wires are bent to make contact with the tube wall and the metal coating.



The illustration shows modified forms of the flash plate coated with metallic filings. The figure at the right shows a glass sphere so treated.

We can go still further with this system. Glass figures may be coated with metallic varnish and lit up by an electric discharge; we may even outline the variouse parts of the figures with various metal powders and thus obtain luminous effects in different colors.

Electric Leveling Device

By C. A. Oldroyd

LEVELING up ground, poles, piles driven into the ground, and similar items, presents great difficulties to the amateur worker, especially if the surface to be lined up is a very long one, as in the case of a fence, etc., which cannot be satisfactorily dealt with by using a stretched cord.

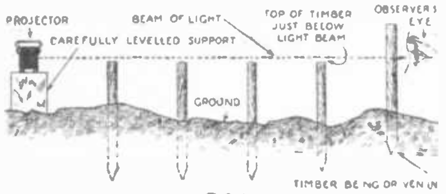


FIG. 1

The illustration shows a novel arrangement for leveling. A beam of light set to a horizontal position and at a definite height above the ground is used to indicate the height of timber marking-posts.

A number of piles are to be driven into the ground in such a way that the tops of all poles are at exactly the same level. The latter point is of importance if the piles are to form the foundation of a building or other structure, so that the beams can bear evenly for their whole length.

On a temporary support, such as a pile of bricks, carefully leveled first with the aid of a spirit level (shown on the left), the beam projector is placed; this throws a narrow pencil of light across the tops of the poles. As long as the poles are not driven in deep enough, the pencil of light will appear on the upper part of the pole, and show how much more the pile must be driven. At the right height, the disc will just disappear, and become visible to an observer standing on the right.

Should the piles be driven in very low, so that the observer would have to lie flat on the ground to observe the beam of light, we can let the disc of light play on the sides of the poles, by moving the projector slightly to one side.

Dim light or night work make no difference to the electric leveler; the darker the surroundings, the better the disc of light will show up; on the other hand, the beam

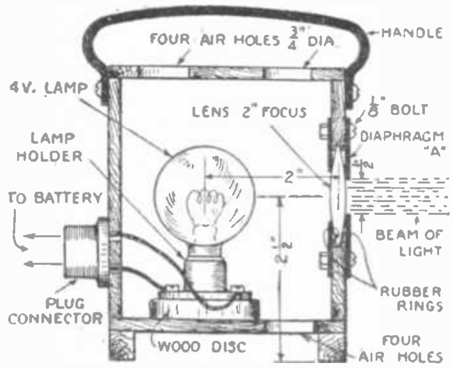


FIG. 2

A detailed view of the light source used in electric leveling. A four-volt lamp and a small lens are its essential elements. A diaphragm adjacent to the lens reduces the beam to a half-inch diameter.

is bright enough to be clearly seen in the brightest daylight. No reading-off of scales, stretched tapes, etc., is necessary, and if the light is made to play on the sides of the poles, several piles can be driven at the same time.

Many other uses for the device will be given later; for the present, we shall turn our attention to the vital part, the projector itself. This is shown in Fig. 2, in section. A small wooden box contains a four-volt lamp, with as concentrated a filament as procurable. The lamp is held in a porcelain lamp holder, the latter is mounted on a wooden disc mounted to the bottom of the box. Connection with the battery is made by a plug and, if desired, a small switch can be added. To prevent overheating, when the device is used continuously for long stretches, ventilating holes are cut in top and bottom, so that the air can pass freely through the box, past the lamp, and cool the interior. To facilitate this air circulation, the box is mounted on two battens which serve as feet. A leather strap mounted to the top serves as a handle; access to the interior of the projector is provided by a hinged side door. (Not shown.)

In front of the box a hole is cut out to take a simple spectacle or other lens of two inches focal length; two diaphragms with smaller openings are fitted inside and outside, and hold the lens in position. Rubber rings between lens and diaphragms prevent undue pressure on the lens, which might crack it.

If the lens is mounted at a distance from the lamp filament equal to its focal length, it will throw a straight beam of light one-half an inch in diameter, as the diaphragms cut off the rest of the light. The whole of the light is concentrated in the narrow beam, and, in consequence, the illuminating power is intense.

> ## NOTICE
>
> **IN our January issue we announced a Cover Page Contest. We invited manuscripts and ideas for cover page suggestions, articles to accompany same. The Contest closed on February 1st.**
>
> **Strange to say, this Contest proved really the worst we ever staged. Only a few entries were received and these were of no use whatsoever. We regretfully announce, therefore, that no prizes can be awarded, as none of the articles received approached our standard of merit.—*Editor.***

The current for the lamp can be taken from three small dry cells, if the device is to be used intermittently; in many cases, the light will only be used for short intervals. A storage battery is advisable if the lamp is used continuously; no special battery is needed, as in most cases a motor will take the working party to the spot, and then the car battery can be tapped for the leveler, connection being made by a long flexible twin cable.

Ground can be leveled very quickly and accurately with this device, as shown in Fig. 3. The beam will pass over the miniature valleys but will be stopped by the small hills; when the beam strikes the latter, soil is to be removed; on the other hand, where no streak of light is visible, soil must be added until the surface is just lit up by the beam playing on it.

Direct visual observation, which might become necessary in direct sunshine, is also possible, as indicated in Fig. 3 (right). The projector is again leveled on a temporary foundation, such as a pile of bricks or stones; the center of the beam ("X"-"Y") should lie 2½ inches above the proposed level ("C"-"D"). (Two and one-half inches is the height of the projector from base to center of lamp.)

To be able to observe the beam from above, without having to kneel down, a reflecting mirror is used; this is attached to a lath at an angle of 45 degrees, periscope fashion. The mirror lath will hang perpendicular when suspended from a nail driven into a temporary post, or, if a portable installation is desired, the nail can be driven into a file handle, which may be held in the hand (Fig. 4). The bottom edge of the lath indicates the height to which soil must be filled up or soil must be removed. A piece of steel bar serves as a bob, and steadies the lath. The square mirror is mounted on a triangular piece of wood; the edges of the mirror should be masked off with black paper, so that the image of the beam fills the opening when in line.

The ground can be mapped out in advance by driving short poles into the soil, their tops indicating what level is to be worked to; or, on the other hand, a trench might be

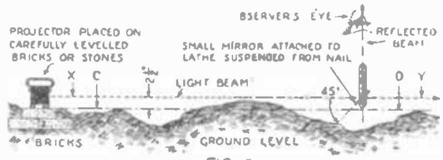


FIG. 3

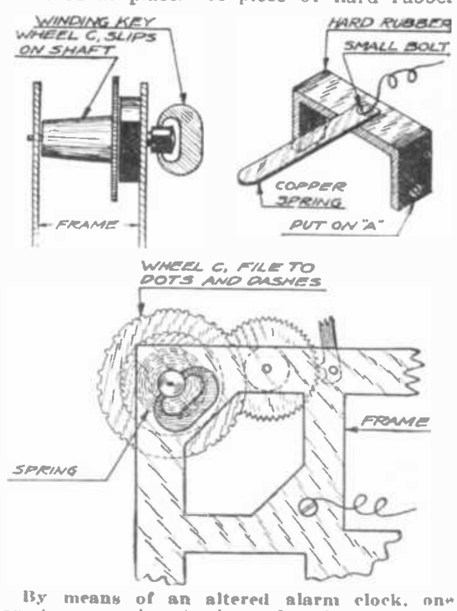
Here the electric leveling device is used to indicate the height of the ground level. By its aid the ground surface can be accurately leveled. The device should prove very useful in the construction of tennis courts.

dug, the bottom of which shows the level to which soil must be removed. Once laid out in this manner, work proceeds rapidly, and a perfect level surface is obtained with the least expenditure of time and trouble, thanks to the assistance of the electric leveler.

Code and Alarm

TAKING advantage of the well-known fact that the mind is peculiarly receptive in the early morning hours, one amateur mounted his code machine on his alarm clock, so that when the buzzer woke him, he could learn to recognize the sounds that made up the letters.

He filed the shaft (D) in the illustration so that it could be slipped out when the frame was pressed slightly apart. A new wheel was slipped on the shaft and as the shaft was coned, the hole in the wheel didn't need to be of exact diameter; it was then soldered in place. A piece of hard rubber



By means of an altered alarm clock, one amateur experimenter is awakened every morning by a message in telegraph code. The illustration shows details of the apparatus.

was fastened with small bolts to the frame and a copper spring so it would rest on the cogs of the new wheel. This is shown in Fig. 2.

The cogs were filed off and the dots and dashes of the alphabet filed in instead. The connections were made from the spring to a battery and buzzer, then to some place on the frame. The speed was slow, for all of the alarm mechanism was left, only the bell being taken off, and the latter could be put back in place and the code connections taken off when the alarm clock is to be used for its usual function.

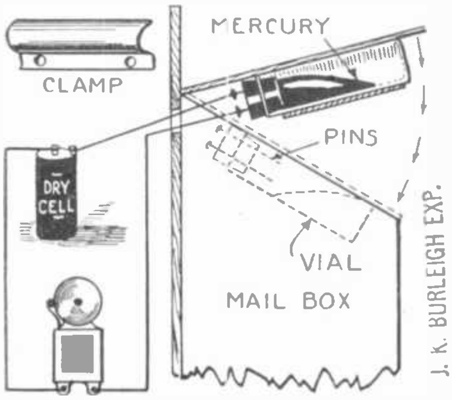
Mail Box Alarm

THIS mail box alarm is very easily made out of a small vial, some mercury, a cork, two pins and the arrangement for mounting.

Press the two pins through the cork so that they will protrude about ¼ inch on the other side of the cork and be ¼ inch apart.

Fill the bottle half full of mercury and insert the cork.

Secure the bottle to the sloping lid of the mail-box on the inside with a small piece of tin, bent to fit the tube, and a stove bolt. Attach it so that, when the lid is raised to put the mail in the box, the mercury will flow down and cover the pin points, thus closing the circuit and ringing the bell.



Mail box which gives the alarm at any desired point, when it is opened for the insertion of letters. It operates by a mercury switch attached to the lid, operating as clearly shown in the cut.

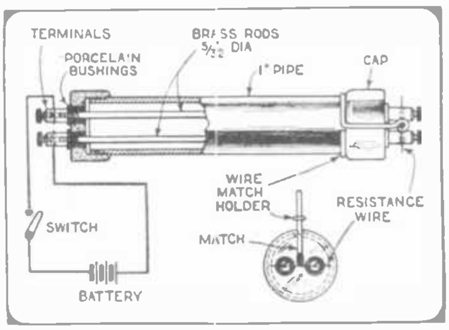
Attach wires to pins, battery and bell as in the diagram and the result is a neat alarm that is entirely automatic, worth many times its cost in the saving of steps to and from the mailbox.

Contributed by F. Alton Everest.

Electric Igniter

THIS electric igniter will light the fire in the stove, also set off a powder blasting charge or fire-cracker from a distant point by simply throwing a switch.

It is made of a 6-inch length of 1-inch iron pipe having a cap screwed on each end. Each cap is provided with two porcelain or glass bushings, which insulate the two 5/32-inch brass rods that they support. Binding posts are screwed to both the threaded ends of each of the two rods. The two wires from the source of current are connected to the binding posts at one end of the igniter. The posts on the opposite end are bridged with a short length of resistance wire. A piece of bent wire serves as a match holder.



An electric stove lighter; in this an incandescing wire lights a match which sets paper or other kindling on fire, so as to start the fire. It is for lighting coal stoves and the like, not for gas stoves only.

When the switch is thrown in and the circuit completed, the current passing through the resistance causes the wire to become red hot. This ignites the match held in contact with it. An auto storage battery makes a good source of current and can be carried to camp or summer cottage with ease.

To start a fire in a stove the igniter is placed in the ash pan under the grate. The "business" end is surrounded by paper or kerosene-soaked shavings. When the glowing resistance wire ignites the match and the combustible material about it, the dry wood or charcoal above in the grate or on the fire irons will be kindled.

Contributed by C. M. Wilcox.

Unusual Arc Rectifier

AS far as the writer knows, this apparatus represents something entirely new in the way of rectifiers. Its output in D.C. power may rise well over 100 watts, but it must be confessed that the input is disproportionately high. The efficiency, however, has no effect on its value from the experimental standpoint.

The principle involved is quite simple and is briefly as follows: If an alternating current arc is maintained between vertical carbons placed in a magnetic field, it will assume the form shown in Fig. 1. The magnetic field crossing the arc at right angles will expand it into a broad flame with upcurving ends. If the magnetic field is steady and unchanging, the arc will follow each reversal of the current with a corresponding deflection to one side or the other. That is, a synchronized vibration will take place.

Now let us suppose that a third electrode placed in line with the arc is adjusted until its end just touches the widest limit of the flame. Then every alternate half cycle contact will be established between the auxiliary carbon and the edge of the arc. Should the third carbon be connected to one of the main carbons, current would flow through it during the instant of contact. The succeeding half-cycle would be suppressed by the "blow-out" action of the magnet on the main arc. Of course, the current drawn from the D.C. circuit must not be high enough to sustain an arc of its own accord, but this is not likely to occur in practice. If it did occur, the rectifying action would be destroyed.

In the photographs is pictured an experimental arc which exploits the foregoing principle. It is capable of supplying about one ampere of direct current under 50 volts pressure. It operates in series with a twenty-ohm charging resistance. Of course, any kind of 600-watt heating appliance could be used.

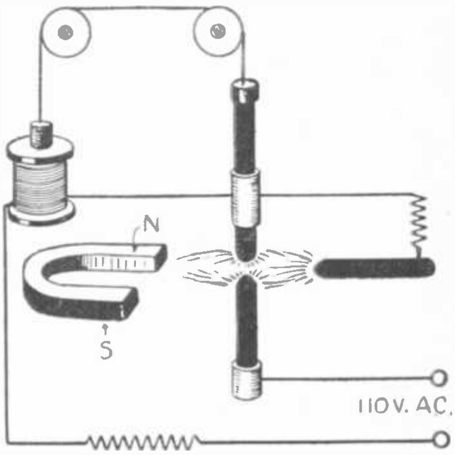
Some simple form of solenoid control is required for striking and maintaining the arc. The photograph shows quite clearly how this automatic feature can be obtained. The upper carbon is incompletely counter-balanced by the weight of the solenoid plunger. The latter is partially inclosed by a coil, wound to carry the full current of the arc: that is, about five amperes. No less current than this should be used on account of the unstable character of the arc.

The strength of the magnetic field applied to the arc is also rather critical, as a strong tendency exists to extinguish the arc. For this reason the writer used a small electro-magnet supplied with dry-cell current through a rheostat. A horseshoe permanent magnet could of course be used if correctly placed.

The third electrode is a carbon rod mounted directly in line with the gap between the main carbons. It also should be made adjustable, although you will find that it burns away with comparative slowness. The degree of consumption is proportional to the amount of current drawn from the D.C. circuit.

All carbons used are of the ¼-inch projection lantern type. Most large photo supply stores can furnish them at a cost of five cents each, and unless you cannot possibly obtain them, do not bother with battery carbon makeshifts. In mounting the upper main carbon, be sure that it is considerably heavier than the plunger of the solenoid, so that on open circuit it will rest in contact with the lower carbon. Make the latter adjustable so that the arc can be kept opposite the auxiliary carbon.

When the arc is burning steadily on a five-ampere current and all adjustments are correctly made, you will be able to draw pulsating direct current from the third carbon and either one of the main carbons. Quite likely you will find that one connection results in a greater current than the other. The reason for this lies in the lower operating temperature of the third carbon, which therefore functions more easily as an anode than as a cathode.



A very interesting type of rectifier which operates by the use of a third carbon, producing a sort of lateral arc which is affected in tune with the frequency of the A.C. by a magnet.

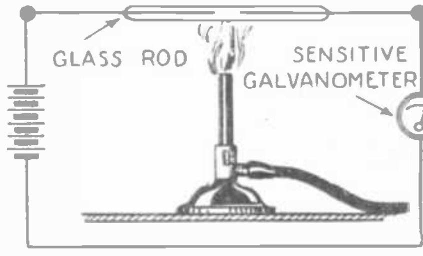
It is said that a rectifying action results from the use of an iron-oxide cathode and a carbon anode. It is not easy to get good results from this experiment, largely on account of the difficulty experienced in maintaining a metallic arc on alternating current The writer can say, however, that it does work with heavy spark coil discharges.

Conductivity of Hot Glass

TAKE a short piece of glass rod and heat the ends until they are soft. Then push a piece of platinum wire in each end until the ends of the wires embedded in the glass are about ¼ in. apart

A milliameter or sensitive galvanometer is joined in series with the wires and glass rod and a battery of about 100 volts or more No deflection is produced, showing that at the temperature of the room glass is a good insulator.

Next heat the rod with a gas burner and as soon as the glass gets soft, the galvanometer will show a deflection indicating conductivity. This is due to the fact that the heating of the glass leaves the iron free to flow.



Another version of the conductivity of hot glass, of which one or more examples have been given in our columns. Here the glass constitutes part of the circuit, and passes no current until heated by the Bunsen burner, when the galvanometer is at once affected.

Contributed by JR. NEWSON

Awards in the $50 Special Prize Contest
For Junior Electricians and Electrical Experimenters

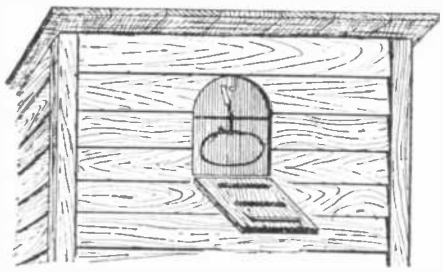
First Prize, $25.00	Second Prize, $15.00	Third Prize, $10.00	Honorable Mention
Charles Shearer P. O. No. 78 Progress, Pa.	Herman E. Schielke P. O. Box 313 Vacaville, Calif.	Abraham S. Saffron 780 Hazelwood Ave. Pittsburgh, Pa.	David Jenkins 410 Washington St. Xenia, Ohio

First Prize
Homer Pigeon Alarm

THE homer pigeon, of whom Thompson Seton has written so beautiful a story, is in some ways a very stupid bird with all its poetic associations. It has been found that if the accustomed door of the pigeon house is changed, and another door is left open, he will stay outside and not enter the strange portal.

In trials of flight of homer pigeons, a very obvious problem is the determination of the time of arrival. Where a pigeon has traversed 100 or more miles, it is obvious that to watch for its arrival and time it would be quite tiresome. Accordingly, an alarm is here suggested for the door of the pigeon house.

A swinging switch is suspended at the entry; as they push through the door they remove the switch, which will open a circuit and ring a bell, or give other notification. It is quite possible to have the time recorded by an electrical connection. This arrangement will give the exact time of arrival of a homing pigeon and decide his record beyond all dispute.



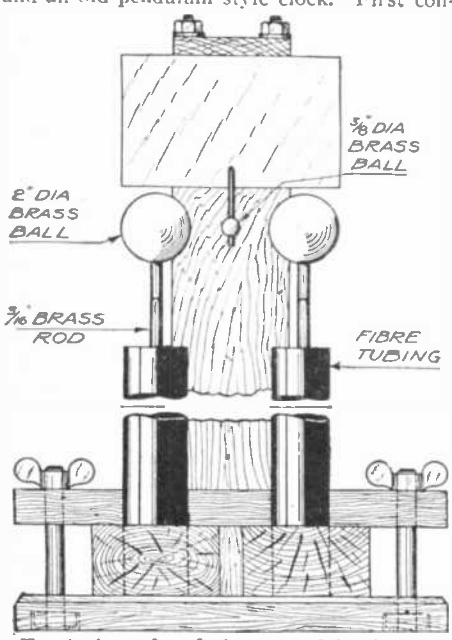
A pivoted frame of wire is hung at the entrance of a dove cote; this is the entrance by which the pigeons go in, and the frame is so arranged that when displaced by the entrance of a pigeon it rings a bell and announces the entrance of a bird. The device is peculiarly available for homers.

In books on pigeon culture a wire gate is described which opens inward only. The wires are so far apart that they will not excite the bird's suspicions, yet he has to push them inward on entering the house, and this the pigeon is found to do without hesitation. The switch, it will be observed, is in line with this idea, and the swinging door could be easily pressed into service as the switch proper.

Second Prize
Dry Pile Battery Clock

WHEN I received PRACTICAL ELECTRICS for October, 1924, an article on page 695 gave me an idea of a "perpetual" electric clock. With some modifications and additions, the following was constructed, using materials at hand, and after two months' service still keeps accurate time.

The necessary articles for the construction of the clock are a set of dry pile batteries and an old pendulum style clock. First con-



Front view of a clock operated by four dry piles; the continuous discharge keeps a little pendulum in motion so that the clock runs for a long time.

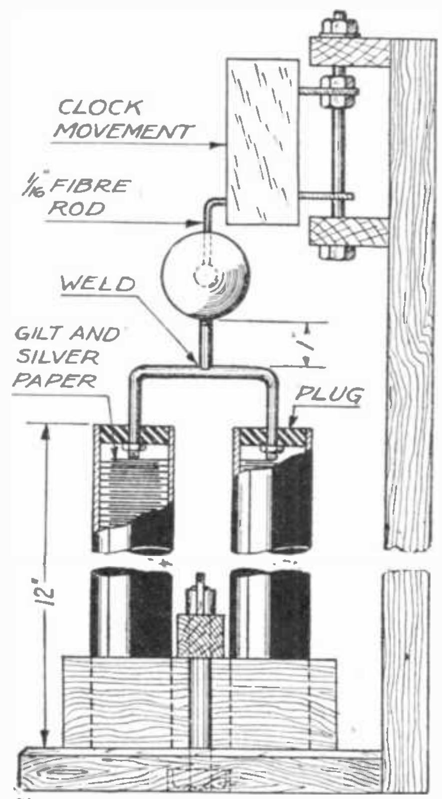
struct the batteries. Procure a piece of wood (preferably oak) one inch thick and eight inches square; this is to be used for the base. Also two pieces ordinary two by four material six inches long, planed smooth, will be required. These are holders for the four battery tubes, each twelve inches long and of an internal diameter of one and a half inches. These tubes may be either glass or fibre. Fibre is the easier to handle.

Next drill two holes in each of the two by four blocks so that the tubes fit them quite snugly. The holes are to be drilled three inches from center to center, equidistant from sides and ends. The outside of the tubes are coated with good glue and forced into the holes until they are positively flush with the under side of the two by four blocks. Be sure the surface of these blocks are perfectly parallel and the holes bored perfectly straight. If care is taken at this stage of construction, it will save much trouble later on.

Obtain a number of sheets of gilt and silver paper, from which to make the electrodes for the batteries; from these sheets cut several thousand discs. To do this easily take a short piece of brass pipe of the same internal diameter as the fibre tubes; sharpen one end to a cutting edge. This will serve as a punch.

Proceed to build up the battery. First take a strip of bright tinfoil and carefully cement it with shellac to the baseboard, being careful to place it equidistant from sides and ends. This piece of tinfoil is two inches wide and about five inches long. Next take one block of the two by four wood holding the two tubes and carefully glue to the under side a strip of silver paper two inches wide and about five inches long "face down." Carefully place this on the baseboards so that the center of this block is about one and three-quarter inches from the exact center of the baseboard and equidistant from the sides, fastening it firmly to the baseboard with wooden clamps; do not glue. Now take two of the gilt paper discs and place one in each tube face up; then two silver discs on top of the gilt discs, face down; load the tube to the top, alternating the silver and gilt discs. Then take the other set of tubes and proceed in exactly the same manner with the exception of the strip of paper which is to be glued to the bottom of the block, which must be gilt paper, face down; then silver disc face up, gilt disc face down, and so on until the two tubes are full.

The tubes which are fastened in the same block must be filled in the same manner with regard to the paper discs, otherwise the battery will not operate. The tinfoil can be regarded as connecting wire.



Side view of the electric clock, showing how the dry piles are coupled together. They are arranged in two pairs.

The top terminals are next constructed. Two brass balls of about two inches in diameter are next obtained. Those from an old brass bed will answer. Two pieces brass rod about seven inches long about three-sixteenth inch diameter have both ends threaded to a length of one inch. Four fibre plugs three-eighths inch thick and of a diameter to fit the tubes snug come next. Drill holes in the exact center of each plug so that the brass rods will screw in. Next bend the brass rods in the shape of a "U" so that each rod will fit the holes in the plugs when they are placed in adjacent tubes.

Get two short pieces brass rod about one inch long and of a diameter to fit the brass balls; thread one end of each rod to fit tight in the brass balls. These short pieces are to be welded one to the exact center of each U-shaped rod. Get six brass nuts to fit the bent brass rods, cut two of them in half, making eight nuts in all. Now assemble the terminals by placing a half nut on each leg of the bent rods, next put on the fibre plugs, then a brass washer one inch in diameter, then a full nut; turn up the last nut until it is flush with the end of the rod, then turn down the half nut until it is good and tight, put on the brass balls, and place in the tubes, first coating the edge of the plugs with good, strong glue or thick shellac. Press the plugs down firmly upon the paper discs so that a good electrical contact is obtained. Wire the plugs in while drying so that the pressure is not released which would result in a weak battery.

Next mount the clock works. The movement used was that of a discarded electrically wound, sixty beat movement. Everything not necessary in the actual gear train was removed, including the main spring; the pendulum was also discarded. The small brackets, which originally held the clock to the back board, are to be bent up. An oak board one inch thick, four inches wide, twenty inches long is firmly glued to the back of the baseboard and further secured with two long brass screws; two cleats of oak are then fastened to this backboard with glue, one at the top, the other six inches below. These cleats form the support for two brass rods of a diameter to fit the clock brackets and in turn pass through the cleats in which holes are drilled for the purpose; these holes must be parallel and straight, therefore it is best to drill the cleats after glueing. The brass rods are first threaded one end just enough to accommodate a brass nut; the other is threaded to a length of four inches. In all, the length of the rods will be about nine inches. The holes drilled through the cleats must be spaced to agree with the distance between the clock brackets, and in such position that the pendulum will hang exactly in the center of the baseboard of the battery stand. This will govern the width of the cleats to be used.

The thin brass rod secured to the escapement must be removed and a thin one-sixteenth fibre rod substituted in its stead which is held in place with sealing wax. Have the fibre rod about three inches longer than necessary. The one used by the writer, as cut to finished length, is six and a quarter inches long. The extra three inches allow for regulating. Attached to the lower end of the fibre rod is a small brass ball three-eighths of an inch in diameter and held on the fibre rod by means of a small rubber band. The fibre rod runs through a hole drilled through the brass ball. Assemble the brass rods and clock movement through the cleats as shown; eight brass nuts are used for this purpose.

Now to start and adjust. It may be necessary to turn the movement upside down, as in the case of the movement used. First make a couple of clamps of oak, one for each side of the battery piles; drill holes in each end to take a quarter-inch bolt; also drill a quarter-inch hole in each corner of the baseboard. Four of these bolts are required about four and a half inches long. The size of the pieces of wood for the clamps is one inch square by eight inches long.

The alternate attraction and repulsion of the little brass ball furnishes the motive power for the clock. Place the small brass ball about five inches from the escapement lever. Now lower the clock movement, by means of the brass nuts on the rods fastened to the upright piece, so that the small brass ball just about hits the center of the large brass balls fastened to the batteries. Now start the pendulum swinging. It must be remembered that the brass balls must always hang at exactly the same distances from the pendulum balls. The slightest difference will affect the proper regulating of the clock.

Place the clamps in position to hold down the battery piles, moving the entire battery (both sides an equal distance always) back and forth and by sliding the pendulum ball up and down upon the fibre rod until the clock is regulated within ten seconds error in twenty-four hours. This requires a world of patience, but it is worth the trouble. If it runs slow, slide the battery piles closer to the center, clamping them down each time with the same amount of pressure, sliding the brass ball upon the pendulum rod and lowering the clock movement down. If too fast, reverse the operation. As accuracy is acquired, cut off a little of the extra length from the pendulum rod. This will make a slight difference each time, but is easily corrected. An error of more than five seconds in twenty-four hours is easily corrected with a little patience.

$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.

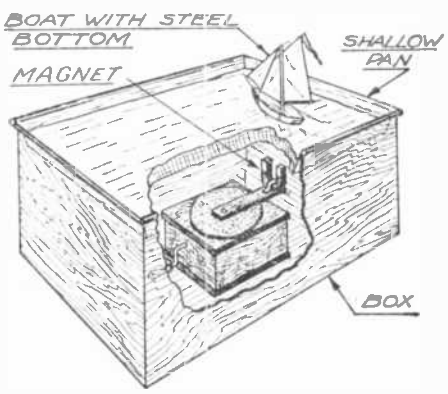
Third Prize
Window Attraction

AN attractive and effective window display is illustrated here.

It consists of a copper pan, which should be as large as possible, resting on a wooden box, which should not stand high. A boat with a piece of iron or steel on its bottom floats on water filling the copper pan.

The phonograph could be operated by a motor and the magnet could be an electromagnet. The latter is mounted on a wooden arm, which is attached to the phonograph disc. The magnet is thus revolved slowly in a good sized circle, attracting a steel or tin strip attached to the bottom of the boat. The boat thus actuated sails around slowly on the water, making an effective advertisement, especially if the boat is painted in bright colors.

The advertisement may be painted on the sails or on the sides. The impression given by the boat is quite mysterious, inasmuch as the propelling apparatus is hidden in the box.



Under a copper pan containing water a magnet is rotated by a phonograph mechanism; a boat with an iron plate or keel floats on the water and goes round and round in a circle following the magnet. Be sure not to use an iron vessel to hold the water.

Honorable Mention
Testing Cell

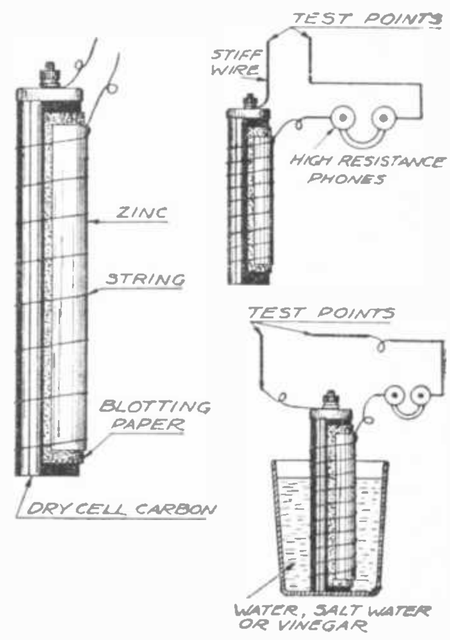
A TEST cell costing next to nothing and which will produce a current strong enough to test coils, circuits, condensers, etc., can be easily made as shown in the diagram. The strip of zinc is about an inch shorter than the carbon and half as wide as the circumference of the carbon. The blotting paper is a little larger than the zinc. These are held on the carbon with string.

Right: An interesting battery whose electrolyte is supplied by the moisture of the hand. It gives a very minute current, enough to affect a head set, and is quite practical for testing for breaks in circuits.

It is only necessary to grip the cell in one hand, which will cause it to generate a current, at the same time serving as a handle for one of the test points.

By standing it in a glass of water, salt water, or vinegar, a much stronger current is produced.

A head set acts to give the characteristic sound if the circuit is not broken.



What Our Readers Think

Wants Information About Photoelectric Cell

Editor, EXPERIMENTER:

I am a subscriber of your EXPERIMENTER magazine and I find it the greatest magazine for science.

Many college youths find your magazine welcome in school and the professors also keep in touch with it every month.

I would like to see published a cheap way of making a photoelectric cell.

Thanking you,

I remain,

KID KEN.

Baltimore, Md.

Wants a Physics Section

Editor, EXPERIMENTER:

Writing you in regards to voting coupon, in the November EXPERIMENTER for 1924.

You ask what articles I like and dislike. I admire all of the articles, and would appreciate it very much, if you could add a number of pages on physics.

Sincerely yours,

JAS. COTHO.

Clairton, Pa.

An Old Friend of a Faithful Reader

Editor, EXPERIMENTER:

Appreciate the return of the old ELECTRICAL EXPERIMENTER in its new form. THE EXPERIMENTER.

Yours truly,

FRANK L. FROST, JR.

Lewisburg, Pa.

We Have Already Enlarged PRACTICAL ELECTRICS and Renamed It

Editor, EXPERIMENTER:

I wish to let you know that I like *Practical Electrics*, as it is, but I think it would be considerably better if it had more in it, and of course charge a higher price for a copy.

When I first purchase my copy I always turn to Short Circuits and always read the questions and answers. In your next edition please print a telegraph from one house to another, using electromagnets and only having one wire or aerial between each house.

Your faithful reader,

DON AULT.

Picher, Okla.

The Paid Electrician

Editor, EXPERIMENTER:

May I avail myself of some of your valuable time and take the liberty to express my wants and whats.

As far as the Magazine goes, it is well worth the money. But why not print some dope for the paid electrician?

I admit that at present he can use a good deal of the contents of the magazine in his daily work. His chief interest lies in the how and why department, new things electric and junior electric departments. Of course, all the rest are O. K. in every respect. What do you think of it?

AUGUST R. ZULISH.

Mohawk, Mich.

An Appreciation of Our Chemical Department

Editor, EXPERIMENTER:

I am writing you to express my appreciation of the EXPERIMENTER. It is just the magazine I have been waiting for, because it covers in an experimental way the three most popular branches of science, *viz.*, Electricity, Radio and Chemistry.

Please do not forget the chemistry department. I am interested in radio also, but there are several magazines, such as RADIO NEWS, devoted entirely to radio, while for chemistry and electricity there are none.

I have just finished reading the third issue, which I thoroughly enjoyed, and I am anxiously awaiting the next.

Sincerely,

RICHARD H. COE.

Macon, Ga.

"B" Battery Elimination

Editor EXPERIMENTER:

The article on the above subject in the January issue was indeed very interesting, fully abreast the current of changing radio innovations and in keeping with the high order of THE EXPERIMENTER.

Can't you give us something on A.C. current 110 volts 60 cycles at an early date? I'm sure lots of readers are waiting.

Yours truly,

C. C. LARY.

Visalia, Calif.

How a Druggist Holds a Bottle Stopper

Editor, EXPERIMENTER:

Inclosed please find an illustration from your November issue, telling the proper way to hold a stopper while pouring from a bottle. I don't know but I might have been taught differently, but I should hate to hold a bottle filled to the top with carbolic or nitric acids and hold the stopper as illustrated, as I am sure it would very often burn in between the fingers.

I was always told to hold it in the little finger, the bottom facing the floor, so if there should be any acids or oils they would not soil the hands or clothing.

Of course, you may be right, and if you should then I shall appreciate having learned something new today. Hoping to hear your criticism on this letter at your leisure,

I remain yours truly,

ALFRED J. DANE.

149 Franklin St., Lynn, Mass.

[The writer of the article is a graduate chemist and always holds a stopper as shown, and never gets chemicals on his hand.—Ed.]

But We Are More Than a New ELECTRICAL EXPERIMENTER

Editor, EXPERIMENTER:

It was with great pleasure that I welcomed back the old ELECTRICAL EXPERIMENTER. I have the first issue and the rest together with about three or four years of the old ones on file in my laboratory.

I also have a Tesla transformer, X-ray tube, spark coil, Leyden jars and a collection of other miscellaneous apparatus purchased from the old Electro Importing Co., where you used to get a dollar's worth for every dollar spent. It is in regard to this company that I am writing this. Why wouldn't it pay to bring back this company along with the old EXPERIMENTER?

Yours very truly,

L. THORNTON.

East Smithport, Pa.

We Hope Soon to Publish More Elec-Tricks

Editor, EXPERIMENTER:

Just to let you know that I am a very interested reader of THE EXPERIMENTER and consider it the best practical electrical magazine to be found. Your "Junior Experimenter" and "Elec-Tricks" are of especial interest to me and I sincerely hope that they will be continued.

Very truly yours,

CHAS. DOCK.

W. Philadelphia, Pa.

From One of Our Contributors

Editor, EXPERIMENTER:

My article entitled, "Electric Door Lock," has been published in the September issue of PRACTICAL ELECTRICS.

I am really very much pleased with the courtesy, service and appreciation given to this matter of practical merits.

In fact, I am proud enough not only of my own part, but of the PRACTICAL ELECTRICS or THE EXPERIMENTER as a whole. Really, it is a magazine of practical ideas of everyday life; it is a magazine of simple, very simple, yet effective original technical science. Neither man nor woman can afford to miss it.

Your contributor,

H. S. MANUEL.

San Francisco, Calif.

Wants a Battery Charger

Editor, EXPERIMENTER:

After reading the announcement made in the December issue of PRACTICAL ELECTRICS on page 54, "State articles you would like us to print," my first thought was, "A battery charger!"

I have had many talks with radio people and they all agree that a battery charger of the type I am about to describe and that could be constructed by the amateur himself would just about solve the nuisance and bother of carting the battery to the service station every time it went dead, and in most cases the carting is done rather frequently. The charger I have in mind would charge 2, 6, 8 and 12 volt batteries, also up to 4-24 volt "B" batteries and is of the carbon-silver contact type.

I might add that a detector cabinet with hinged top and panel would make an excellent case for such a charger.

The following departments are well liked in PRACTICAL ELECTRICS: Experimental Electrics, Junior Electrician, Elec-Tricks and the How and Why columns.

Yours truly,

G. B. TEALL.

Temperance, Mich.

The EXPERIMENTER and SCIENCE AND INVENTION

Editor, EXPERIMENTER:

Have been reading THE EXPERIMENTER and SCIENCE AND INVENTION for two years and my interest has never varied in either of them. The new EXPERIMENTER is the "berries," if you will pardon slang words, and SCIENCE AND INVENTION is getting better every month. The two best features of THE EXPERIMENTER are: the minimum amount of advertisements which tend to make a magazine lose its popularity with the public; secondly, the chemistry department. I always turn to the chemical experiments first. I only wish there were more, especially in SCIENCE AND INVENTION.

Wishing you the best of luck, I am,

Sincerely yours,

RICHARD COREY.

New York.

We Did More Than Change the Name

Editor, EXPERIMENTER:

Having read all Gernsback's publications for several years, I think THE EXPERIMENTER is the best of all.

Having No. 1, 2, 3, I am now anxious to get No. 4.

If it *is possible to make it any better by changing* the name again, go to it; brother, go to it.

Yours truly,

CHARLES DAY.

Box 218, Sqlupa, Okla.

No Paper Can Take Its Place

Editor, EXPERIMENTER:

I have been a constant reader of your magazine since the first edition of the ELECTRICAL EXPERIMENTER years ago.

I am certainly glad to see the first edition of THE EXPERIMENTER published. There are few good papers for the average chemical or electrical (not radio) amateur experimenter. I trust you will find it is this type of publication that your readers want.

There are about four thousand magazines (more or less) covering fiction, motor electrics, prize contests, etc., but not one that can take the place of a publication that can sincerely and honestly fill the needs of the young, interested in chemical and electrical experiments. By "electrical" I do not mean radio either.

This is a day when "general electrics" is found everywhere, and that is only one good reason why SCIENCE AND INVENTION or similar papers can never take the place of your first editions of ELECTRICAL EXPERIMENTER.

Yours very truly,

D. C. PRICE.

Detroit, Mich.

Wants More Experiments

Editor, EXPERIMENTER:

It was with the greatest pleasure that I noted the return of your magazine. In the past I was a subscriber to the ELECTRICAL EXPERIMENTER and never could find a magazine, to my mind, as practical as that was.

Allow me to offer a word of advice: *Please, please* do not proceed to fill your new magazine with radio articles. I assure you there are many experimenters like myself who want a magazine of our own. Those interested in radio can and do subscribe to RADIO NEWS and other such publications, while those interested, like myself, in chemical and mechanical experiments hate to see so much space given over to that which does not interest us in the least.

Hoping for the greatest success you have ever achieved in your new attempt, I remain,

EUGENE FERRIS,
Rutgers Prep. School.

New Brunswick, N. J.

(You have our pledge that the EXPERIMENTER will be continued indefinitely with the present editorial policy. You might read our editorial in the November, 1924, issue.—EDITOR.)

The Experimenter Is Precious

Editor, EXPERIMENTER:

I have the three last numbers of the EXPERIMENTER, and they are as precious to me as any book or magazine I have ever possessed.

I am much interested in chemistry, and I have never come across a magazine that contains better information along that line than does the EXPERIMENTER.

I am also much interested in the general section of the magazine. Junior Experimenter, Historic Experiments, and Fiction Stories; but by all means, I hope you will continue and increase the publication of news coming under the subject of chemistry, because I believe it is just what all high school students and other people want.

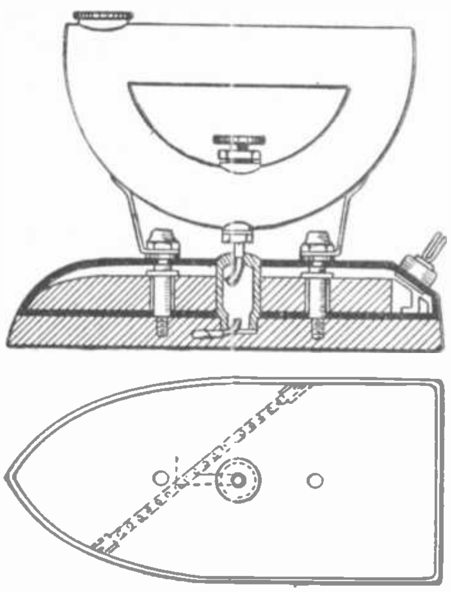
Very truly yours,

ARTHUR G. RAUCH.

New Tripoli, Pa.

Latest Electrical Patents

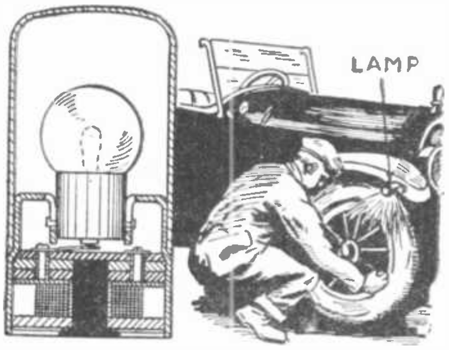
Pressing Iron



A water reservoir in the hollow handle of the pressing iron supplies water to a small duct passing near the heating coils. Here the water is vaporized and escapes through small apertures in the face of the iron. The iron thus itself steams the cloth.

Patent No. 1,521,058 issued to O. Walker, Zurich, Switzerland.

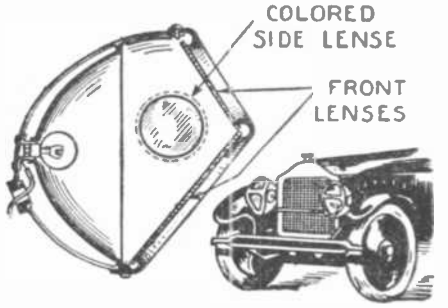
Portable Lamp



This small electric lamp is specially designed for repair work and is provided with a small electromagnet in its base, by means of which a magnet with a disc of magnetizable material at the upper end thereof can be attached to any iron part of the machine being repaired. The lamp operates on the usual automobile storage battery.

Patent No. 1,520,473 issued to A. C. Kleckner, Racine, Wis.

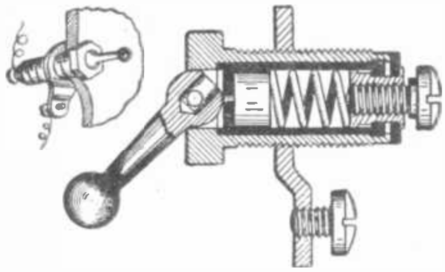
Headlight



The peculiar construction of the lens system of this headlight for automobiles provides a better illumination of the roadway, eliminating objectionable glare. It has two main lenses set at an angle with each other and one facing upward, the other downward and both forward. Small side lenses throw a warning light to the sides of the car.

Patent No. 1,520,405 issued to C. F. Damm, Buffalo, N. Y.

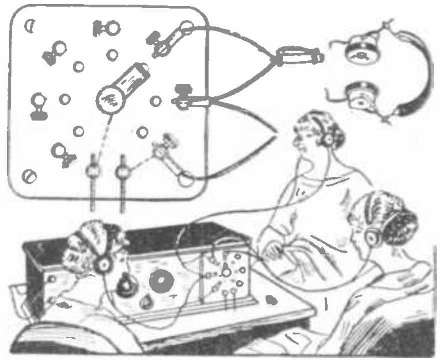
Toggle Panel Switch



The toggle lever makes contact between a central contact point and the outside brass tube. In its normal, open position the central portion of the lever being drilled out no contact is made with the said contact point.

Patent No. 1,521,432 issued to J. F. Cavanaugh, Providence, R. I.

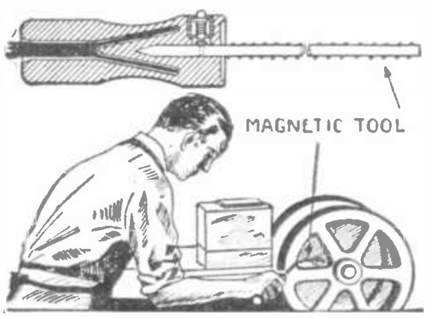
Radio Receiver Block



There are a series of terminals into which the telephone receiver wires can be plugged; all the terminals connect into the receiving circuit and aerial. There is also a shifting circuit which opens and closes the individual circuits as desired.

Patent 1,518,050 issued to Walter G. Conger of Independence, Mo.

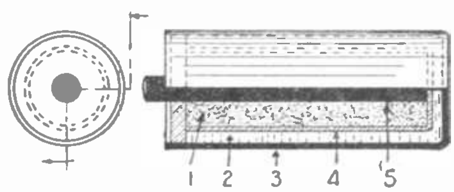
Electromagnetic Tool



A single layer coil wound on a long flexible iron rod magnetizes the latter and enables the operator to pick up various objects of magnetic material from inaccessible places. The rod, which with its coil is an electromagnet, can be bent in any shape so as to reach all places.

Patent No. 1,521,173 issued to R. W. Catching, Roseburg, Ore.

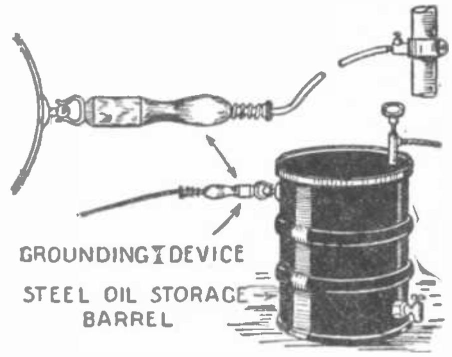
New Dry Cell



The battery shown is claimed by the inventor to be of cheaper construction than the usual type. It contains (1) a mixture of manganese dioxide and graphite moistened with an exciting fluid, (2) an electrolyte of gelatinizable paste, (3) a zinc shell as negative electrode, (4) a mucilaginous coating, (5) and a carbon rod as positive electrode with the application of powdered starch thereto.

Patent No. 1,516,974 issued to W. B. Loveman, Bridgeport, Conn.

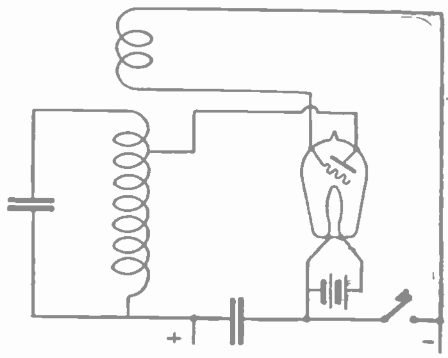
Static Electricity Ground



It is well known that when gasoline is delivered from storage tanks through small apertures into truck or automobile tanks, static electricity is generated and may accumulate to dangerous intensities causing explosions and inflammation of the gasoline vapor by discharges. To eliminate this danger the device shown above is used to ground the gasoline tanks and thus prevent the accumulation of electricity. A ball of metal is permanently attached to the truck and a specially constructed grounding conductor is clippped upon it.

Patent No. 1,520,485 issued to F. C. Singleton, Chicago, Ill.

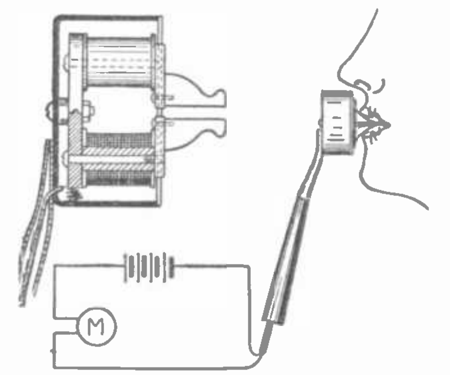
Continuous Wave Transmitter



In the oscillator here shown, designed for continuous wave transmission, no oscillations of any kind are produced when the circuit is broken by means of the key or interruptor. The key is interposed between the high tension supply leads in a circuit including the grid and the filament of the tube.

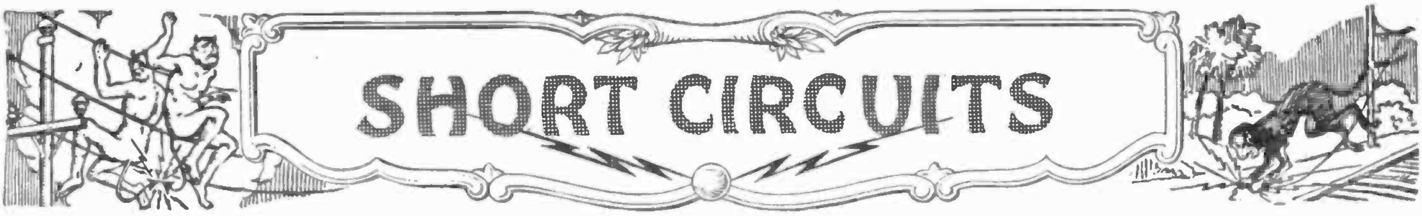
Patent No. 1,520,580 issued to N. Lea, Coventry, and J. Reed, of Pinar, England.

Osophone



By means of this ingenious apparatus, the deaf are enabled to hear ordinary conversation and even radio. By means of two electromagnet pole pieces, gripped by the teeth, and which are connected in a microphone circuit, the vibrations are communicated to the teeth and thence to the entire osseous structure of the head. The acoustic nerve becomes thus affected.

Patent No. 1,521,287 issued to Hugo Gernsback, New York, N. Y.



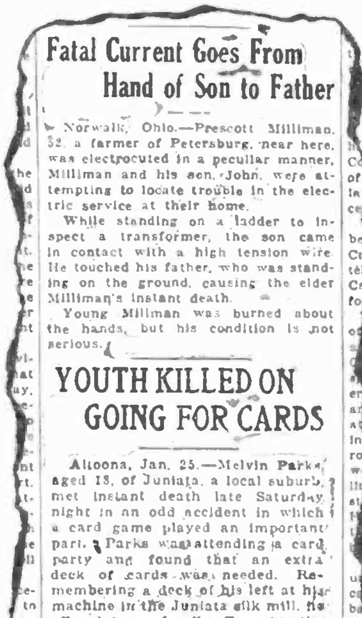
THE idea of this department is to present to the layman the dangers of the electrical current in a manner that can be understood by everyone, and that will be instructive too. There is a monthly prize of $3.00 for the best idea on "short-circuits." Look at the illustration and then send us your own particular "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!

This stone marks the grave
Of Thomas A. Folly,
Who on a wet day
Made a ground for his trolley.
—Guy Barnett.

This is the grave
Of Joseph McGhad,
Who perspired through the cloth
Of his heating pad.
—H. M. Freeman.

This tomb belongs
To Harry M. Stound.
His soldering iron
Touched his radio ground.
—David Vermesch.

Beneath this sod
Is William A. Clark,
Who tried to find
A switch in the dark.
—Stanley Symms.



Fatal Current Goes From Hand of Son to Father

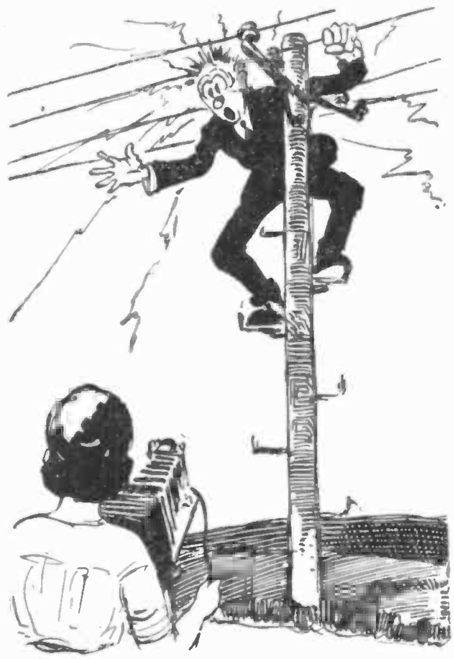
Norwalk, Ohio.—Prescott Milliman, 32, a farmer of Petersburg, near here, was electrocuted in a peculiar manner. Milliman and his son, John, were attempting to locate trouble in the electric service at their home.

While standing on a ladder to inspect a transformer, the son came in contact with a high tension wire. He touched his father, who was standing on the ground, causing the elder Milliman's instant death.

Young Milliman was burned about the hands, but his condition is not serious.

YOUTH KILLED ON GOING FOR CARDS

Altoona, Jan. 25.—Melvin Parks, aged 18, of Juniata, a local suburb, met instant death late Saturday night in an odd accident in which a card game played an important part. Parks was attending a card party and found that an extra deck of cards was needed. Remembering a deck of his left at his machine in the Juniata silk mill, he offered to go for it. To enter the mill he climbed an eight foot steel fence at the rear of the mill. At the top of the fence he grabbed a wire to steady himself. It happened to be a 2,300 volt primary line of the Penn Central Co.'s leading into the mill and he was instantly electrocuted.



Here lies the body
Of William Bowle.
He posed for his photo
On a high tension pole.
—L. G. Cook.

In connection with our Short Circuit Contest, please note that these Short Circuits started in our November, 1921, issue and have run ever since. Naturally, during this time, all of the simple ones have appeared, and we do not wish to duplicate suggestions of actual happenings or short circuits. Every month we receive hundreds of the following suggestions, which we must disregard, because they have already appeared in print previously. Man or woman in bath tub being shocked by touching electric light fixture or electric heater. Boy flying kite, using metallic wire as a string, latter touching an electric line. People operating a radio outfit during a thunderstorm. Stringing an aerial, the latter falling on lighting main. Picking up a live trolley wire. Making contact with a third rail. Woman operating a vacuum cleaner while standing on floor heating register, etc. All obvious short circuits of this kind should not be submitted, as they stand little chance of being published.

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.
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.

Pyroelectricity and Piezoelectricity

(507) Mr. Chin Fu, of Canton, China, writes:

Q. Will you be kind enough to give a brief explanation of what is meant by pyroelectricity and piezoelectricity?

In reply we quote from Poynting and Thompson's "Text Book of Physics":

"Certain crystals initially showing no electrification develop, if heated uniformly, opposite surface electrifications on opposite surfaces. If they are cooled from the neutral condition, the polarity is reversed. The phenomenon is termed pyroelectricity and it was observed first in the eighteenth century.

"If these crystals without being heated are subjected to pressure along the axis of electrification which was observed when the temperature was changed, then opposite electrifications develop at the end of the axis. If they are subjected to tension, the polarity is reversed. The phenomenon is termed piezoelectricity. It was discovered by J. & P. Curie in 1880. They found that the electrification under pressure was the same in sign as that used for cooling, while that under tension was the same in sign as that due to heating. The phenomena are evidently related to each other."

Direction Finding

(508) Mr. J. T. Haight, Swift Current, Sask., Canada, asks:

Q. How can I locate a source of very marked and persistent interference in my radio reception?

A. Mount a receiving set provided with a loop aerial in an automobile and by adjusting the loop determine the direction from which the interference seems to come. Draw a line on the map corresponding to this direction, then assume a new position considerably distant from your first one and repeat the observation. Draw another line on the map corresponding to the new direction and where these two lines intersect will be located the interfering station. To check your results three or four such observations can be taken from different positions. All the lines so drawn should intersect very nearly at the same point, that point indicating the position of the station.

Magnetism and Light

(509) M. Olivier de Val-Tourraine, Bordeaux, France, inquires:

Q. 1. What is meant by polarized light and what relation does it bear to magnetism?

A. 1. According to the widely accepted undulatory theory of light, it consists of waves of the ether, which waves like those of water, advance in a direction at right angles to the amplitude or heights of the vibration. In ordinary light, the vibrations are distributed all around in a circle, the waves of ether existing at every possible angle referred to the lines of propagation as a center.

If any portion of the waves are restricted in their vibrations to a single plane, the portion is said to be plane-polarized. This condition can be brought about by various means; light reflected from a glass surface is partly polarized, and by transmitting light through certain transparent crystals, such as tourmaline, a well-known mineral, a transparent sample of which must of course be used, the light passing will be polarized. A crude analogy pictures the action of such a crystal as that of a bird cage, which would only permit waves to go through it whose undulations rose and fell parallel to its wires.

If light polarized in a definite plane is made to pass through glass and some other transparent substances, exposed to a strong magnetic field, the plane of polarization will be rotated just like twisting a ribbon of paper. This is the relation of magnetism and polarized light expressed in a very crude way.

> *EXPERIMENTERS and amateurs, we want your ideas. Tell us about that new electrical stunt you have meant to write up right along, but never got to. Perhaps you have a new idea, any new chemical or wireless experiments, perhaps you have seen some new electrically arranged "do funny"—we want these ideas, all of them. For all such contributed articles that are accepted we will pay one cent a word upon publication. The shorter the article, and the better the illustration—whether it is a sketch or photograph—the better we like it. Why not get busy at once? Write legibly, in ink, and on one side of the paper only.* EDITOR.

Curing Sulphated Batteries

(510) H. Shimigu, Tokio, Japan, writes:

Q. I am informed that sulphation of storage battery plates can be remedied. Can you tell me how this is done?

A. The following excerpt from G. W. Vinal's book on Storage Batteries answers your question:

"A simple and effective remedy for this condition is to pour out the electrolyte and fill the cells with water. After being allowed to stand for about an hour, the battery may be put on charge at any rate of current, provided that the voltage at the terminals of the cells is less than 2.3 volts per cell. It is desirable to make the voltage as near 2.3 volts per cell as is convenient and to give the battery what is practically a constant-potential charge. The resistance of the battery will be high at the start and the current initially small, but the current will increase as the sulphate is broken down. The cells will take the current as fast as they are capable of being charged, and the process becomes more or less automatic, but the temperature must be watched and the batteries cut off or the current decreased if the temperature reaches 40 degrees C. (104 degrees F.) The charging may also be done by the constant-current method. The water which was put in the cells becomes a solution of sulphuric acid as the charge proceeds, and readings of the rising specific gravity can be made. If the final specific gravity obtained after prolonged charging becomes constant at too low a value, more electrolyte should be added. It not infrequently happens that the specific gravity of the electrolyte, initially water, will rise above the normal figure, say 1.300, and this is clear evidence that acid has at some time been added to the cells improperly, that is, when they needed only water."

Phosphorus and Life

(511) S. G. Hudson, Salt Lake City, Utah, writes:

Q.—I was told that phosphorus is one of the essential elements of life, but have been unable to get more detailed information on this subject. Will you tell me in what respects phosphorus is necessary to the maintenance of life?

A.—Phosphorus is essential to the growth of plants and animals. Various compounds of phosphorus are present in the soil, and plants absorb and store up these compounds, especially in their seeds. This vegetable matter is then eaten by animals, who thus assimilate the phosphorus compounds originally in the soil, and deposit them in the bones, brain and nerve tissues. Most of these phosphorus compounds are very complex and we cannot here give their exact characteristics. Bones, however, consist of about 80 per cent. of calcium phosphate, $Ca_3(PO_4)_2$.

The frequent growth of crops in the soil would rapidly exhaust its phosphate content, unless the latter were replenished. For this purpose various phosphorus-bearing substances are added to the soil in the form of natural or artificial fertilizers. Artificial fertilizers are made from phosphate rock which is found in large beds in South Carolina, Tennessee, Florida and elsewhere. Slag from basic steel works is used a great deal as a fertilizer in Europe. It contains a large percentage of phosphates. There are other sources of supply.

Chemistry of Vinegar

(512) Ichobad Meriweather, Salem, Mass., asks:

Q.—Will you give me some information concerning the nature and production of vinegar?

A.—Vinegar is dilute acetic acid containing from 4 to 6 per cent. of the acid. It is prepared by oxidizing dilute alcohol. The transformation is accomplished by fermentation. When dilute solutions of alcohol such as beer, or weak wines, are exposed to air, they slowly become sour, owing to the conversion of alcohol into acetic acid. This change is due to the presence and activity of a ferment named from the Greek, *mycoderma aceti;* this is what is familiarly called "mother of vinegar." It is a fungus. Strong wines and pure dilute alcohol do not become sour, because the fermentive fungus cannot live in such liquids. Substances containing starch and fermentable sugars, such as fruit juices, cider and molasses, slowly ferment when exposed to the air forming alcohol first and finally vinegar. Cider vinegar is made in this way.

Telephone Repeaters

Erratum.—The illustrations for this query of our March issue were accidentally omitted. We reprint it with the diagrams referred to.

L. C. Schneider, White Plains, N. Y., writes:

Q. 1. I have heard that radio vacuum tubes are used in wire telephony. Will you please explain the function of these tubes in a telephone system?

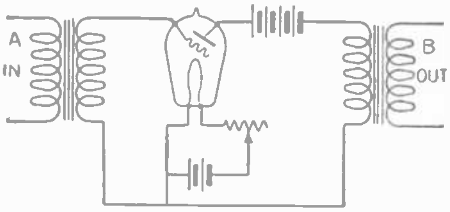


FIG. I

Single way telephone circuit.

A. 1. The length of wire over which audible and distinct messages can be sent is limited, and when it is desired to communicate over distances exceeding this limit, it is necessary to employ some device that will repeat or relay the message with added energy at points on the line where messages would otherwise become too weak. Fig. 1 illustrates one form of this repeater. Messages are impressed on the grid circuit of the tube and are amplified in the plate circuit and transmitted on the output side of the system. This type evidently is a "one-way" repeater, for messages can be sent in only one direction through it. In Fig. 2 a "two-way" repeater is represented. Modulations of the current from either side of the line may be impressed on the grid circuit of the vacuum tube and fed back to the line from the plate circuit. The coils (L) are inserted to balance the line which would otherwise become unbalanced by the transformers (T). Sometimes a condenser is placed in the plate circuit to prevent continuous currents from circulating. In this case only the high frequency modulations of this current will traverse the plate circuit.

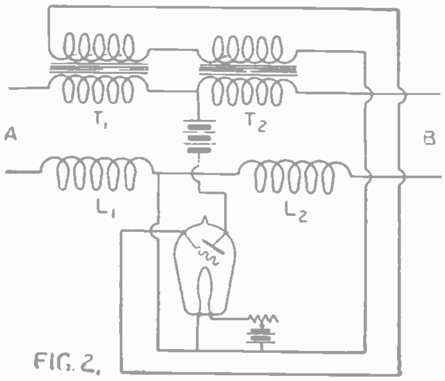


FIG. 2.

Double way telephone circuit.

Model Electric Furnace

(*Continued from page 397*)

duced to a molten state. Of course, the melting point of the metal used has a bearing on the time element.

This little furnace beautifully demonstrates one of the most wonderful electrical laws, and even though the young experimenter does not put it to a practical purpose, he will be able to acquaint himself with a principle which may prove valuable at a later date. The art of heating by high frequency currents is still open to further development, and there is plenty of opportunity for the youth of inventive talent to produce efficient heating appaatus of this nature.

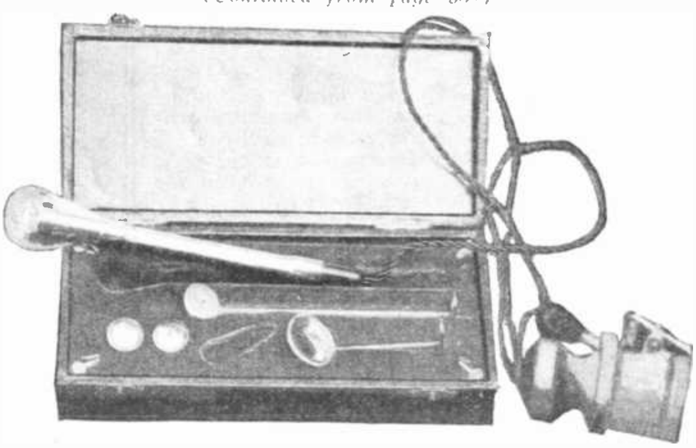
If the experimenter does not care to go to the trouble of constructing the complete furnace, the phenomenon may be beautifully demonstrated with very simple apparatus. In place of the furnace as described, a small tubular insulator such as used for house wiring is wound (for about 1½ inches) with bare No. 18 copper wire. This is connected to the oscillating circuit in the same manner and in place of a charge of iron filings a small wire nail may be placed in the tube A current application of a few minutes is sufficient to heat the nail to a temperature where holding it is far from comfortable.

The Automate Lamp

(*Continued from page 369*)

This is another version of the Automate lamp designed for surgeons' use. It is carried in a convenient case and is operated by hand exactly as described for the other forms. It is even safeguarded by the fact that it cannot well be made too hot for the patient's organs.

It will be observed that the case contains a variety of specula for different uses. It will be recognized that the case of the instrument recommends it strongly to the physician and surgeon who carry their case of instruments with them, as they have to be prepared for emergencies. The mere weight and bulk of batteries would be objectionable unless the small flashlight batteries were used, and these have the unfortunate habit of failing in an emergency.



Automate lamp in this case to be carried by a surgeon enabling him to light the cavities of the body.

The Ark of the Covenant

(*Continued from page 379*)

"Say, Milliken," I said, "why don't we——"

"—take them with us," he finished with a grin. "I was just thinking what a pity it was to leave them to the mercy of the railroads."

"Can she do it?"

"Can she do it!" Milliken repeated scornfully, "Huh!"

The job presented no great difficulty. We unshipped the limousine top of the *Merlin*, then laid stout battens across the floor of the cabin. The three engines were brought, one after the other, on a traveling crane into the boat-shed, and were lowered into the open cabin. To preserve our flying balance, we had to bring them forward almost up against the pilot's seat. The job was over and the top replaced by four o'clock, and we set off for Long Island, six hundred kilometers away.

II

As we passed over the northern spurs of the Alleghenies, with their little towns and hamlets dotted about, it seemed to me, with all my thoughts on the raids, that it was not outside possibility for a camouflaged airship shed to be concealed among their woods and valleys. There were wide spaces enough, sparsely inhabited, where the secrecy of such a base could be preserved for a good length of time, sufficient except for accident, at any rate —to enable the raiders to carry out quite a number of operations before making their get-away.

Remembering the wide areas of thinly populated land in this modern America, even within a few hours' striking distance of the crowded Eastern States, it came to me that the hunt for the lair of the marauders could easily be a long one. It was amazing to think that the airship could so easily descend on a town without observation and vanish, so to speak, in thin air. In none of the raids so far had there been any reliable story of the vessel having been seen—except for the dream of the besotted Finn, Klenski. There had been the usual crop of lies, fantastic enough to defeat themselves, but the clear, unstrained evidence of the credible witness was lacking.

Although none of the raids had been attended by loss of life, there was something terrible in the silent approach in the middle of the night, the uncanny power of robbing all waking folks of consciousness, in the rapid operations in the dead quiet, and in the stealthy retreat when the work was done. It did not need the recollection of the nerve-wrecking first sight of the helpless *Parnassic* to make one's hair prickle at the thought of the marvelous potency in the hands of creatures more definitely malign than the raiders had shown themselves.

As I thought of these things, a whimsical notion came to me, and I turned to Milliken.

"I wonder if they use the Boon double silencer?" I said.

"Shouldn't be surprised," he returned, picking up my thought with that queer quickness of his. "There was a mechanic down at the Louisville levee who had been awake all night. He never heard the slightest hum."

"Was he out of doors during the time of the raid at all?"

"Yes."

"And saw nothing?"

"Not a thing."

"Did you ask him if he looked up at the sky?"

"No, I didn't bother. He was an air mechanic, I tell you."

I had to grin at Milliken's sparing way of making inquiries. He knew too well that an air mechanic would be sure to glance up at the wind indicator, and every now and then look for any change in the weather.

"Funny thing if they're using my silencer," I said.

"Huh!" said Milliken, and I had to guess whether he agreed or otherwise with my sense of the curious.

We made Gardiner Bay before six o'clock, and turned all hands on to unloading the new engines We shunted them through the sheds on the overhead electromagnets, and deposited them, each to its own bed, on the new planes ready for fitting Milliken was not content until he had the propeller and the engine cap fixed on one of the buses, just to get an idea of the general effect.

"Pretty," he said grudgingly, "quite pretty. I'm glad we gave them green bands, though. Wouldn't

(*Continued on page 420*)

Risler Fluorescent Tubes

(Continued from page 380)

The principal difficulty consisted in making these substances in a state of vapor penetrate into the interior of a vacuous tube to be submitted to an electric discharge. To carry this out, he connected a secondary circuit to a glass tube; the two terminals of this current ended in disc cathodes, whose beams converged on the matter to be subjected to bombardment. Then the whole was soldered into a tube. On the other hand, an interrupter in the circuit gives a power of increasing the potential and frequency of the secondary circuit.

When a luminescent tube grows hard, in consequence of the absorption of gaseous molecules by the glass interior, the electric current leaves the secondary circuit and goes through the interrupter, the potential energy increases and the cathode rays impinging upon this substance bring about an emission of metallic vapor, but the formation of a tube of this kind requires a most minute attention for its exhaustion.

Metals and salts are never found in nature in a state of purity and even in their course of preparation they attract in differing degrees most of the elements with which they come in contact. We find that traces of nitrogen of hydrogen of carbon dioxide and other gases are to be found in chemicals rated as chemically pure.

The elimination of all these impurities requires a series of delicate operations, for the tube must first be made very hard, being reduced to an almost complete vacuum so that the electric current cannot traverse it. The photograph taken in the Physiological Laboratory at the Sorbonne, shows a complicated apparatus required to make a Risler tube. On the left we see the recipient of phosphorous anhydride, which will absorb the molecules of hydrogen covering the anode, then following to the left still further we see the successive recipients which enclose the magnesium ribbon, and the filament of tungsten recovering the red phosphorus, as well as the vessel of liquid air in front of the electrician. By these various supplementary appliances the tube is rapidly brought to its high vacuum. To bring it up to the proper degree of hardness, it is subjected to electric discharges of increasing intensity until the normal excitation is reached. As the tube is being made, the technicians examine its fluorescence by means of a hand spectroscope which gives them very useful indications as to the development of the vacuum and the occluded gases and other characteristic peculiarities. The tube should never operate with a higher potential than that to which it was subjected during its preparation; in the other case a new metallization of the interior of the tube will be produced, which will give a secondary emission of the occluded gases.

Great care has to be taken in passing current to the electrode. As a filament M. Risler uses tungsten or ferro-nickel alloy covered with borax (Cooper-clad) whose coefficient of expansion is almost identical with that of radiox or pyrex glass, such as the tube is made of. Such an electrode will stand the passing of a current of 100 amperes.

Once the exhaustion of the cathode is completed, the maker of these luminous tubes determines the value of their constants. Utilizing the absorption power of carbon at the boiling temperature of liquid air (—272° C.), we recoup the occluded gases eliminated in the course of the operations of pumping and purification. If after this readmission of gases the needles of the voltmeter and the ammeter stay almost fixed upon their respective dials, the constancy of current and potential are assured. The tube is then considered to be formed; it can be separated from the leading-in tubes by the blow-pipe and will act just as long as there is a sufficient volume of vapor in the crystallized salts.

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Under the action of the electric excitation, an absorption phenomenon results, which exacts an automatic valve to introduce a new supply of gas. As the average of a series of experiments, M. Risler assigns a duration of 12,500 hours for ten grammes of a salt of alkali metal, under a pressure of one millimeter of mercury and a current of six amperes.

The Risler tubes possess a conductivity corresponding exactly to the potential of ionization of the elements of a chemically pure gas, and by rubbing the tubes with a cloth, their brief illumination is accomplished, while a little magnet brings about a brilliant shimmering light following the cycles of the alternating current. On the other hand, if they are supplied from a high potential transformer or an induction coil, their light is stabilized and gives 275 candles to the meter (39.37 inches). There is no need of a transformer when certain gases are used within the tube such as neon or nitrogen in the natural state. In this case M. Risler utilizes the make-and-break spark for bringing about the luminescence, which is given by the Edison effect. In that case he uses a filament battery and a filament covered with radio-active oxide, as thorium oxide for example. The electronic emission is enough to make the gaseous ion luminous.

There is no doubt that radio-activity will form in the future the principal source of this kind of lighting. But the problem is not yet fully solved so that the final definite selection of the gaseous mixture to be employed in the vacuum tube cannot yet be determined. For a long time past it has been known that the coloration of a luminous source varied with the period of rotation; that it produces on our retina impressions of varying colors according to its frequency. We also recognize that xenon in particular has a conductivity of but one-hundredth that of neon; the latter is used by Claude in his luminescent tubes. Unfortunately, this gas, xenon, which also is a by-product of liquid air, is not yet produced commercially.

Perhaps the emanations from radio-active bodies, as our illuminant, will yet come into use, and then the ideal lighting will have been determined, for it will cost hardly anything, the emissive power of these mysterious substances lasting for several centuries.

(Continued on page 418)

Getting On the Air

(Continued from page 373)

turning the Bradleystats slowly to the right and placing the coupling between the antenna and ground at maximum. Slowly vary the tuning or condenser dial, keeping the tickler or regeneration control fairly tight. C.W. stations will almost immediately be heard, and by various manipulations of the grid leak, condenser and tickler coil, any desired station may be brought in at its greatest strength. If interference from nearby stations is experienced, loosen the antenna coupling by turning the right-hand dial and then retune slightly. Fine adjustment of the grid leak will then help considerably in clearing up and bringing in the signals at their best. When tuning on the extremely low wave-lengths, say from 40 to 80 meters, it will be found necessary to loosen the primary coupling in order to keep the set in oscillation. It is found that if the primary is coupled too closely to the secondary, it absorbs so much energy from the latter coil that the circuit cannot oscillate. All these adjustments, however, may be quickly learned.

When fixed condensers are plugged into the circuit and broadcast stations are to be tuned in, keep the tickler coupling loose so that the set will not oscillate and thereby radiate and interfere with other nearby receivers. After one learns the knack of tuning this set, which may be easily acquired, no trouble at all will be experienced in bringing in long distance stations and by listening to various ones and copying their messages you will quickly pick up on your code-speed to a point where reading code will become second nature.

The reader may wonder why no vernier was placed on the condenser dial, as he may often have heard that tuning on short waves is extremely sharp. This is true, but by using four-inch dials with large knobs it was found possible to control the condenser within one-quarter of a degree on the dial.

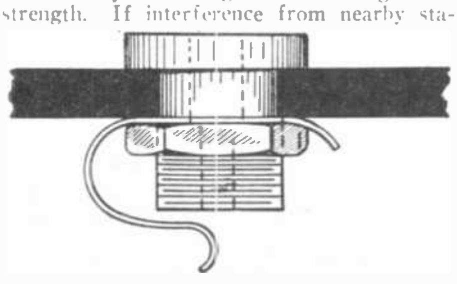


FIG. 6

Detail of tip jack for standard telephone cord tips.

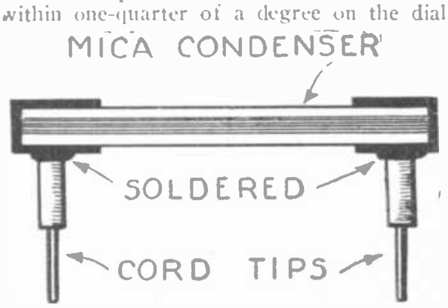


FIG 7

Method of mounting a fixed condenser on cord tips.

The Electric Kitchen in the Restaurant

(Continued from page 381)

THERE is a restaurant in Paris near the Saint Lazare station, in which an electric cooking system on a very large scale was recently installed, prominent members of the Government taking part in the inauguration.

The kitchen proper is described as having its walls coated with enameled tiles; its ceiling of a glistening white; the whole presenting a great contrast to the typical kitchens of the olden times. A two-phase current is utilized at 42 cycles from a 12,000-volt circuit, connected by two cables, one as a substitute for the other in case of a breakdown.

A transformer installation of 300 kilowatts capacity lowers the potential to 200 volts for the cooking and to 110 volts for the lighting. The ranges in general consist of a heavy frame of bar iron with white enameled sheet iron panels to close in the heaters and other parts. The walls of the boilers in which the gridirons are held in a vertical position are double, and made heat insulating by a layer of asbestos, to prevent radiation and ensuing loss of heat. Below each furnace there is installed a glazed box which leads to a ventilating pipe of elliptical cross-section which carries of all odors into the chimney.

The first thing to be described is the electric service range which the cooks have entitled the "communard." It is so called because almost any dish requiring quick heat and rapid cooking can be taken care of on it. The heating elements consist of nickel-chrome wire coiled around quartz tubes. Above each such furnace there is a grating on which sauce pans can be placed. The service range uses 45 kilowatts and can give a heat of over 1,000 degrees Fahrenheit. This is the extreme, as there are two standard heating connections.

The roaster shown in Fig. 2 has six independent spits and the same heating coils are used in it as are used in the last described range. It is also shown in another illustration.

A small electric motor above the apparatus turns the spits by a bicycle chain and sprocket wheel which will be seen clearly in one of the pictures. The juice escaping from the meat is used for basting automatically, and eventually escapes and is collected. Then comes an electric grill shown in the same picture; the roaster takes 50 kilowatts and the vertical grill seen on the left requires 20 kilowatts. There is even a separate place for broiling fish.

There is also a pastry range, a two-storied structure, which comprises two ovens completely independent of each other and insulated by a non-conducting pulverulent material. Although we are now in the face of lower costs, each of these ovens uses no less than 5 kilowatts. There are three stages of heating which can be applied to these pastry ovens.

Tell-tale lamps and the pyrometer are used specially in the pastry ovens where temperature is so important. The expense of running them is reduced by taking advantage of the periods of day when there is a reduced scale of prices for electric power.

In one of the restaurants as many as 400 lunches and as many dinners have to be supplied each day, so that the ranges are going from six in the morning until night. Before the installation of the ranges 20 tons of charcoal were burned per month, while now only 700 kilowatts of power supply the heat required.

Risler Fluorescent Tubes

(Continued from page 417)

At the present time the Risler tube with converging cathodes for the bombardment of various metallic salts gives us sources of cold light of incomparable beauty, and they consume but one-sixth of the electricity of half-watt incandescent lamps. (A half-watt lamp indicates a lamp which consumes only one-half watt of electric power to produce the light of one candle.—Ed.) A gammut of tubes of ten millimeters diameter (about ⅜-inch) which were coated on the inside or outside with a phosphorescent substance mixed with various salts, gave a scale or gamut of greatly varying shades of color. M. Risler excited these tubes by a current of high frequency from a transformer. Under the influence of electric excitation they lighted up vividly, the radiations seeming to be concentrated on their immediate periphery. This peculiarity makes them adapted for the decoration of rooms and the ornamentation of shop windows, of cafes and of club rooms. Hidden in the hangings and the decorations, they can bring about phosphorescence of various costumes of actors, which then become luminous in the dark, and thus develop most decorative fluorescent effects. The illumination has been applied to the façades of several Parisian establishments; thus a drug store shows the Geneva cross upon its front.

In the Physiological Laboratory we have participated in the sensations due to excitation at high frequency with the human body in circuit therewith of a carbonic acid gas tube covered with a layer of zinc sulphide. A lady carries the motto "Tailo" on one side and a man who carries the other end of the sign with his left hand grasps a conductor with his right hand in the proximity of the transformer.

In electro-medical science the luminous tube will find useful application, and in particular in photo-therapy, where now ultra-violet light is used for treatment of certain external affections. Doctors now use quartz burners or mercury vapor lamps for such treatments. They obtain in this way a group of radiations some of which have antagonistic physiological actions. M. Risler has succeeded in isolating the ultra-violet rays by adding to his tube caesium chloride or calcium chloride, or by introducing metallic salts into the interior of carbon electrodes. Practicians now can treat each pathological case with the proper radiations on account of this selectivity. Finally, zinc sulphide containing cadmium sulphide spread in very thin pellicules on a mercury lamp or on a screen held in front of the voltaic arc produces a light for the operators of moving picture projectors, which has no injurious effect. It is evident from this brief description of the investigations that the fluorescent tubes will have extensive application if made on the industrial scale.

Light by Electrolysis

(Continued from page 400)

and two electrodes shaped as shown in Fig. 2. The inventor of the device suggests a lamp of the type shown in Fig. 3. Here the electrodes and electrolyte are contained in a sealed tube made of glass or other transparent material. The anode is a tube of aluminum alloyed with manganese and copper while the cathode is a carbon or lead rod. The latter carries a few insulating washers to prevent contact of the two electrodes.

Of course, in all these forms, two aluminum alloy electrodes could be employed and the lamp could then be supplied with alternating current. Other modifications in shape can be devised by the experimenter.

As stated above these lamps will emit very little light but they are remarkable because, if successfully developed, they will provide sources of light which can be safely used in the presence of explosives and in all places where the heat due to incandescent lamps renders these latter dangerous. In addition, the electrolytic lamp has the advantage of extreme simplicity of construction. It will operate on circuits with widely fluctuating voltages.

The Ark of the Covenant

(Continued from page 416)

like the old girl to see them making free with her own particular blue!"

"Say, Milliken," I protested, "don't get absolutely stuck on the old girl, as you call her. We're going to design even a better bus yet."

He looked at me pityingly.

"Some people," he remarked in a general sort of way, "are like Julius Cæsar. They keep on bein' ambitious till it busts them!"

"That," I reminded him cruelly, "was pretty much what you said when I first suggested the *Merlin* to you."

"Aw, well," said he, with a half-ashamed grin, "the *Merlin's* a peach." Then he broke off thankfully. "Here's your dad on the *Seven*."

He Meets Lord Almeric and His Father in Long Island

We went down to the jetty as the *Seven* was brought to, and to my surprise the first person to step ashore was not my father, but Lord Almeric Pluscarden.

"Hullo, Lord Almeric!" I said. "Thought you were in Washington?"

"I have been in Washington," he smiled, "but I have had to come back in a hurry. Your father kindly sent the seaplane for me."

"Hullo, Jimmy!" my father broke in. "Been to Louisville?"

I nodded.

"I thought you'd go. Come along home to dinner, Lord Almeric and I have something to discuss with you."

The three of us got into the roadster, and soon were sitting down to dinner at Hazeldene. There was a touch of gravity in both my father and Lord Almeric, though they spoke without restraint, discussing the Louisville affair very keenly.

"The radium settles it," said my father. "We're up against no ordinary crooks."

"It's a big thing," I agreed.

"There's some idea underlying the whole series," said Lord Almeric. "It is hopeless for your press to attribute it all to a revival of the I. W. W. idea. Men who give gifts of radium to hospitals and research institutes are hardly of that kidney."

"No," said my father.

"What would you say was the notion back of it all?" I asked them.

"Heaven alone knows!" the old man burst out. "It could not have come at a more awkward time. We have enough on our hands already—eh, Lord Almeric?"

"Truly." Lord Almeric nodded gravely.

"I had better take my son into our confidence, my lord," the old man said formally.

"I agree. It would be better."

The old man turned to me and gave me a keen look.

"Jimmy," he said quietly, "Lord Almeric will agree with me that the world is ready to seethe over. Unless we can pull back in a hurry, we will be in a world war again. Let me show you. Our situation here. Japan, over-populated in the most appalling fashion, is knocking at our door insistently, wanting some of our room. The British dominions are closed to the yellow immigrant, and Japan is prevented by the world from getting all she wants in Siberia and China. That pot is ready to boil over.

"Take the European situation. There is Germany snarling over new Russia like a dog with a bone, and—your pardon, Lord Almeric——"

"Not at all, Boon," said Lord Almeric. "And Britain—ah—Jimmy, if I may take the privilege—Britain ready to fly at Germany's throat because the bone is a particularly juicy one."

"Poland, too," my father went on, "betrayed for the second time in history by the European powers—and by America, who ought to have known better. France, again, hardly mended yet from the devastation of '14-18, naturally sick at seeing a country in her debt forging ahead of her, ready to take up the sword against her old enemy. Then there's that hotbed of swaggering, clashing nationalities, the Balkans, each new state more bumptious and aggressive than the other. I tell you, Jimmy, if any lesson came out of that war, where you fought, and which cost so much in treasure and blood simply chucked away, the world has forgotten it."

"Why on earth can't they all settle down with what they've got and do a bit of work?" I asked. "What's at the root of it all?"

"What is the root of all evil, Jimmy?" said Lord Almeric.

A Discussion

"That's it," said my father. "Money. Each nation thinks the other is making more than itself, and that without working for it. The great cry is 'unfair competition'! If one nation has the wit to think ahead, to take the right line of development to meet a coming want in commerce, its neighbor yells, 'Unfair competition!'"

"I know little of things international," said I to Lord Almeric, "except concerning my own line. I hope there's no chance of a row between your country and ours, sir?"

"No, thank God. There's that comfortable streak in us both that makes us admire a successful rival in trade rather than immediately want to cut his throat. The shopkeeping instinct, if you like—but of value to our sense of proportion. But we may find ourselves on opposite sides, willy-nilly, if some of the hot-heads come to blows. If America had to take a firm hand with Japan, what could Britain do? If she sided with Japan, she would alienate her overseas dominions, who will not have the Jap on any consideration. If we in Britain supported America, we should endanger large financial interests we have in the East. We should lay our Eastern possessions at the mercy of the yellow people, for new China would be dragged in. It is an exceedingly complex situation, Jimmy, and not one that can be threshed out after dinner."

"Let me accept it as threshed out," said I. "Where do you, Lord Almeric, and dad come into it?"

"On the money side," said the old man. "There's lots of them that would like to fight, but they can't do it without money. And there are numbers of people asking for loans at the moment, ostensibly for development work. We have to go very carefully. Lord Almeric's mission in America has been for the formation of an understanding between Britain and our people as to how far we may go in this or that direction. In our discussions—between an American group of financial firms and banks and an English group, as represented by Lord Almeric—we have come upon a new situation that may well upset the whole arrangement. It may lead us into a big war, nominally through one with Japan."

"Good Lord!"

"Now, Lord Almeric has to get to London in quick time, to put the case before his people. There can be no question of cabling it. We did not want you to work in the dark——"

"I don't mind working in the dark, dad. You want me to get Lord Almeric to England?"

"You've got it, Jimmy. I have pledged Lord Almeric my word that you will get him to London by some means or other by Saturday."

"I wondered if you could put me aboard some ship reaching Southampton on Friday morning," said Lord Almeric. "I am ashamed to throw myself into your hands so helplessly—but your father insisted."

Transatlantic Aviation

"Dad was quite right, Lord Almeric," said I. "You'd be leaning on a broken reed to try the Transatlantic Aviation. Their weekly plane doesn't leave until Friday midnight, and it would be the early hours of Sunday morning before you reached London. Clumsy brute!—for all its four engines!"

"I thought perhaps you could overtake the *Thessalic* or the *Purthalia*," said his lordship.

"Let me see." I searched for a shipping list.

"The *Thessalic* sailed on Friday night, and is due to reach Southampton next Friday morning. The *Purthalia* left last night, Sunday, and reaches Southampton next Sunday morning, so she washes out.

"Suppose we started to-morrow. The *Thessalic* will be over three days out, more when we reach her. Lord! She'll be well over three thousand kilometers out when we overtake her! I might as well fly you all the way, sir."

"But surely that would be unnecessary—I could not think——"

"Don't you see, sir? The whole distance is under six thousand kilometers. I should have to fly about seven thousand on the double journey to the ship and back. I had better fly you the whole way. It will give me time to put the *Merlin* in first-class order, anyhow. I'll have to ship new tanks for extra oil and gasoline."

"Will the *Merlin* do it?" the old man asked.

"You bet you, dad. In thirteen hours. We leave here on Thursday evening before dinner, and we reach Battersea aerodrome at one o'clock on Friday, allowing for the difference in time. How will that do, Lord Almeric?"

"Splendid! I cannot find words to thank you, Jimmy—or you, Boon—you overwhelm me with kindness——"

"We won't say anything about that," said my father gruffly. "Will we, son?"

"Surely not," said I. "I'll be glad to give the *Merlin* such a good test. All you have to do, Lord Almeric, is to regard yourself as so much make-weight cargo."

"Heaven forbid!" Lord Almeric laughed. "You might find it necessary to jettison me!"

"I'd jettison the *Merlin* first!" I blundered, reddening at my apparent rudeness to a man so courteous.

"Heaven forbid that, too!" said Lord Almeric. "The sea police might arrest us in midair for having no visible means of support!"

He put an arm on my shoulder and we went to the billiard room, where his lordship conscientiously collected a nice selection of the Boon dollars by thoroughly beating my dad and me at pool and snooker. I went to bed early, for I intended to get some work done before breakfast, and left my elders trying trick shots.

I was just dropping off to sleep when my father came into my room.

(Continued on page 424)

Build the Set you have dreamed of

TROPADYNE SUPERADIO OUTFIT

THIS Superadio 6 Tube Set brings in Station KFKX (Hastings, Nebraska), 1200 miles, in New York City, clearly on a loud speaker, using only the small loop which comes with the outfit.

The outfit advertised here is complete, as listed below, everything needed is included, down to the last screw. The charts, blueprints, directions and photos furnished are so complete and explicit that anyone can build this set and have it working within a few hours. There is nothing additional to buy except the necessary batteries and tubes. Price includes mahogany cabinet and folding loop aerial.

You can pay $150 or more for an outfit, or $200 or more for a set, but you cannot possibly buy a better set than this one.

READ THIS Utmost sharpness—Cuts thru locals bringing in long distant stations as if they were locals.

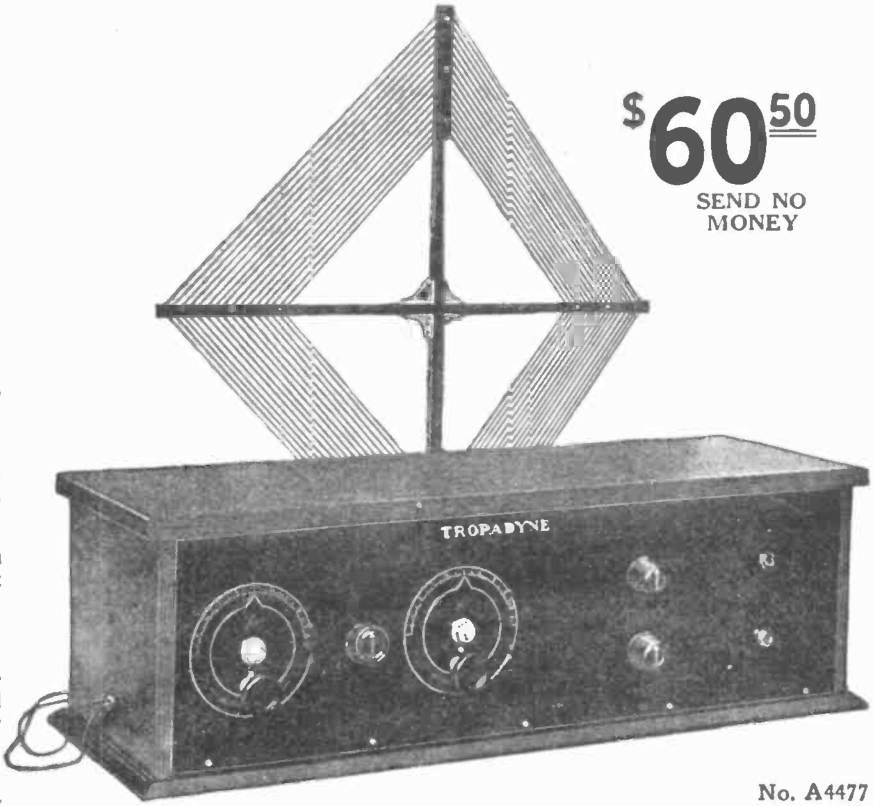
Ease of Tuning—Only two dials.

Tuned Intermediate Transformers; the only real BALANCED set of its kind made. Once transformers are tuned they need not be touched again.

Your Money Refunded if this set does not satisfy you in all respects—if after 5 days' fair trial you do not proclaim the TROPADYNE the best radio set you ever listened to.

$60.50

SEND NO MONEY



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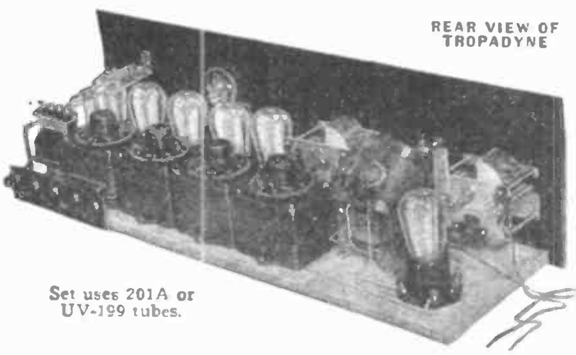
REAR VIEW OF TROPADYNE



Set uses 201A or UV-199 tubes.

Note These Important Features:

DISTANCE, VOLUME AND TONE QUALITY equal to any 8 tube set sold anywhere at any price.

LOOP RECEPTION—Outside aerial not to be used with this set—the complete loop is included in outfit.

PERMANENT LOGGING OF STATIONS—Follow chart furnished; there are only two tuning controls and you will always find the same station at the same spots on the dials. Our log chart shows you at what point to find any station.

MICROMETER VERNIER DIALS giving you the full advantage of the exceptionally sharp tuning.

OUTFIT IS ABSOLUTELY COMPLETE—Drilled panel, Mahoganite Cabinet and everything else needed, except tubes and batteries.

ECONOMY and SIMPLICITY—This is not a reflex, yet six tubes do the work for which other sets require eight to ten.

The Editor of Radio News

In the August 1924 issue, said this about the Tropadyne: "Here is a remarkable receiver which we warmly recommend to our readers. It has several new and unusual features. In the first place only 6 tubes are used giving as much volume as the average 8 tube Heterodyne. The selectivity of this set is unusual. Unequalities of the intermediate transformers have now been done away with by tuning each transformer. After the transformer has been tuned, it can be left this way, no further tuning being necessary.

"This system makes for maximum sharpness and maximum volume. Another outstanding point of superiority of the Tropadyne circuit is that it practically does not radiate, thereby not interfering with other nearby receiving stations. A saving of two tubes as well as an increase of selectivity is obtained with this new circuit."

Complete List of Parts:

4 *RICO* Tropaformers; 1 Standard Variocoupler; 2 *Certified* Low Loss 23-plate Condensers; 1 *Calibrated* Transformer; 2 Jacks; 3 Fixed Condensers; 6 Bakelite Sockets; 2 Vernier Dials; 1 Rheostat; 1 Potentiometer; 1 7x24 Panel; 1 7x24 Mahogany Cabinet and Baseboard; 40 ft. Bus Bar Wire; 1 Folding Loop Aerial; 1 Grid Leak and Mounting; Binding Posts; Flexible Wire; 1 Bakelite Binding Post Strip; 4 doz. Screws; Full Directions.

We ship in 24 hours

RADIO SPECIALTY COMPANY, 98S PARK PLACE, NEW YORK

Tropadyne Gets Europe!

"Received 2BD, Aberdeen, on November 25th. Results good, except noises. 11:30 to 11:40 talk, from 11:40 to 12:00 piano number. Piano number good, talk poor. Used Tropadyne Circuit."

J. ZIMMER, 157 James St., Newark, N. J.

The above has been verified by "RADIO NEWS"

SEE OUR 2-PAGE AD ON PAGES 1842 and 1843 RADIO NEWS

Exp. 4

SEND NO MONEY

RADIO SPECIALTY CO., 98S Park Place, New York, N. Y.

Please send at once one complete Tropadyne Superadio Outfit as advertised in April "Radio News." I will pay postman or expressman $60.50 upon arrival.

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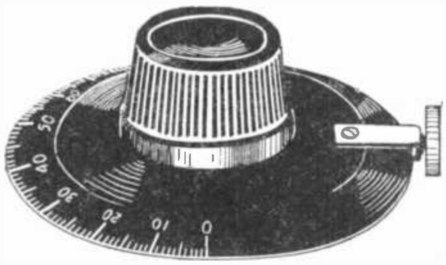
EXPERIMENTER'S PATENT SERVICE

On this page every month we will give our readers the benefit of our experience on patents and questions pertaining to patent law. Years of our treatment of the subject of patented, patentable (and many unpatentable) devices has proved satisfactory to hundreds of thousands of experimenters. The writer, who has handled the Patent Advice columns of SCIENCE AND INVENTION MAGAZINE for the past seven years, will answer questions pertaining to the experimental side of Patents in this publication. If you have an idea, the solution of which is puzzling you, send it to this department for advice. Questions should be limited to Electrical, Radio and Chemical subjects. Another of our publications, SCIENCE AND INVENTION, handles patent advice in other branches. Address "Experimenter's Patent Service," c/o The Experimenter, 53 Park Place, New York City.

Vernier Attachment for Radio Dials



B. L. Ipswich, Okmulgee, Okla., asks whether we would advise that he apply for a patent on a vernier attachment for radio tuning dials. This attachment is a small friction wheel bearing against the panel of a radio set and screwed fast to the dial itself.

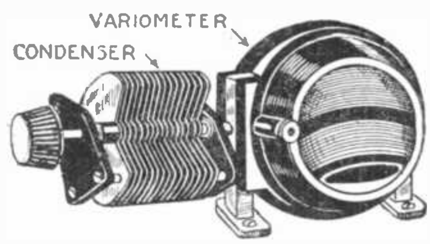
A.—A device of this nature is very impractical by reason of the fact that it must be screwed fast to the dial itself. Such an operation is not desired by the average layman who can secure verniers at costs varying from ten cents up. Most of these require no change in the dial, although some of them do require a hole in the panel.

You may argue that it is easier to drill a hole in the dial than it is in the panel. On this point, however, we would disagree. A great many of the dials are made of composition material and drilling a hole through them with the average dull drill is a first guarantee of the breaking of the dial. Other dials are made of metal, some are thin and some thick. All these factors must be taken into consideration when constructing a vernier of the type you have specified. On the other hand, panels do not vary very much in thickness, and except for the occasional glass panel they are easy to drill and are not liable to breakage. Consequently we would not advise you to apply for a patent on the vernier attachment mentioned.

Combination Variometer and Condenser

Philip Hartley, New York City, asks whether he should try to secure a patent on a one knob tuner using but one control for both capacity and inductance changes. The variometer in the circuit is connected directly to the shaft of the variable condenser and both rotate at the same time.

A.—We are quite positive that you could not possibly secure a basic patent on this sort of an arrangement, because it has been used by a great many concerns, and is now entirely removed from the radio market. The system has been found impractical because it was inaccurate and tuning by its use was not very sharp.



Typewriter Electric Carriage Return

Floyd Peterson, Columbus, Nebr., advises us that he believes he has a system for electrically returning the carriage of a typewriter after it has reached the end of its movement, and asks our opinion as to its patentability.

A.—Returning carriages on a typewriter by means of an electric motor or by means of foot or hand pressure are old ideas. We doubt if you could secure a patent covering such claims.

At one of the Inventors' Shows in New York the writer saw no less than eight different devices for this purpose. None of these are being used today, except on the automatic machines which operate without employing a regular stenographer and on the heavy billing machines. We would not suggest that you apply for a patent on the idea, because we doubt if you could place it upon the market.

Drafting and Specification Room of Clarence A. O'Brien, Registered Patent Lawyer, Washington, D. C.

These books free

The Ark of the Covenant

(*Continued from page* 420)

"Hullo, dad!" I said. "What's the matter?"

"Nothing much—just wanted to say good-night, son."

"Good-night, dad——"

"You know, Jimmy," he said slowly. "I'm tickled to death with my own son——"

"That's funny, dad," I sat up to say. "I was just thinking I was sort of proud of my own father."

"Oh!" said he. "Well—good-night, Jimmy."

"Good-night, dad."

The New *Merlin* Preparing for an Ocean Trip

III

The next two days were spent in fixing the engines in the new *Merlins* and in tests. Milliken and I were in the air a good deal, trying all sorts of fool tricks to prove the design no good, but we could find no fault in it. We had a winner, all right."

In the meantime, the old *Merlin* was being tuned up—not that she needed much tuning—and the work of putting in the extra tanks for the Atlantic flight went ahead.

Lord Almeric's luggage was brought over by Didcot on the *Seven*, and everything was put in order. We rigged up a pair of collapsible bunks from the side walls of the cabin, so that our passenger could sleep if he wanted to, and so that Milliken and I could lie down in our off spells. Then we had a little vacuum-box for hot food, and everything necessary for feeding in comfort.

At seven o'clock on the Thursday evening, we said good-bye to my father and Dan Lamont, who had come over to see us off, and to a great "Rah-rah!" from the staff of the workshops, we shot off across the bay, the *Merlin* quietly picking up into her cruising speed of four-fifty kilometers an hour.

The weather report had given warning of low storms off the coast, and we climbed high to ride over them, so there was not much to see below us. At 3,000 odd meters up, we came into a side wind from the north, fairly strong, which must have given us a lot of drift. But the *Merlin* was flying easy, and there was no pitching to speak of.

Milliken relieved me at eight, and I joined Lord Almeric in some food, for we had not dined before leaving. He was a charming companion, who talked interestingly, and had the knack of making one talk as well. It seemed that there were few corners of the earth he had not visited, and his outlook on life was correspondingly wide. There was nothing insular about him. With his open collar and its old-fashioned broad silk cravat, of the shape the English call "Ascot," he looked what he was, a very distinguished Englishman of the best type, but the curious thing was that he appeared as much at home in the cabin of the *Merlin* as he would have been in his own library.

When I spelled Milliken so that he could have something to eat, Lord Almeric continued his talk with him, charming my mechanic into an unwonted loquacity. It was gently done, and it had its reward, for Milliken, when he did talk, talked very much to the purpose. Over my shoulder I heard more of Milliken's life laid bare to Lord Almeric in half an hour than I had got from the mechanic in the years we had been working together.

"Now, if you'll excuse me, sir," I heard Milliken say, by and by, "I'll just chuck some of this stuff overboard and wash up."

"Let me bear a hand," said Lord Almeric. "You wash and I'll wipe!"

"If it comes to that, sir," said Milliken, "you wash and I'll wipe. I know better than you do where to stow."

"Good. This the grease remover?" Lord Almeric had taken off his jacket.

"That's the stuff, sir. And here's the dish-cloth."

A rush of cold air at this moment made me turn around. Milliken had prized up the hatch with a fork through the ring, and was scraping the refuse through the opening.

"All the world is my garbage can, which with this fork I will open," Lord Almeric laughed.

"Ah," said Milliken. "That's old Pistol, isn't it?"

"Slightly amended——"

They fell to discussing Shakespeare, and by the time they had finished their chores and were lying down on the bunks on opposite sides of the gangway, they were pooh-poohing the Bacon-Shakespeare theory. They then fell to talking of dry-points and etchings. I could not help thinking the subjects curious common ground for a great banker and a fine mechanic to meet on.

Milliken relieved me at midnight, our time, and I took my turn on the bunk.

"Where are we now, Jimmy?" asked Lord Almeric sleepily.

Off the Banks of Newfoundland

"Just clearing the Newfoundland Bank, we should be—400 odd kilometers west, a point or two south of Cape Race."

"Splendid!" murmured his lordship and fell asleep, an example I proceeded to follow.

It was bright day when I woke to relieve Milliken, four o'clock by our timepiece, and about seven in the longitude we were passing.

"Passed the *Parthalia* about fifteen minutes back," said Milliken. "I'd say a hundred kilometers to the north."

"Then we've drifted a bit, but not so much as I expected."

"Ah-ha'!" he yawned. "Wind shifted round about two—blew us back again."

He fetched me a cup of coffee, and then turned in.

Two hours later Ireland came up like a smudge of blue smoke on the horizon to port, and a few minutes later the Lizard widened out into the spearhead of Cornwall and Devon.

I can never fly high over England. I love to see the patchwork of fields, the dark purple of her woods, and the tiny white ribbons of her roads, the slender threads of silver that mark her waterways. I had to come down close enough to get the shape of her red roofs, all the jolly, homey villages, nestling in wooded hollows or sprawled over low downs, each with its church spire or tower rising from a patch of green, green sward, white speckled with the headstones above her ancient dead. It was April in England then.

There was no time to saunter, but I wanted to. We had to get our passenger into London by one o'clock, English time. Lord Almeric was astir, and had made an astonishingly neat toilet. He was drinking coffee.

"This is the first time I have been robbed of five hours in a day," he said. "I am certain I shall order eggs and bacon at lunch from force of habit."

Big Ben on Parliament House chimed out the quarter to one as we dropped into the basin at Battersea, and before he spoke again at the hour, we were stepping into the taxi that was to take us to Lord Almeric's house in Knightsbridge. But I don't think that Milliken was very easy in his mind that the *Merlin* was safe, even in the lock-up shed in which she was berthed.

Lord Almeric would not hear of either Milliken or myself going to an hotel. He insisted that we make his house our own. Milliken tried hard to refuse, but his lordship effectually stopped all protest. He led us to a little nest of rooms, not separate from the house, but somehow possessing an individuality—if one may use the word—of their own. He opened the door of a tidy, mannish sitting room.

"I had a boy at one time, Jimmy," he said quietly. "He was killed at Messines. These are his rooms—just as they used to be when he lived in them. Nothing has been touched, though my servants keep them warmed and aired. There are two bedrooms and a bathroom—through there—and another living room. I have had them made ready for you both. I shall be very, very glad if you and Milliken will occupy them while you remain in London."

I heard a joint in Milliken's hand crack softly as his fist clenched.

Lord Almeric in London

"My only fear is that I shall be a poor host," Lord Almeric went on. "My time will be much occupied, as you will understand, Jimmy—in fact, I must be back in harness at once. I have a conference in the City at three, and another in Westminster at six. I question if I shall be back until late at night. My people will attend to all your wants, and will serve your meals here. If you should think of going to a theatre, I'm certain that Milliken would like the production of 'Twelfth Night' at the Haymarket. Bunter, my butler, will get tickets for you. Now I must go. Pray excuse me. I shall hope to see you tonight."

He went out, leaving us there. Milliken and I looked at each other in silence for a space.

"I didn't want to stop in his lordship's house, Mr. Boon," Milliken said slowly. "But when he asks us to use his dead boy's rooms, he gives me the one thing I couldn't refuse. It must mean a lot to him—this."

"You bet you, Milliken."

"And I thought lords and such-like all bunk! That one," he nodded to the closed door—"that one makes me see I've been a fool!"

We bathed and changed, and lunch was brought to us in another of the rooms. The butler appeared to see if we were all right, and we let him get tickets for us.

"Can you tell me," I asked him, "where I might find files of the London daily papers for a week or two past?"

"In the small library downstairs, sir. We keep files of the *Times, Morning Post* and *Telegraph* and of a number of the financial journals. May I show you the room, sir?"

"Please."

I found that the London press had treated the New York raids in daily reports that never got over half a column. The *Parnassic* had the honor of a full column on the first day, and dwindled to

The Simplest Practical Radio Set Made

$2.50

A Complete Radio Receiver including Radiogem, Phone and Aerial

The Complete Outfit Consists of Three Parts

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The RADIOGEM

The simplest radio outfit made—yet as practical as the most expensive. A crystal receiving set that you can operate and enjoy even though you know absolutely nothing about radio. You receive the RADIOGEM unassembled, together with a clearly written instruction book, which shows you how to quickly and easily construct the set, using only your hands and a scissors. The outfit comprises all the necessary wire, contact points, detector mineral, tube on which to wind the coil, etc., etc. The instruction book explains simply and completely the principles of radio and its graphic illustrations make the assembling of the RADIOGEM real fun.

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An adjustable, 1,000-ohm phone complete with 3-ft. cord—the first inexpensive adjustable receiver made. The Gemphone is of standard type and made of the very best grade of materials throughout. The case is made of turned wood, an exclusive feature with the "GEMPHONE." This is responsible for its exceptionally rich, and mellow tone. Like RADIOGEM, the GEMPHONE is sold unassembled. Our Instruction pamphlet shows how to assemble it in two minutes, using only a screw driver.

(Three)

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Consisting of 100 ft. of standard copper aerial wire and two porcelain insulators.

Complete Radiogem Outfits - $2.50
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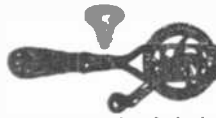
Radio Headquarters for the Finest and BEST Radio Tools

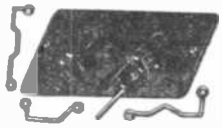
RADIO TOOLSET

This is the handiest set of tools ever made for Radio Work by the makers of the famous "YANKEE" Tools. It contains the following: 1 Rachet Screw-driver, 6½ in. long holding all attachments; 1 Blade, 5½ x 3-16; 1 Blade, 3½ x ⅛; 1 Blade 2½ x ¼; 1 Countersink; 2 Socket Wrenches for all small nuts; 1 Reamer to enlarge holes in panel from ⅛ x ½; 1 Wrench, one end 5-16" square or hex. for jack, other ½" hex., etc.
PRICE per set—No. 701 .... $3.00



HAND DRILL

The hardwood handle is hollow to store drills. Iron frame, nickeled parts, ball bearing three jawed chuck holding and centering accurately round shank drills from 0 to 3-16. Length of drill, 12 inches.
PRICE—No. 303 .... $2.25

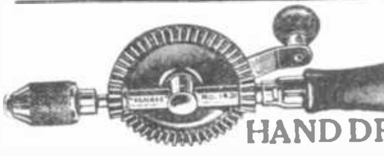


WIREBENDING TOOL

For making eyes, loops, bends, and offsets on Bus Bar wire. With this device any Radio Constructor can wire his set to compare favorably with any factory made set. Easier to use and more accurate than pliers. Full directions in box. Made of heavy steel blued and finished.
PRICE—No. 203 .... $1.00

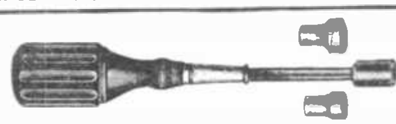
CIRCLE CUTTER

Especially designed for the Radio Constructor. Made of the finest material and equipped with the highest grade high steel cutting bits. It does three things at once. It drills its own pilot, cuts out plug and puts bead or scroll around the hole in one operation. Cuts holes ¾ to 1 in. in diam.
PRICE—No. 402 .... $3.00
401. Same tool but smaller and not fitted with bead or scroll in one operation.
PRICE—No. 401 .... $2.00



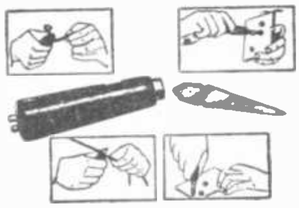
HAND DRILL

Especially designed for Radio Work by the makers of the famous "Yankee" Tools. A beautiful balanced, small, powerful drill with 1 to 1 ratio of gears for speed. Special chuck 9-32" capacity, to take largest drill, mostly furnished with drill or tool sets. Length over all 9½ in. Weight 1¼ lbs.
PRICE—No. 302 .... $2.75



Three-in-One Nut Wrench. Consists of handle with hollow stem 6 inches in length and three interchangeable sockets fitting popular sizes of nuts. The hexagon sockets grip the nut solidly.
PRICE per set—No. 301 .... 65c

Side Cutting Nipper, Lap Joint. For cutting all kinds of wire. Jaws hardened and oil tempered. Natural steel finish with polished jaws. Length 6 inches.
PRICE—No. 201 .... 75c

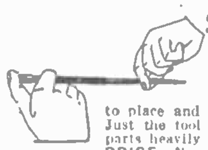


RADIO HANDI-TOOL

Bends Bus Bar or wire strips and scrapes wire, bores and reams holes, etc. Tool consists of 4 in. black japanned handle, to which is attached wire bending device, with nickeled ferrule and 3 in. long two sided reamer.
PRICE—No. 702 .... 50c

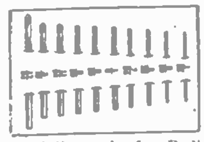
TOOL CHEST

Set consists of "LOCK-GRIP" master handle, 5" long, black Rubberoid finish with steel chuck, nickel plated, buffed and with the following 9 tools: Saw, brad-awl, large screwdriver, file, scratch awl, gimlet, reamer, chisel, small screwdriver. Each tool of fine steel, drop forged, tempered, hardened, and nicely finished. Set comes in leatheroid box with tray.
PRICE—No. 703 .... $1.85



SCREWSTARTER and DRIVER

Holds any screw by its slot with a firm grip, makes it easy to place and start screws in difficult places. Just the tool for the Radio Constructor. All parts heavily nickeled and polished.
PRICE—No. 304 .... $1.00

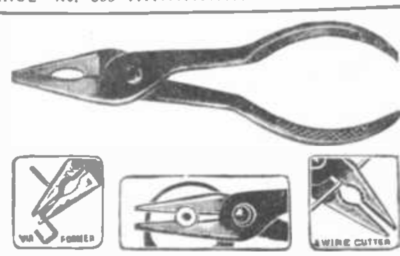


RADIO DRILL SET

Composed of 10 straight shank twist drills, fitting all hand and breast drills. The selection of these drills has been especially made for Radio Constructors and consists of the following sizes: 1-16, 5-64, 3-32, 7-64, ⅛, 9-64, 5-32, 11-64, 3-16, 17-64. Drills are mounted on white Holland Linen with sizes clearly marked.
PRICE—No. 305 .... $1.25

ELECTRIC SOLDERING IRON

A perfect tool for Radio Work. Operates either on 110-volt A.C. or D.C. The heat element is of Nichrome, which prevents overheating and assures the desired even temperature. Size of Iron, 10½ in long. A 1-ft cord and plug is furnished.
PRICE—No. 800 .... $2.00



Combination Plier, Wire Cutter, Wire Former and Wrench. Drop forged, slender but exceptionally strong. 6 in. long.
PRICE—No. 202 .... 75c

Long Sharp Nose, Side Cutting Pliers. Just the pliers for the radio constructor. Bends and cuts all kinds of soft wire. Nose 1½ inches long, black body, polished jaws. Length 5½ inches.
PRICE—No. 200 .... 75c

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The RADIOGEM CORP., 66-E W. Broadway, New York

half a column on the next, while the *Westbury* was squeezed into 12 lines. Louisville was almost crowded out by two pages of parliamentary crisis, and a long murder trial. That which had taken all America by the ears, seemed to matter little in England. It was, according to a note in the *Times*, purely an American concern.

We saw nothing of Lord Almeric until late at night, when we found him waiting for us to arrive from the theatre. We sat for an hour or two round the fire in his sitting room, yarning, and drinking some of the best whisky I have ever tasted. It must have been close to one o'clock in the morning when we went to bed.

CHAPTER EIGHT
A RAID ON LONDON

I

Somewhere in the house a telephone bell was ringing insistently. It rang in long peals, and just when I would think it had stopped for good it would begin again, more furiously than ever. I put my hand under my pillow for my watch, then switched on the light over my head. It was half-past three. The bell still shrilled through the house. Then came the sound of a door opening, and the bell was stopped by the murmur of a voice. Presently came the shuffling of feet, and somewhere nearer at hand another voice took up the murmuring. There was silence again. Firm footsteps now came masterfully to my door, and a knock.

"Yes. Come in!" I cried.

The handle turned, and Lord Almeric entered, wrapped in a dressing robe.

"Something has happened at the Bank," he said.

"Good Heavens, sir!" I exclaimed. "You don't think——?"

"I'm inclined to think it is—our friends of the *Parnassic*—or others of the tribe."

"But—but in London! It's incredible, sir!"

"We live in an incredible age, Jimmy. Would you like to come with me to the City? I'm going there at once."

"Sure, I'll come," said I, and jumped out of bed.

While I was dressing, Lord Almeric having gone off to give orders for his car, and to dress, Milliken appeared in my doorway.

"Anything the matter, Mr. Boon?" he asked.

I told him.

"Jinks!" he said. "Want me with you?"

"Not unless you're keen to come——"

"I'm not," said he shortly.

"Very well, then. If I don't get back by breakfast time, go over to Battersea by yourself. Hire what mechanics you want for the *Merlin*, and get her overhauled. Have you any British money?"

"Oh, yes. Didcot changed a hundred dollars for me in New York. Is it two and a half of these florin things to the dollar?"

"As near as doesn't matter. Two florins and eight pennies are more like the sum."

"All right. I'll get back to bed."

And he did, with no further comment.

There was little stir about the streets as we sped cityward, except for great trucks of fruit and vegetables, the big horses of them plodding along sagaciously with little or no guidance from drowsy or even sleeping drivers. The asphalted streets were wet from recent washing, and here and there we came upon sweeping machines with their wide rotary brushes working anglewise to the gutters. Now and then we would pass a solitary policeman, or a pair of them, their rubber capes glistening under the street lamps. Even this slight activity slackened by the time we reached the Strand. Then we came to Fleet Street, where the newspaper offices were ablaze with light.

"They have not received the news yet," Lord Almeric said softly. "If they had you would see the reporters streaking toward St. Paul's like hornets from a nest."

We whizzed up Ludgate Hill and passed under the shadow of St. Paul's. The City was like a place of the dead.

"It looks like the stillness of an actual raid, Lord Almeric," I whispered.

Ludgate Hill at Night

"Yes—but the City is always like this at night. Thronged during the day, and a jam of traffic—but like Herculaneum for stillness after eight o'clock."

At the corner of the Mansion House, a policeman stopped the car and peered in at us, flashing his torch. When he saw Lord Almeric he saluted and waved us on. Policemen were streaming into the open space in front of the Royal Exchange. We pulled up outside the Bank of England, and a policeman opened the door of the automobile. A white-faced inspector met us inside the building, and he was immediately joined by a subaltern of one of His Majesty's Footguards—the Coldstream, I think it was. This officer was as white faced as the policeman, but keeping a stiff upper lip in spite of his obvious misery.

"This is a bad business, my lord," said the inspector. "The Bank of England robbed!"

Lord Almeric nodded and turned to the young guardsman.

"You're Guy Pennefether, aren't you?" he asked.

"Yes, Lord Almeric."

"Permit me to introduce a friend of mine, Mr. James Boon. Mr. Guy Pennefether—Inspector Trueman. Now, let us go to your quarters, Pennefether. You'll come also, inspector. You shall tell me quietly what has happened, then we shall inspect the damage."

"There isn't much to tell, Lord Almeric," said the young fellow, when we had reached one of the rooms occupied by the officers of the nightly guard. This was a neat little mahogany-panelled dining room in the heart of the building, and sort of surprising to find there.

"Sit down, Pennefether, and compose yourself," Lord Almeric said kindly. "You, too, inspector. I don't wonder you are shaken. Jimmy, find a seat for yourself, please."

I took a chair near the table that stood in the middle of the room.

"Now, Mr. Pennefether."

"I haven't much to say, Lord Almeric. We took over at the usual time. The sentries were mounted in the usual way, inspected, changed, all according to orders. Nothing unusual happened until half-past midnight, when my sergeant came into the room here with me after doing the rounds. I had asked him something about one of the men in my platoon—as a matter of fact, it was about his chance of winning the cruiser-weight championship of the brigade—when suddenly Sergeant Withers stopped speaking. 'What's the matter, Withers?' I said. He blinked at me. 'Nothing, sir, nothing,' he said; 'something passed over me—queerlike.' Then something queer took hold of me. I began to see the sergeant as through a haze. He got further and further away, his voice becoming fainter—then he seemed to crumple up—like a concertina. I don't remember anything more . . . until I woke up.

"I had fallen asleep, or become unconscious, spread across the table and still sitting in the chair. My watch was in front of me—and to my horror, it pointed to a quarter to three. I had been asleep for a full two hours. I got up in a hurry to make for the door, when I stumbled across my sergeant, who was lying stretched on the floor!"

"A moment, Mr. Pennefether," I said. "What metal is your watch?"

"Eh? Oh, gold—gold—a little plain watch I wear with my uniform——"

"May I see it, please?"

"It is still lying on the table beside you there—under that paper."

I found it and turned it over. I nodded to Lord Almeric.

"Tarnished," I said.

"Ah," said Lord Almeric. "Go on Pennefether."

"Naturally, I was bewildered. I stooped over Withers and shook him. He woke up without effort, and presently was on his feet, stammering out excuses. . . ."

The rest of the young guardsman's story was as we expected. He had rushed out into the corridor and found all his men fast asleep, his sentries fallen at their posts with their rifles beside them.

(Continued on page 429)

His next thought was for the vaults. The big steel doors had been cut open and the interior of the vaults were strewn with the wreckage of cases.

In the matter of the Bank of England, the inspector could bring up no new point. He had been awakened by one of his men, having fallen asleep without any premonitory symptoms, and on going his rounds he had found all his points asleep or on the verge of waking. He had joined Mr. Pennefether at the vault door. But he told us that three of the joint stock banks in Old Broad Street had been forced open and their strong-rooms cleared.

"Our friends hold to their thorough methods," said Lord Almeric to me. "There is a breadth in their rascality that takes the breath away."

He turned to the young officer of the Guards. "It is useless to beg you not to be concerned, Pennefether," he said gently. "That you must inevitably be. But I beg you—and you also, inspector—to be rid of the idea that you are in any way culpable. You could not have foreseen this event, nor could you have helped yourselves if you had. The blame, if any, attaches to me. I should have taken steps to protect the Bank from this outrage. Come—let me see the extent of the damage."

In the Bank premises, everything was scrupulously neat and tidy, until we came to the vault door, and that had a section cut through it. It was big enough for Lord Almeric to go through, and I followed him.

"They have not been greedy," said he. "They have taken only a million pounds sterling, Jimmy—and have left the remainder. Now, let us see how they have treated our securities."

He turned to a side-door, which also had been treated with the flame. Inside the room was a heap of smouldering papers, and from this there rose a pungent smell. The papers were securities, and they had been destroyed beyond recognition by having had acid poured over them!

"The wantonness of it!" cried Lord Almeric. "The sheer damned wanton uselessness of it! Ur-r-r! The theft of the gold I can understand—but this!—this means months of work—chaos—endless, useless bother and vexation!"

"Does it represent much money, sir?" I ventured.

"Millions. I cannot say how much. It will be recoverable, the greater part of it, perhaps. But when I think of the complications—the damned messiness and bother—ur-r-r!"

He recovered himself quickly.

"I beg your pardon, Jimmy. I'm making an exhibition of myself—but the thing is so unpardonably stupid. Come' we'll go to my room and think this out."

"Your pardon, Lord Almeric. There's something I'd like to do before the crowd gets about. Could you put me in charge of a police officer, while I go snooping around to find out if the thing links up with Wall Street?"

"Why, of course. Would you oblige me by taking Mr. Boon around, inspector, and seeing that he is not interfered with?"

"Very good, my lord."

I went off with the inspector and got outside the buildings. I hunted around the streets about the Bank in comparative quiet. The London police are nothing if not efficient, and they had drawn around the district a cordon that was impassable. Only a few civilians were about the streets.

I found four star-shaped splatters of powdered glass on the Exchange side of the Bank, and two in a sort of courtyard within the buildings. They were perfect in shape, and showed me what the smears I had found around Wall Street would have been but for the crowds that had trampled them about.

(To be continued)

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Super-Heterodyne Circuits

(Continued from page 374)

never before appeared in print is shown in Fig. 5. This circuit is given merely for experimenters to investigate as to the best of the writer's knowledge it has never been hooked up.

We are all familiar with resistance coupled amplifiers, using a vacuum tube as the coupling resistance. In this circuit we use a UV-199 tube for this purpose and light its filament by a separate small flashlight battery. This is tube 2 in the diagram. An Amperite is recommended in the filament circuit. In addition to acting as a coupling resistance in a short wave radio frequency amplifier, we connect our oscillator coil to this tube and make it act as an oscillator also. Thus in tube 1 we have a short wave amplifier using tube 2 as a coupling resistance, which also is an oscillator and heterodynes the received currents. Both oscillator frequency, signal frequency, and the difference between the two or beat frequency are impressed on the grid of the detector, tube 3, which detects the intermediate frequency. This, of course, is amplified by tubes 4 and 5, and the audio currents are detected by tube 6 and amplified by tube 7. In both this circuit and the Tropadyne circuit, Fig. 4, no grid condenser and grid leak is used for the second detector. Far better results are obtained as regards quality and volume when using a "C" battery for the second detector, instead of the grid condenser and grid leak.

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