November 1924 25 Cents

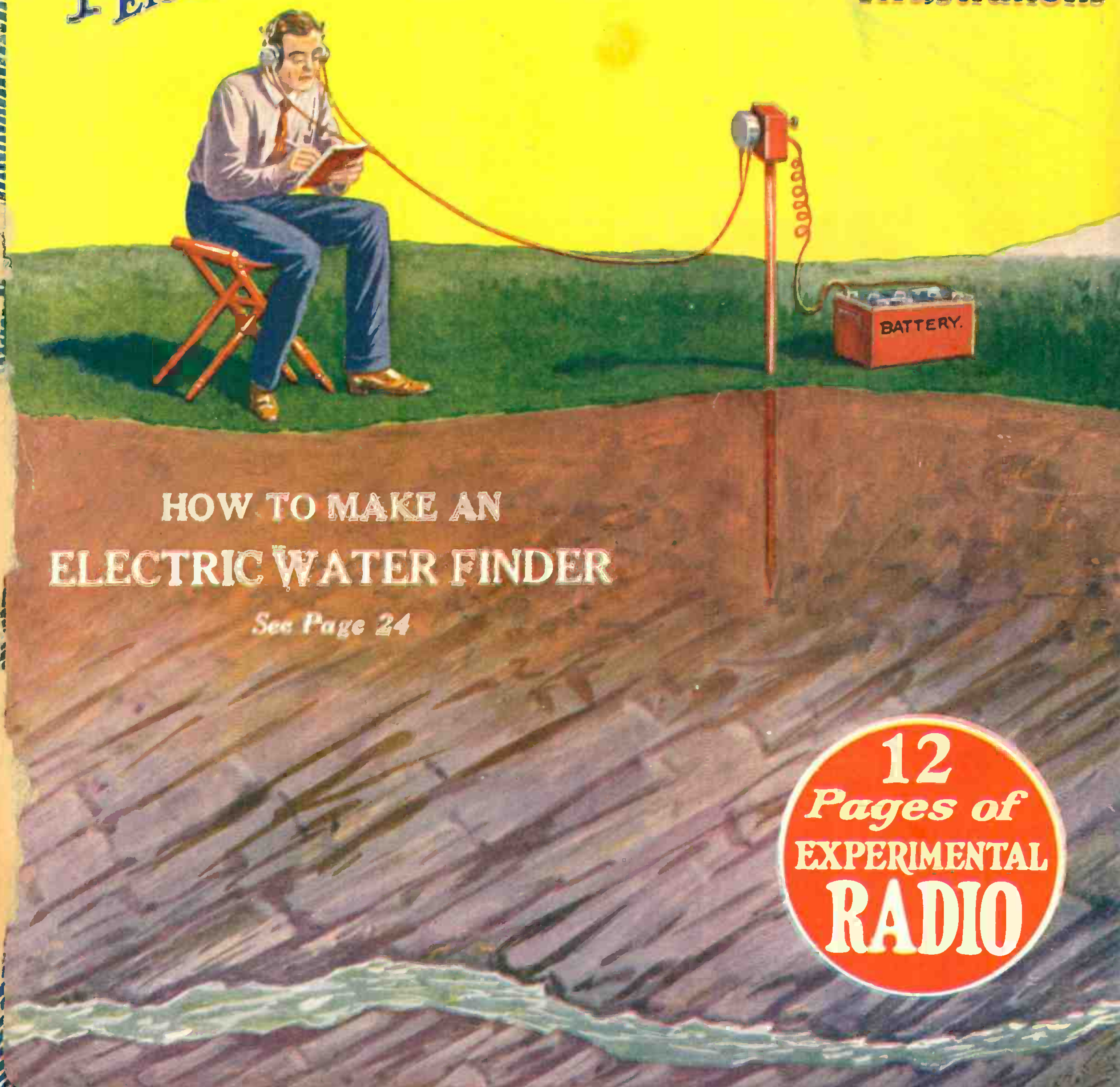
The EXPERIMENTER

Electricity ~ Radio ~ Chemistry

Edited by HUGO GERNSBACK

formerly Practical Electrics

Over 150 Illustrations



HOW TO MAKE AN ELECTRIC WATER FINDER

See Page 24

12 Pages of EXPERIMENTAL RADIO

Be a Dunlap-Trained Electrical Expert
CHIEF ENGINEER DUNLAP
MAIL COUPON To-DAY
If you want to earn $4,000 to $12,000 a year!
How would you like to be Chief Electrician of the LEVIATHAN or the WOOLWORTH Building, or the PENNSYLVANIA HOTEL? How would you like to draw the pay of the SUPERINTENDENT of a great Power Plant? How would you like to own an Electric Contracting business? I'm not talking about ordinary Electricians who earn $12 a day. I want to prove to you that YOU can become an Electrical Expert—I will show you how with my training you can BOSS Electrical jobs at $100 to $200 a week!
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Do you realize how big the Electrical business is today—what wonderful opportunities are waiting for the trained Expert? Everywhere around you are great Electrical industries, enormous light and power plants, gigantic electrical machinery. Every building must be wired. Automobiles use nearly a billion dollars worth of electrical equipment a year. Then there's Radio, Telegraphy, Commercial Wireless. And the future is a hundred times greater than what you see today. Where else can you find equal OPPORTUNITY?
CHIEF ENGINEER DUNLAP, Electrical Division, AMERICAN SCHOOL, Dept. E-869 Drexel Av. & 58th
22 of world's greatest Electrical Engineers helped me to prepare this training. AMERICAN SCHOOL said to me, "Dunlap, we want our Electrical instruction to prepare a man for the big-pay executive positions. We want to be able to truthfully say it is the biggest, MOST COMPLETE Electrical training on earth." Well, that meant neither I nor any other ONE man could prepare such a course in a dozen life-times, no ONE man could know everything about EVERY subject in Electricity. So I secured the help of 22 of America's greatest Electrical Engineers and executives of the following great corporations and Universities:
Lehigh University
University of Kansas
Dartmouth College
University of Vermont
Western Electric Co.
Columbia University
General Electric Co.
Crocker-Wheeler Co.
Commonwealth Edison Co.
Cutler-Hammer Mfg. Co.
American Telephone & Telegraph Co.
Westinghouse Electric & Mfg. Co.
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and many others
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You can turn my training into money quick!
"Earn while you learn" is my motto. It brings you experience and practice and welcome cash. Soon after you start I show you how to turn your Electrical knowledge into money—how to make this training pay for itself.
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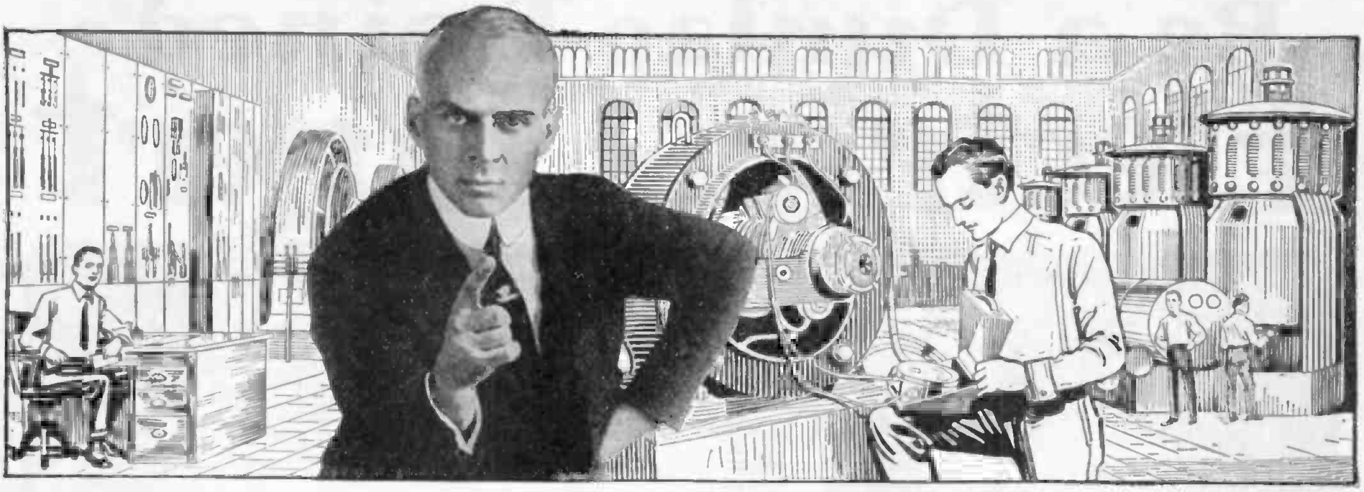
AMERICAN SCHOOL is an educational institution, pledged not to make a profit. Because this is not a money-making business, those who take my training get more for their money here. The entire resources of this 27 year old, million dollar institution stand back of my guarantee that if you are not satisfied we will refund every penny of your money.
FREE ELECTRICAL OUTFIT
Prepares You For BIG-PAY Job!
I don't hand you a book and say "study this." I send you ABSOLUTELY FREE a big, complete, costly outfit of electrical instruments, materials, motor, tools, etc., and you learn the principles, laws and theories of Electricity in a practical way. Only part of this wonderful outfit is shown here. My "lessons" are actual ELECTRICAL JOBS—such as you will do and BOSS after you finish my training.
Upper picture shows my student working on an Electrical Job with the Free Outfit I send him. Lower picture shows similar job in big Power Plant good for salary of $100 a week.
Only a Part of FREE Outfit
PAY-RAISING COUPON!
Chief Engineer Dunlap, Electrical Division
AMERICAN SCHOOL Dept. E-869
Drexel Av. and 58th Chicago
Please tell me how I can train at home in spare time for Executive positions in Electricity, also send me your big Free Book, Free Scholarship and Free Outfit Offer.
.... Name
.... St. No.
.... City .... State



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Stop right here. This is YOUR opportunity! Electricity is calling you, and the Electrical Business is in for a tremendous increase. But it needs more trained men—at big pay. By my Home Study Course in Practical Electricity I can train you for these positions.

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A fine outfit of Electrical Tools, Instruments, Materials, etc., absolutely FREE to every student. I will also send you FREE and fully prepaid—Proof Lessons to show you how easily you can learn Electricity and enter this splendid profession by my new, revised and original system of Training by Mail.

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Special newly-written wireless course worth $45.00 given away free. Full particulars when you mail coupon below.

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What are you doing to prepare yourself for a real success? At the rate you are going where will you be in ten years from now? Have you the specialized training that will put you on the road to success? Have you ambition enough to *prepare* for success, and get it?

You have the ambition and I will give you the training, so *get busy*. I am offering you *success* and all that goes with it. Will you take it? I'll make you an ELECTRICAL EXPERT. I will train you as you should be trained. I will give you the benefit of my advice and 20 years of engineering experience and help you in every way to the biggest possible success.

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Valuable Book Free My book, "How to Become an Electrical Expert," has started many a man on the way to fortune. I will send a copy, free and prepaid, to every person answering this advertisement.

Act Now! Good intentions never get you anywhere. It is action, alone, that counts. NOW IS THE TIME TO ACT.

L. L. COOKE, Chief Engineer

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Dept. 218

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Chicago Engineering Works
Dept. 218, 2150 Lawrence Ave.
CHICAGO, ILL.

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Address ....

City .... State ....

The "Cooke" Trained Man is the "Big Pay" Man

The EXPERIMENTER

Vol. 4 Contents No. 1

For November

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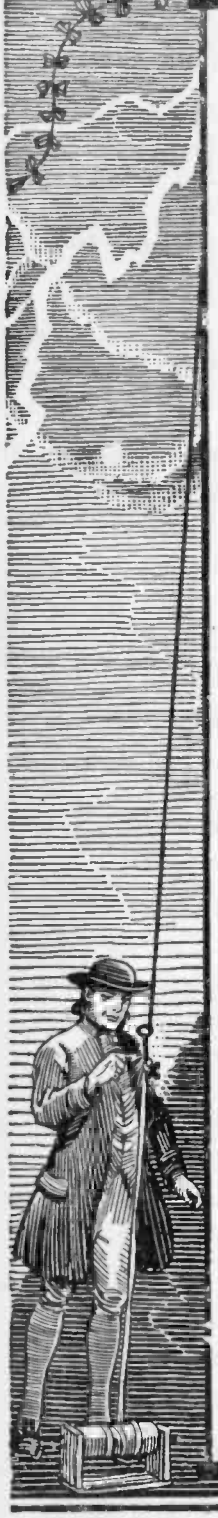

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Volume 4
No. 1

The EXPERIMENTER
Electricity ~ Radio ~ Chemistry

November
1924

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

The New "Experimenter"

By Hugo Gernsback

WHEN the writer started his first magazine, MODERN ELECTRICS, in 1908, it was at that time the largest and most widely read magazine in this country devoted to electricity and wireless, as radio was then called. MODERN ELECTRICS was created to be an inspiration to experimenters. It is still remembered by thousands of experimenters the world over. It was a pioneer in many ways, not only in the electrical field but in radio as well. It was the very first magazine printed anywhere that published radio articles monthly.

In 1913 the writer launched the ELECTRICAL EXPERIMENTER, which also became widely known and enjoyed one of the largest circulations of such a magazine in the country. It was read everywhere, quoted by its contemporaries, and is still referred to daily by many experimenters and scientific investigators. The ELECTRICAL EXPERIMENTER during the succeeding years encompassed a number of different subjects, such as electricity, chemistry, radio and physics in general.

During these years it carried the largest amount of radio text of any radio magazine printed anywhere. It also had the largest circulation of any such magazine. But in 1919 radio had become a big thing. The urgent need for a separate magazine became apparent in that year, and this led to the creation of RADIO NEWS, which today enjoys the largest circulation of any radio magazine in the world.

By that time the ELECTRICAL EXPERIMENTER had become a more general scientific magazine and its name was changed to SCIENCE AND INVENTION. But the clamor for experimental and "how to make it" material in the intervening years seemed to grow rather than abate. The old readers of the original ELECTRICAL EXPERIMENTER had somehow never become reconciled to the new SCIENCE AND INVENTION or RADIO NEWS. They wanted experimental and "how to make it" articles.

For that reason the writer started PRACTICAL ELECTRICS three years ago, in 1921. At that time it was thought that what the readers wanted were strictly electrical articles of an experimental nature, telling how to make things at home and in the laboratory. This was indeed so, but there were only about 50,000 readers who were looking for this sort of information. At any rate, PRACTICAL ELECTRICS never printed more than 60,000 copies, and the circulation simply would not go above this amount. PRACTICAL ELECTRICS also left the radio experimenters and the chemical experimenters high and dry. These readers would not buy either PRACTICAL ELECTRICS, SCIENCE AND INVENTION or RADIO NEWS because none of these magazines gave any or enough of such material.

We therefore decided last month to bring back the old ELECTRICAL EXPERIMENTER once and for all, and this issue, now in your hands, is the result.

The writer now trusts that he has satisfied all of the 100,000 readers of the old ELECTRICAL EXPERIMENTER. As will be seen, nothing has been taken away from the usual PRACTICAL ELECTRICS text. We have retained all the Departments, but have added new departments, which we were enabled to do by adding a sufficient number of pages. The magazine as you have it before you now contains the following:

A general section which we might term the Picture Section, which includes a rotogravure section.

The electrical section, largely composed of experimental articles.

The radio experimental section.

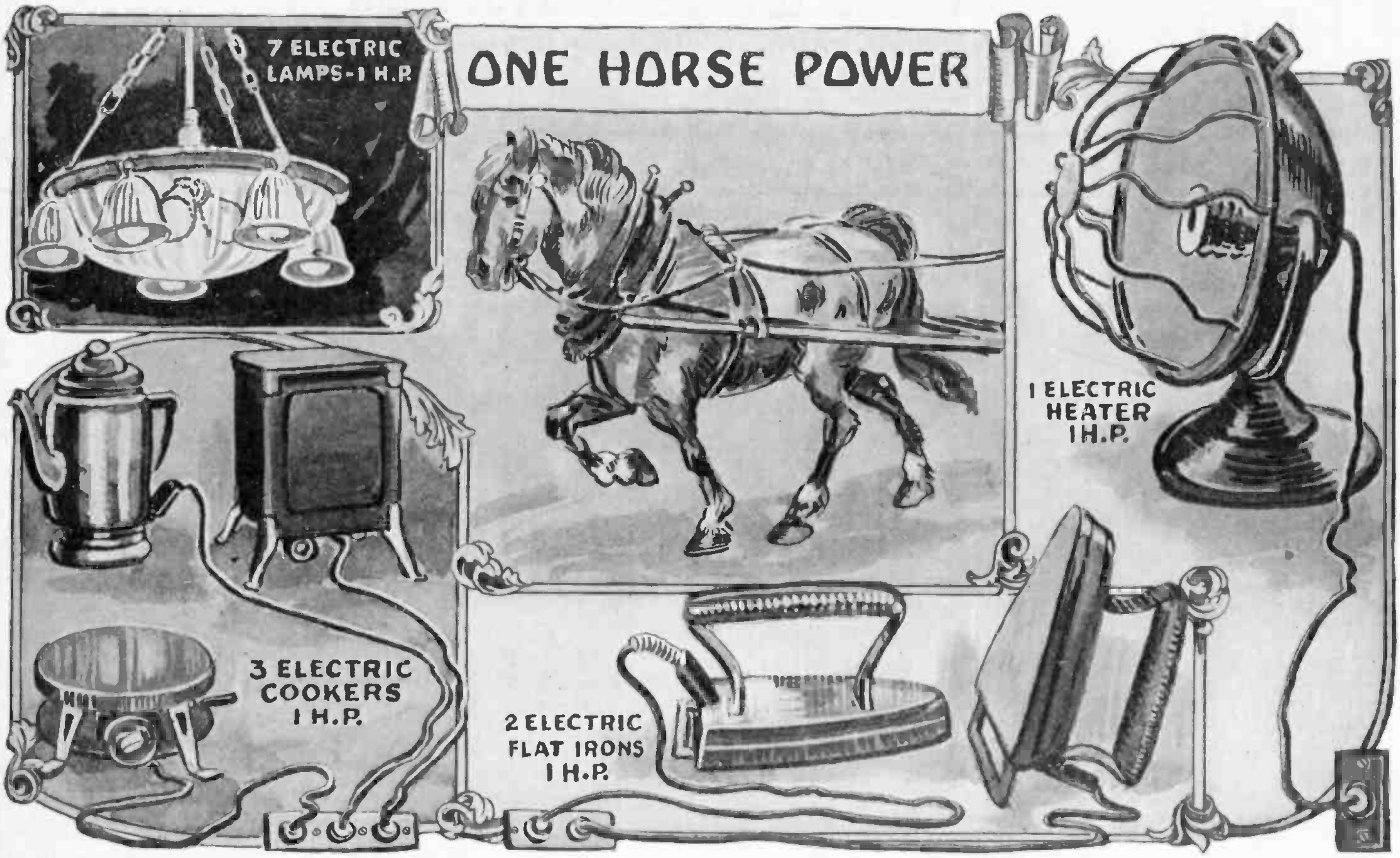
The chemical experimental section.

The keynote of the magazine, as you will note, is 90 per cent experimental. This, we believe, will satisfy everyone and make many new friends for THE EXPERIMENTER. If we are wrong, and if the text as represented by this issue is not what the majority wants, we will make such changes as are requested by our readers. Hence the voting coupon on page 86. If you will fill this out and mail to us it will be a guarantee of giving you exactly the kind of a magazine you want.

At any rate, the writer would greatly appreciate a few words from you telling him how you like the first issue of THE EXPERIMENTER. And if you do like this issue, be sure to tell your friends about it, because more readers mean more circulation, and more circulation means that we can give you more reading matter. That this is the case is best proved by THE EXPERIMENTER'S sister magazine, RADIO NEWS, which, with a circulation of 400,000, enables the publishers to give its readers 240 pages, of which more than half is pure reading matter.

THE EXPERIMENTER begins its life with 100,000 copies. The immediate future will show how good you—our readers—can make this magazine by your patronage.

Horsepower in the Household



Household appliances of one horsepower rating are shown above. Even a couple of flat irons are equal to the horse in rate of energy exerted.

WE read and hear so often of a motor car which has its 50 horsepower motor, ship turbines that deliver 12,000 horsepower, how many horsepower do we draw upon in our household economies?

We light our dwellings with electric incandescent lamps; we draw the current from an electric power and lighting plant in which there are machines with 1,000 and more horsepower each, how much do we use for ourselves?

We can easily figure this out when the meter readers from the electric company come to our houses and give us the kilowatt hours. Suppose, for instance, that this month we have to pay for 30 kilowatt hours. That means we have used one *(Continued on page 61)*

Silencer for Public Speakers

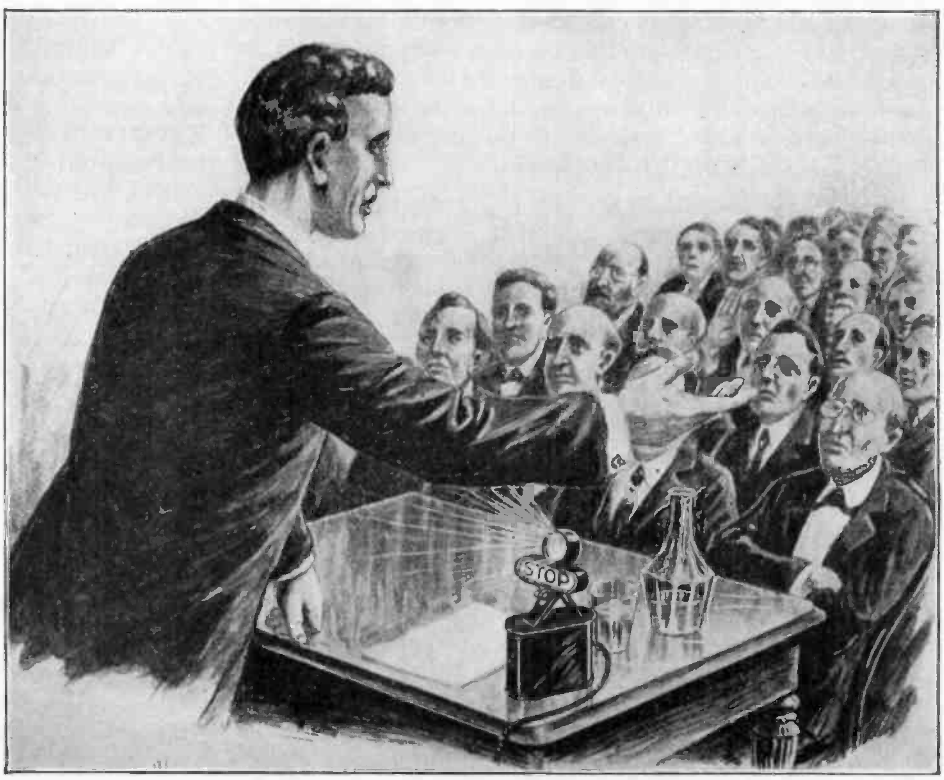
By Charles W. Geiger

IT is a very delicate matter for a chairman to stop a speaker without offending or embarrassing him in the presence of an audience. Consequently the electrical silencing device illustrated will render very valuable service and fill a long-felt want.

The device is placed in position in front of the speaker and is controlled by two switches which are placed in front of the chairman. The upper signal is used by the chairman to warn the speaker that he is approaching the time limit at which he should close his talk.

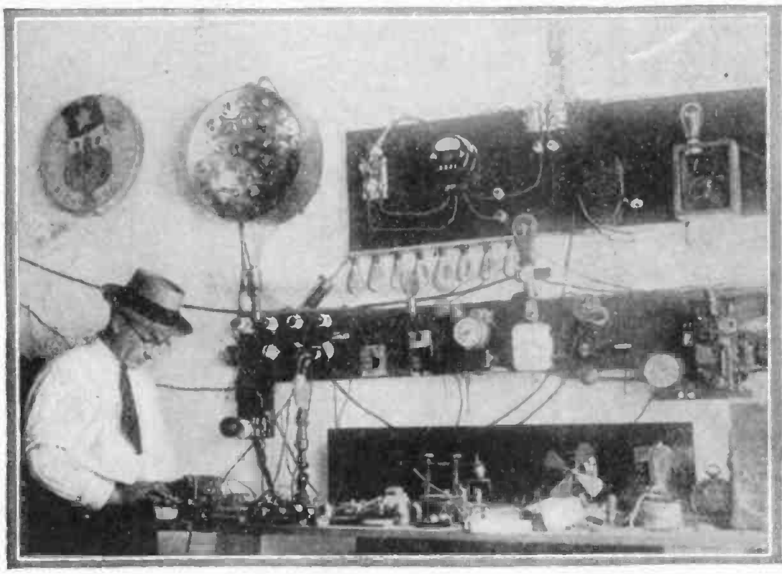
The apparatus has a great range of flexibility in the hands of a clever chairman, as he is able to vary the periods of illumination. When the chairman has lost his patience he can use the other switch and throw on the stop signal. This in almost all cases is sufficient to accomplish the purpose, *except in the case of a woman speaker.*

When we consider that every week (in every large city) thousands of business men must spend five to ten minutes or sometimes more time than they should spend every day at luncheons, due to lack of proper facilities to inform the speaker when he has passed his limit, this invention is a worthy contribution to the Daylight Saving Plan.



The public speaker is here supposed to be silently suppressed. An electric light tells him when he has spoken long enough.

Talkless Telephone



This may be called a telephone for the deaf, although it does not make any sound; by playing on a board like a keyboard on a typewriter attachment, lamps are lighted, a special one for each letter.

A VERY interesting method of transmitting messages by telegraphy to the deaf and dumb is illustrated here.

The telephone, as far as its transmission is concerned, is restricted in its use to those who can speak, while at the receiving end the person using it must be able to hear.

We show a very interesting system of conveying messages for people thus afflicted, which in a way was suggested perhaps by the typewriter. Mr. William E. Shaw of Cambridge, Mass., is himself deaf and dumb. He is a graduate of Thomas A. Edison's laboratory and the great inventor himself is exceedingly deaf and has been so for many years, all of which gives the apparatus a sort of personal touch.

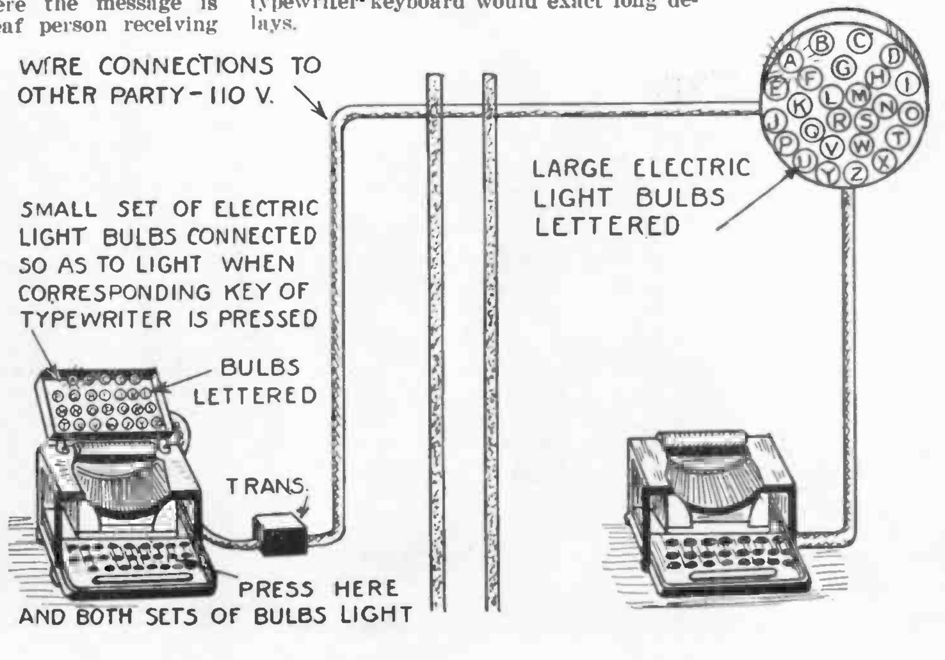
The sending apparatus in shape suggests a typewriter. Immediately back of a keyboard there is a bank of lettered incandescent lamps. Each key turns on a specific lamp, so that the letter is indicated by a light. This is at the transmitting end.

At the receiving end there is a corresponding bank of lamps, regularly lettered, and these are lighted in exact accord with the keys pressed at the distant instrument. Here is where the message is received, and the deaf person receiving by watching the bank of light, reads off the message sent.

The sending apparatus is quite portable and can be held in the lap, if desired, while the message is being sent. The small bank of lamps is not a necessity, as the large bank can answer every purpose.

The instrument is termed a "talkless telephone." The inventor, who resides in a stone house, once lived in a wooden house which caught fire. So now he proposes not to take any more risks, as the talkless telephone can give no warning to fire departments, for it is not installed by them.

By repeated use of this system abbreviations in spelling and arbitrary symbols will be developed between "speakers," if they may be called so, which will become a sort of code. The effect of this will be to greatly abbreviate the time required for the transmission of a message. To laboriously spell out communications on a typewriter keyboard would exact long delays.

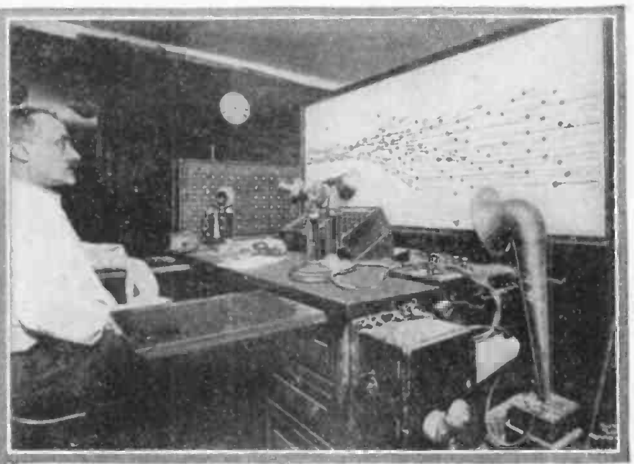


The layout of the telephone apparatus is clearly shown here in diagrammatic form. The inventor is a graduate of the Edison laboratory, and it would seem that the great inventor would be interested in it, as he is very deaf.

We Pay One Cent a Word

WE want good electrical articles on various subjects, and here is your chance to make some easy money. We will pay one cent a word upon publication for all accepted articles. If you have performed any novel experiments, if you see anything new electrical, if you know of some new electrical stunt be sure to let us hear from you. Articles with good photographs are particularly desirable. Write legibly, in ink, and on one side of the paper only. EDITOR.

Grand Central Terminal Switchboard



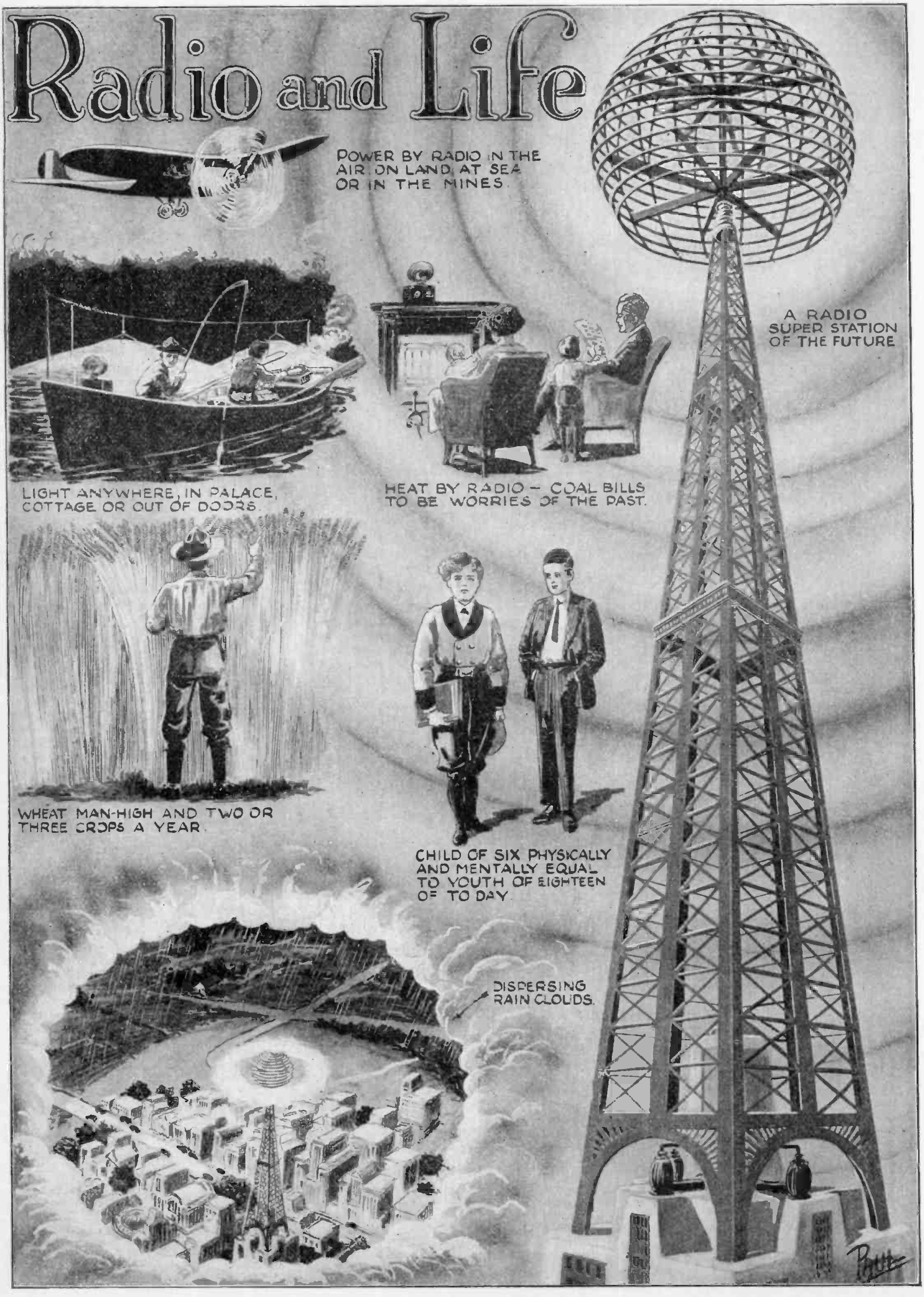
A great terminal switchboard and signaling board in use at the Grand Central Station, New York City. This is one of the world's greatest railroad stations, and requires the most advanced electric appliances to be successfully operated.

THE Grand Central Terminal in New York City takes care of trains carrying over 36,000,000 people a year. The electric signal machine illustrated here is located in the Grand Central Terminal building, and directs the movements of the trains within the terminal area.

To give an idea of its complication, it may be stated that there are 400 levers in the machine, each operating a switch or signal. To each 40 levers a man is assigned, who works under the instruction of the train director.

An incoming train is announced to the director by telegraph from the interlocking station at Mott Haven, about five miles from the terminal. The director's work consists in sending the train on to the proper track. When the train has passed a certain point, nearer the station than Mott Haven, the track is fixed and switches set to receive it. The director transmits his orders to the lever man. As soon as the incoming track is provided and settled, the information is transmitted to the signal tower by a telautograph to other instruments in other parts of the terminal.

The Grand Central Terminal is one of the world's greatest railroad stations. In the rush hours a single minute may be a fair interval between trains. There are two levels in the station on which trains enter and leave, and the tracks leading into the station form a sort of maze, and it is hard for the layman to understand how it is possible to get the multitude of trains in and out day after day without confusion. Confusion would mean delay and accidents. The traveler takes everything for granted in the movements of trains on which he travels, but if he realized the interlocking of the system he would be almost surprised to reach his destination on time.


Radio and Life
POWER BY RADIO IN THE AIR, ON LAND, AT SEA OR IN THE MINES.
A RADIO SUPER STATION OF THE FUTURE
LIGHT ANYWHERE, IN PALACE, COTTAGE OR OUT OF DOORS.
HEAT BY RADIO — COAL BILLS TO BE WORRIES OF THE PAST.
WHEAT MAN-HIGH AND TWO OR THREE CROPS A YEAR.
CHILD OF SIX PHYSICALLY AND MENTALLY EQUAL TO YOUTH OF EIGHTEEN OF TO DAY.
DISPERSING RAIN CLOUDS.

Radio and Life

By Hugo Gernsback
Member American Physical Society

WHENEVER there is a heavy continuous rainfall in the country almost any farmer you meet will tell you that he blames it all on the radio. Whether there is a cyclone, a long extended rain or, for that matter, a long extended drought or an earthquake, radio is sure to be blamed for the result. Of course, scientists scoff at the suggestion that radio can have any effect whatsoever on rain or drought, but it is also true that radio waves have some effect on our atmosphere, although this effect is comparable to that of an electric fan in the midst of a prairie. The fan will make some breeze and create some disturbance, but the effect ten or fifteen miles away from the fan will be practically nil. So with radio.

The entire power which is actually sent out into space all over this globe does not amount to more than 5,000 kilowatts; in other words, a power that would light about 100,000 50-watt incandescent lamps. If in the future this power should amount to a million kilowatts or over there is no telling but that this power may actually have a slight effect upon our atmosphere; but even then it could never be serious enough to interfere with rain or shine. The super-radio station of the future—when we will send power by radio—and which may radiate 500,000 kilowatts into space, will be quite a different matter. Such a super-station will probably keep the immediate vicinity free from rains if sufficiently elevated. It has been demonstrated recently that aviators using electrified sand were able to disperse clouds and actually cut huge holes into cloud-banks by this means. It would seem that such huge radio power stations might clear the air from rain, sleet or snow for possibly miles around, but even such huge stations will probably not very greatly affect the rest of the atmosphere to any marked degree.

The writer has often been asked, "What effect do radio waves have upon the human body?" It is a fact that as you are reading these lines, radio waves are passing through your body from all sides. No matter where you are these days, radio waves of various frequencies will actually pass through your entire body almost every second of the day. If you are in the open, such waves will surge more strongly through you than when you are in the city. When you are standing alone on a plain, you will possibly receive the maximum effect of the waves. If you are in the city surrounded by tall steel buildings, these buildings, rather than your body, will absorb most of the radio waves, and finally, if you should place yourself in a hermetically sealed steel vault no waves would pass through your body at all.

But what is the effect of these waves upon the human body? As far as we have been able to observe, directly and indirectly, the effect is practically nothing, or no more than the effect of sunlight on a pane of glass. There *is* some effect, but it is very slight; that is, with the radio power being employed by the radio stations at the present time, it is so weak that you must amplify it thousands of times in a receiving set in order to hear a single note.

The human body itself, as far as radio waves are concerned, is a medium that conducts them fairly well. If you live right underneath a powerful radio station there would undoubtedly be some effect on your body, and this effect would be beneficial. It would possibly be of considerable benefit to you, that is if you were *continuously* under the influence of the radio waves for twenty or thirty years. Under such influence you would probably not be subjected to *arterio-sclerosis* (hardening of the arteries). This is the most common disease of man as he grows old.

It was discovered by d'Arsonval some years ago that high frequency currents actually had the effect of greatly reducing this ailment by lowering the blood pressure. Of course, this beneficial action would only occur if you were living very close to the transmitting station. One mile away from it and there would be practically no effect.

Twenty-five or fifty years from now, with thousands of super-radio stations generating millions or billions of kilowatts, the situation will probably change. The beneficial action will then be felt by anyone, no matter where located on this globe. By that time the high frequency currents will have become sufficiently powerful to have a vitalizing effect on every human being. We will all be electrified then in the full meaning of the term. Not only that, but plant life will also be greatly stimulated, as recent high frequency experiments on plants have shown. Our crops and plants will grow practically two to ten times as fast, and the crops will be more productive under this electrification. Under such stimulation it will be quite possible to raise crops at least twice or perhaps more times during the year; and the most interesting part about this is that it will cost the farmer absolutely nothing except fertilizer. And this he requires anyway.

Once we have these super-radio power stations in operation to supply light, heat and power by radio to the entire country and to the world, these plants will then of necessity be in operation twenty-four hours every day. The high frequency radio waves naturally will travel over hill and dale, sweeping all over the land into every nook and corner. Plant life, therefore, will be benefited wherever it exists. But planted seeds, to become crops later, naturally will be benefited more strongly the nearer they are to the radio power station. This, however, is only a theoretical consideration for the reason that in time to come—and our children will surely see it—even the smallest town will have its radio power station the same as it has its electric power plant today. And let no one think that power by radio, or rather electric power without wires, is a dream. In the September issue of PRACTICAL ELECTRICS there was shown a way in which power can be transmitted to a distance without wires. Huge towers supporting at their tops large circular wire hoops face each other at given distances. The electric high frequency currents jump, so to speak, from one hoop to another with electromagnetic induction in the same manner as the power which leaves the aerial from the present-day broadcasting station reaches your aerial through the intervening space.

Perhaps the careful reader will find a slight inconsistency in some of the statements made here. It was stated that the huge radio stations of the future would be used to disperse rain, snow and sleet. Now, on the farm we cannot do without the selfsame rain and snow. We cannot raise crops without water and it is not practical, although feasible, to raise crops with irrigation alone. Plant life must have rain. What, then, is the answer? On the future farm district there will be set aside one or two days a week when the rural radio power station is not in operation. During that period the farming district will derive its power from surplus energy stored during the preceding days. Or it may draw its power from a distant point by radio, just as the street cars of Syracuse, N. Y., are run from the distant Niagara Falls today. By this time the meteorological science will have advanced so far that it will be possible for the Government to predict with accuracy exactly in what region it is going to rain during the next twelve hours. The section that is to be benefited by the rain will be notified automatically, and if it needs the rain its radio power station may be shut down. If the rain is not needed, the power will be "on the air" as usual.

The writer spoke above of the beneficial effect on the health of human beings under the stimulation of super-radio frequency currents. There are, however, other physiological effects on the human body that should be mentioned. Everyone knows of the beneficial effect that we experience when we grasp the handles of a small electrifying machine, known better under the popular name of the electric shocking machine. Technically this is known as Faradization.

We know how this treatment stimulates our nerves, how it injects new vitality into us, and in popular parlance, "peps us up." If we could be under such stimulus 24 hours a day, and it is perfectly harmless as we all know it, it certainly would increase our working efficiency to a very marked extent. It would probably do away with such common troubles as headaches. It would improve our digestion. Rheumatism would be practically unknown, and the "nervous wreck" would only be found in ancient histories. In a small way the electrification effects just mentioned may be actually experienced in the vicinity of any large radio station. For instance, the Government station at Arlington, Va. (NAA), is so powerful today that if you walk underneath the aerial wires you will experience a tingling sensation on the soles of your feet as you step on the moist earth. If an automobile drives along the road underneath the aerial you are able to draw stinging sparks from the car and from the occupants, because the automobile, due to its rubber tires, is insulated from the conducting ground, while you, standing on the ground, are not insulated.

Remember also the power of NAA is comparatively weak compared with the radio super-stations we will have in the future.

We have mentioned above that plant life is greatly benefited by electric high frequency currents and that plants grow much more rapidly under such influence. Certain experimentation made with insects and small animals have also shown an increasing growth tendency under such electrification, and if constant electrification increases the growth of plants tenfold, it is not improbable that the effects on animal life and upon human beings may be analogous. Perhaps it will be possible for children under such electrification to grow up quicker without bad effects. A dog is fully grown up when he is a year old, while it takes the human being sixteen or more years to accomplish the same. Under constant electrification it may be possible a hundred years from now that a child of six, mentally and physically, will be equal to the youth of eighteen of today.

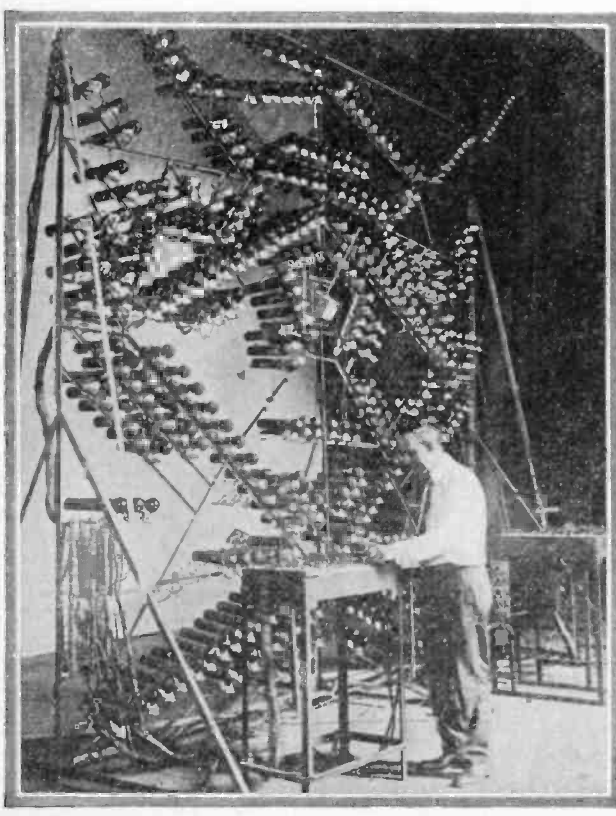
(Continued on page 61)

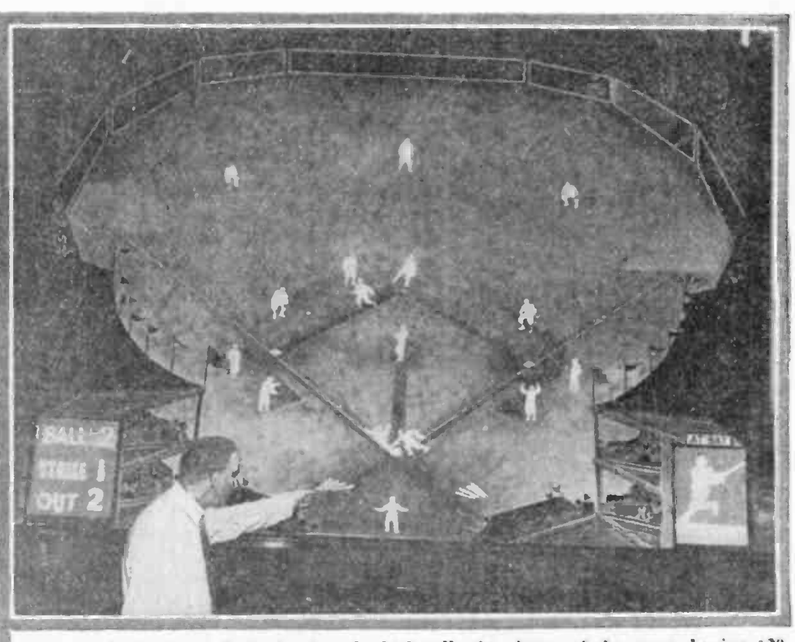
Airplane Night Advertising

A new version of night sky advertising by airplane—smoke writing for the day is succeeded by electric lamps for night.

OUR illustration shows the great advertising plane with its ten-foot letters, advertising the moving picture production entitled "The Iron Horse." The great letters can be seen at a considerable distance and while the exhibition is restricted of course to night work, the fact that it is independent of the condition of the sky, gives it a great advantage over smoke writing which is restricted to daylight hours. The latter to be impressive requires a clear blue sky.

Baseball Record Board





A wonderful baseball display board which tells the phases of the game, having 400 electric lamps and over three miles of wire.

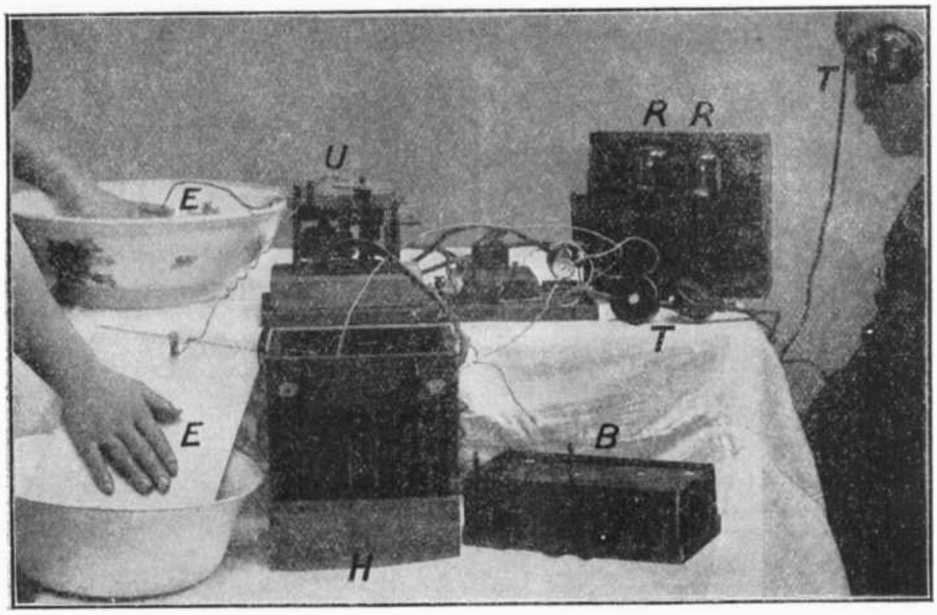
WE illustrate an apparatus, a baseball record or exhibition board, recently produced. It indicates with a sort of motion picture effect all the plays made on a baseball field during a match, each one almost at the instant it is made.

The apparatus is said to be one of the most delicate of appliances. It contains 19,000 feet of wire and 400 electric incandescent lights to indicate the movements of the players as they travel the bases, hit the ball, slide, catch, throw, etc.

Such details as the "winding up" of the pitcher, the curve of the ball and right or left hand batter or pitcher are all said to be shown; even the umpire has his decision exploited.

Hearing Muscular Action

By Dr. Lilienstein



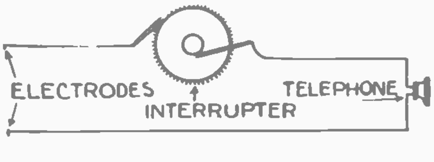
The hands are pressed on electrodes in basins of water (E, E) with a little salt dissolved in it. (B) is the battery to produce the current, (R, R) are vacuum tubes, (T) the ear-phones, (U) the interrupter mechanism, (H) the filament battery. The clenching of hands modifying the heart action gives a characteristic sound.

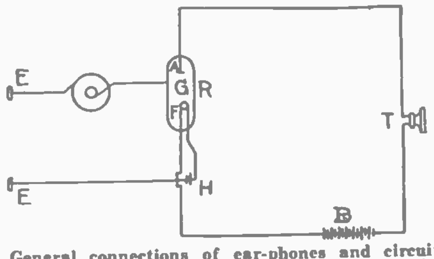
ALREADY since Galvani's discovery of the operation of the electric current on the muscular system of frogs, the question of the electric processes in living men, in animals and recently even in the tissue of plants has not been settled. With every new step in the direction of progress in the electrical field the methods of research and the line of investigation have changed.

Today we regard as the field of these electric processes the fluids of the body with the electrolytes in solution therein, whose ions in the cell and nuclear membranes develop a potential as they pass with varying velocity through the membrane (the ion sieve).

Such currents are developed in especial strength through the action of the muscles, glands, nerves, etc. These are therefore called "action currents."

Such small electric potentials and currents can be shown with a very delicate suspension galvanometer. Formerly they were known to various physiologists (Dubois-Reymond, Hermann) under the name of "negative charge." The currents going out from the heart and from the muscles when in action (Fig. 1) were especially the subject of scientific investigation (Boruttau, Einthoven, Kraus, Nikolai and others).





General connections of ear-phones and circuit breaker or interrupter, letters corresponding to the upper illustration. (G) is the grid.

In every muscular contraction and also in every movement of a heart muscle there occurs a change in potential which can be transmitted by a conductor and indicated by a suspension galvanometer. In the electric organs of the electric eel these currents are also evident.

Fig. 2 shows the heart action of a subject of heart disease. Normally the heart action produces a current represented by the curve of Fig. 3 in general.

These investigations, which from the surgical standpoint are of great importance, hitherto have been carried out by a large, expensive and extraordinarily sensitive instrument, one which is not even portable, the suspension galvanometer, with sensitized photographic film. A motor turns a cylinder carrying the film. This is certainly one of the reasons why it has found no greater favor in the general surgical practice.

With the extensive introduction and the frequent use of the audion or vacuum tube, and the loud talker which has been brought about in the last few years as radio has been so extensively taken up, it seemed very natural to use the appliances for the recognition of bio-electric currents. Nevertheless I find in medical literature up to 1919 no suggestion of such a means of investigation.

So I made the very simple experiment of "hooking up" a human body at a broadcasting station in place of the antenna. A soldier dipped both hands and the lower arm in two separated wash basins filled with salt water. To these basins I led both wires, that originally served as leads to the antenna and for earth connections.

To my great joy I at once heard the expected rhythmic tone developed from the heart action-current. Also the necessarily accompanying hum of the muscles could be heard as I made the soldier clench his fist while under the salt water.

This experiment and its result made it at once clear to me that here a new road for physiological investigation was opened up. I naturally was well aware of the difficulties which had to be overcome, to know the meaning of each individual sound. But I compared these difficulties with the bewilderment with which the unlearned examine objects in the microscope to get the meaning of the quantity of manifold objects on the stage.

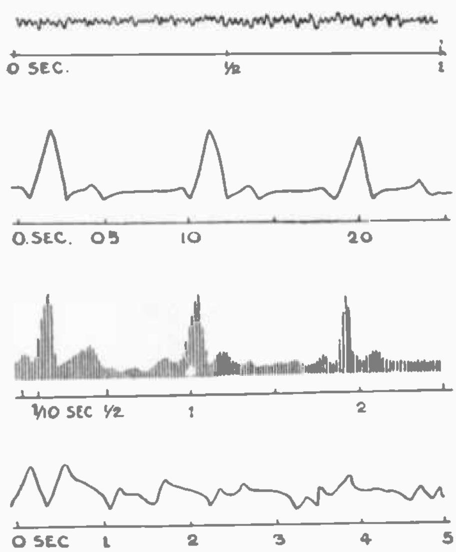
For further investigation I put together an apparatus, the following description of which will be clear to everyone who has busied himself with wireless telegraphy.

The electric potential or current due to human, animal or plant organism is to be changed into audible tones with unchanged pitch but with rising and falling strength of sound. This feature is attained by subjecting the current to be investigated by a quick-acting circuit breaker, for instance a "tikker," and leading it to a telephone. Between the telephone and the circuit breaker, which is a simple rotating toothed-wheel with a wire contact resting upon it, there can now be connected a vacuum tube as sound amplifier.

While, for instance, the simple variation in the heart action current (Fig. 1) cannot make itself heard in a telephone, because this variation has a frequency of only 70 or 80 a minute, by connecting the circuit breakers (Figs. 2 and 3) a definite tone of 300 to 500 periods of vibration per second is clearly audible. The current caused has its graph represented here. The arrangement of the whole apparatus is shown.

For the meaning which appertains to electric processes in the human body for its physiology and pathology and its influence on therapy, it is only necessary to indicate the great number of questions now to be settled therein.

When we realize that movements of ions and electric manifestations occur not only in heart and muscle action but also in the activity of the network of the nerves, in the operations of the glands, and in all functions of life, such as sleeping, breathing and digestion, etc., it follows that the field of investigation is enormously great. We must succeed in making the individual processes of life audibly distinguishable to the ear and to point them out. It may come about in time that man with the help of the vacuum tube will not only literally hear the more important processes of life in human and animal organisms, but also will hear the "grass grow."—*Translation from Die Umschau, Dr. Bechhold, Editor.*



These illustrations show various curves or graphs of the currents produced by heart action of the subject. The muscular actions of clenching the fists and the like give similar interesting results.

Historical Experiments

I

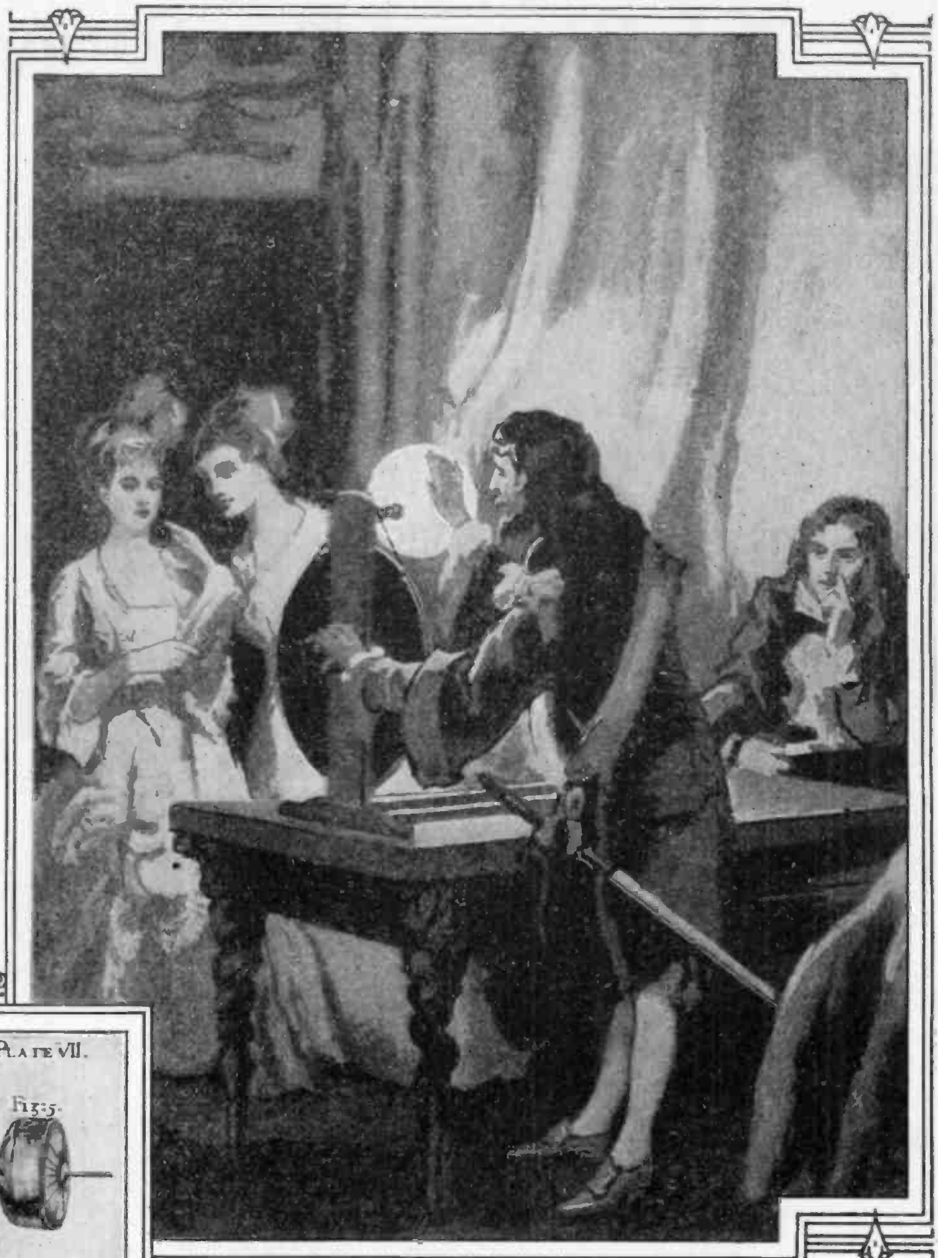
The Frictional Electric Machine

IN ancient times static electricity was generated by rubbing amber with a woolen cloth. Otto Von Guericke, the famous Burgomaster of Magdeburg, although greatly engrossed in the phenomena of atmospheric pressure, gave much thought to electricity. He discovered, probably without knowing it, that sulphur is perhaps the best of all substances for receiving static excitation. He cast sulphur into large balls or spheres; through which a shaft passed. The balls were mounted so as to be rotated and were rubbed with the hand.

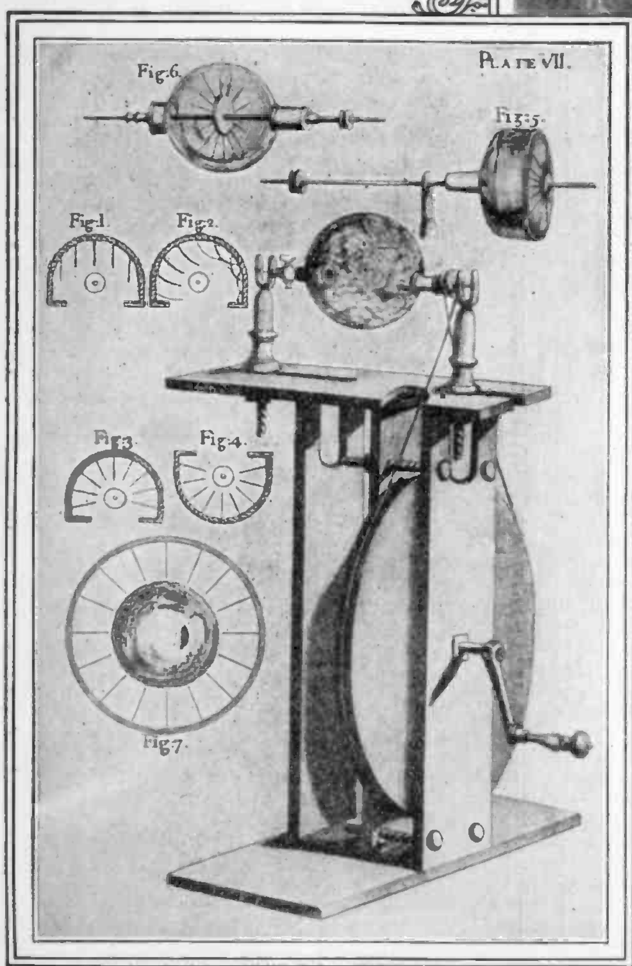
The large illustration gives an interesting version of the experiments at court, The ball of sulphur will be seen about at a level with the experimenter's head, and turning the handle of the multiplying gear, it was whirled around at high velocity, and the experimenter's hand was held against it so as to develop excitation and from it slight shocks were produced.

A very interesting experiment by Von Guericke consisted of the excitation of a ball of sulphur on the end of a stick. Getting this charged with static electricity he caused it to drive a feather about through the air.

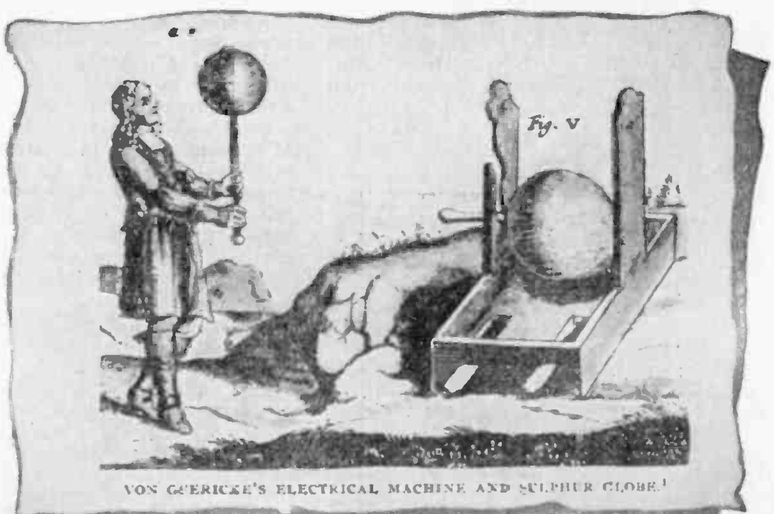
Almost contemporaneous with Von Guericke but a little later was the English experimenter, Francis Hauksbee. He substituted glass for sulphur and whirled his glass globes at high speed of rotation, observing the effects upon threads in the way of attracting or repelling them.



Exhibition of Otto Von Guericke's (C. 1602-1686) sulphur ball frictional electric machine in high circles. Electricity was a password for admission to the court in his day, as it proved to be in the days of Benjamin Franklin in Paris and in the French courts.



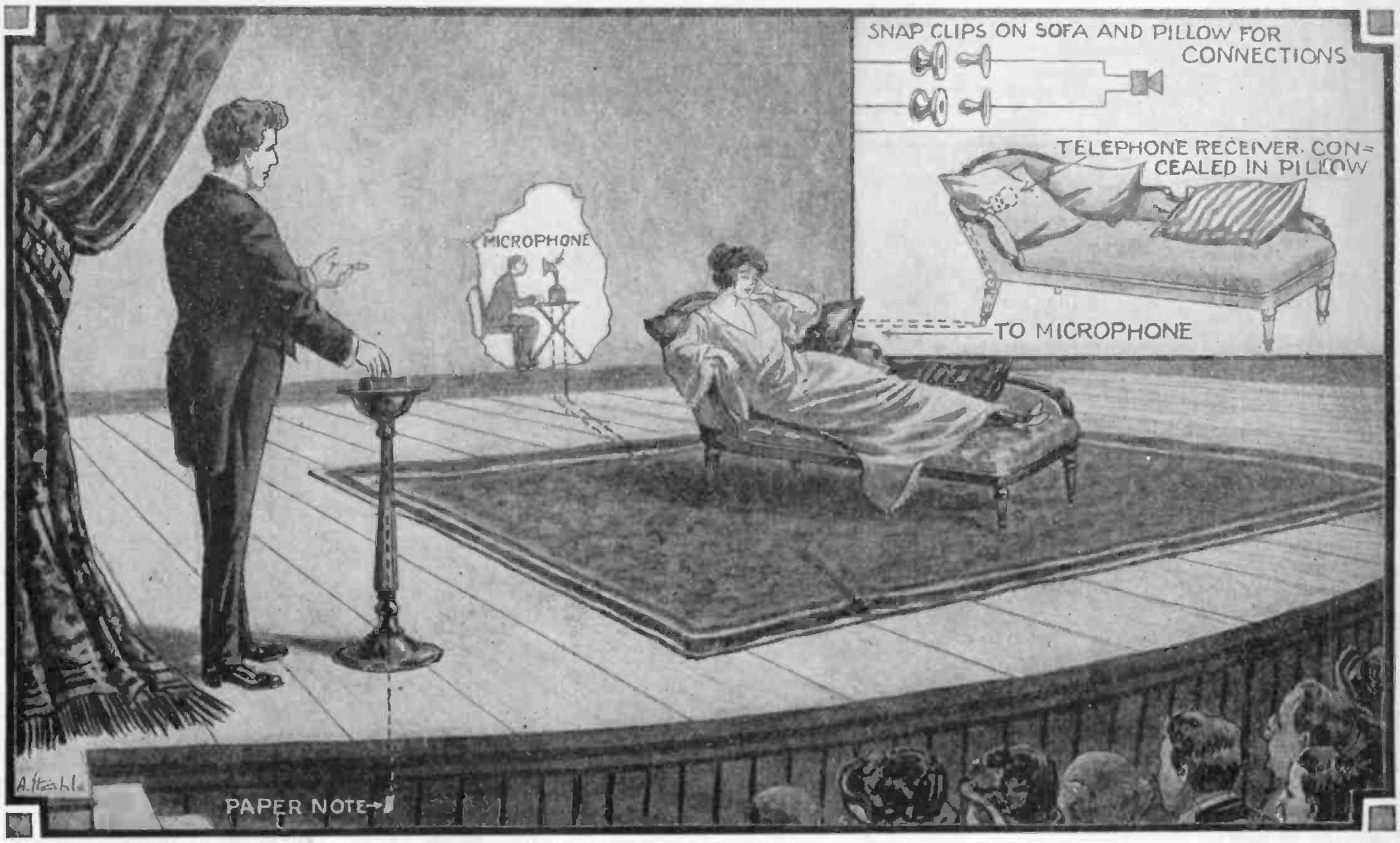
Hauksbee's machine made of glass and showing the action of the excited substance upon threads. Of Hauksbee little is known beyond his celebrated book. He is supposed to have died in 1713.



Here the primitive frictional electric machine with no multiplying gear is shown, and the experimenter, carrying an excited ball of sulphur, is driving a feather about through the air.

Madame X the Wonder Girl

By Robert Grennon



Mysterious second-sight; the lady on the sofa answers the most recondite questions enclosed in envelopes by members of the audience. It is a successor to the old-time second-sight.

"MADAME X will answer any question that you have in mind."

Seeing this advertisement recently in one of our local papers, I came down to the theatre that night to see what it was all about.

Now Professor Y was on the stage claiming that Madame X would answer any question, providing you write it on a piece of paper (any kind), add your name and address and also put your initials on small envelopes, which were furnished by the Professor himself. He then would put them all in a tray on the stage and come back among the audience.

Madame X—comfortably seated and covered with a white cloth to prevent the lights from disturbing the work of her mind (and to enable her to see the audience and the latter not see her)—would name the initials of somebody in the audience, who had to raise the hand to show his presence, and she would answer the questions he wrote on the paper very satisfactorily.

The Professor once in a while would interrupt her, saying, "This gentleman here would like to know his birthday," and the answer was always correct. Everybody was astonished at Madame X's wonderful power, and so was I until I discovered the trick.

Now here is the trick. When putting the envelopes in the tray on the stage, these envelopes fell down under the stage floor (everything was fixed, as you can see). Then the contents of these envelopes were inspected by a third person behind the back curtain, and this person would communicate the initials, questions and so forth to Madame X through the aid of a microphone, the receiver concealed in the pillow. Then the work of Madame X consisted in giving clever answers to those questions, which she got not by reading through the minds of the audience, but simply by the microphone.

Interesting Articles to Appear in December Issue of "The Experimenter"

Making a Radio "B" Battery
By Dr. E. Bade

Socket and Switch Testing Machine

Electrical Voice Investigation

Radio Frequency Circuits
By W. L. Pearce

Experimental Short-Wave Receivers
By A. L. Groves, 3 B1D

Superdyning the Reflex
By R. Washburne

Experimental Heterodyne

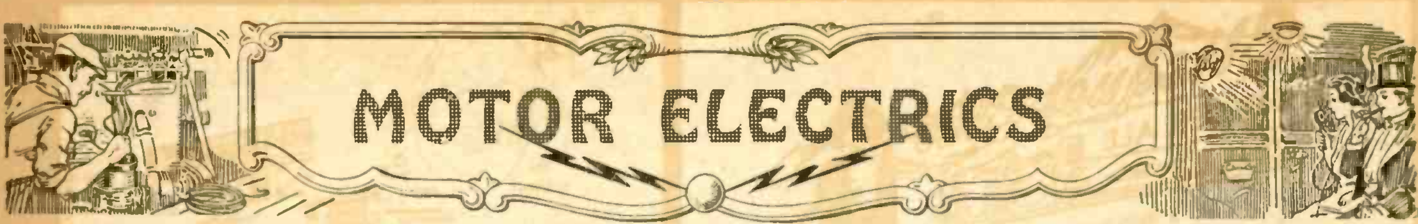
Filtration and Crystallization
By J. Edmund Woods

Now in the tray on the stage there was another package of envelopes left so that the Professor could persuade the audience that the envelopes containing the questions had not been removed. And to guess somebody's birthday, the Professor would go to somebody, ask him for his birthday (the audience could think that this somebody wanted Madame X to guess his birthday and was asking the Professor for that). Then the Professor would say: "Madame, this gentleman here would like to know his birthday." And the Professor, through a clever motion of his fingers, would tell Madame X that the gentleman's birthday was the fifth month of the year (five with the fingers), and the date the third. So Madame X would answer correctly May the third, and so on.

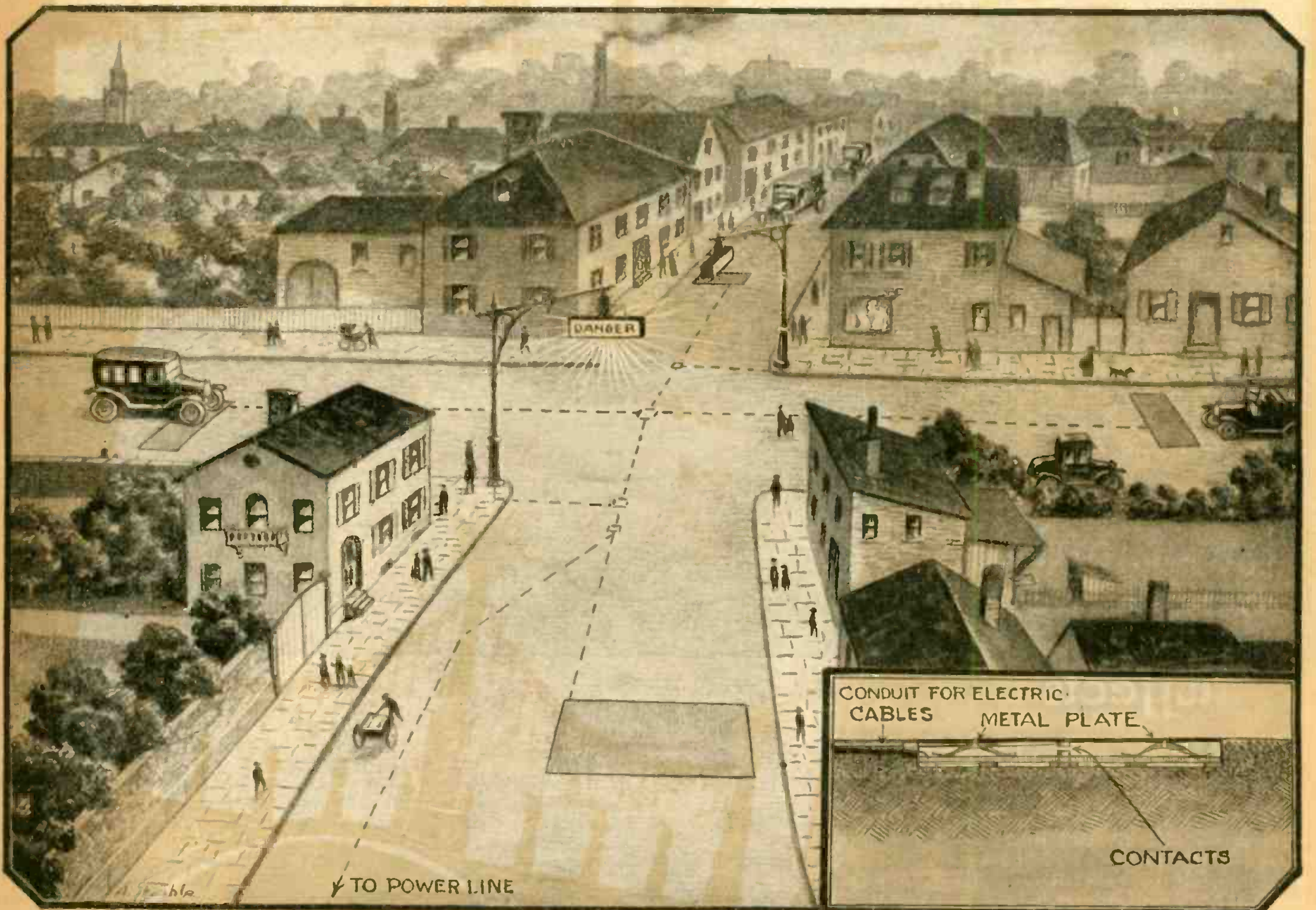
Many years ago in this city a celebrated magician excited much attention by his exhibitions of second-sight. His assistant on the stage, a lady performer as in this case, answered questions, such as "What do I hold in my hand?" "Can you tell me the number on this piece of paper?" The articles asked about and the questions all came from members of the audience, so there was no possibility of the questions and corresponding answers being learned by heart. The most out-of-the-way things would be produced and no failure was ever recorded.

The system was a purely mnemonic one. The form of the question, the change in order of its words, perhaps the initial letters, all meant some specific thing.

It must have been a heavy strain on the memory of both performers. Here in the system presented above electricity does the work. The receiver is hidden, and the deception is perfect and complete.



Electric Cross Road Signals



The latest evidence of electricity in the service of safety is this electric alarm at road crossings. Experiments performed at a dangerous crossing have proved decidedly successful. The pressure of the automobiles on steel plates set in the road a good distance from the crossings rings the alarm and flashes an electric sign, warning drivers on the other road of the approach of your car.

IT seems that no matter how many danger signals and signs are placed at cross roads and railroad crossings accidents do happen, and whether they are due to improper warning signs or carelessness of the drivers or both is hard to tell. Usually no accidents happen at the most dangerous places, as drivers are extra cautious when passing them. This no doubt accounts for the old story of a traffic cop who removed a danger sign from a bad curve because that sign was in place several years and no accidents happened. The worst accidents usually happen at the least dangerous and unexpected places.

As a positive warning to automobilists near Bordeaux, France, the Frenchmen have installed automatic electric danger signals. Up to the present these devices have given good results. The two crossings chosen for the experiment have been the scene of many accidents, but since the electric signals have been installed some months ago no accident has happened.

The apparatus is entirely automatic. It is operated by the passing automobiles. The weight of the car passing over a metal plate in the street depresses it, thereby closing a circuit and operates the signals. The signals flash instantly in front of the car and warn the driver of a dangerous crossing and at the same time another signal facing in the opposite direction warns cars passing along the cross-street. At night the signals are illuminated, and remain so for several seconds. Plenty of time is allowed for the driver to slow up or stop after passing over the metal plate before reaching the crossing.

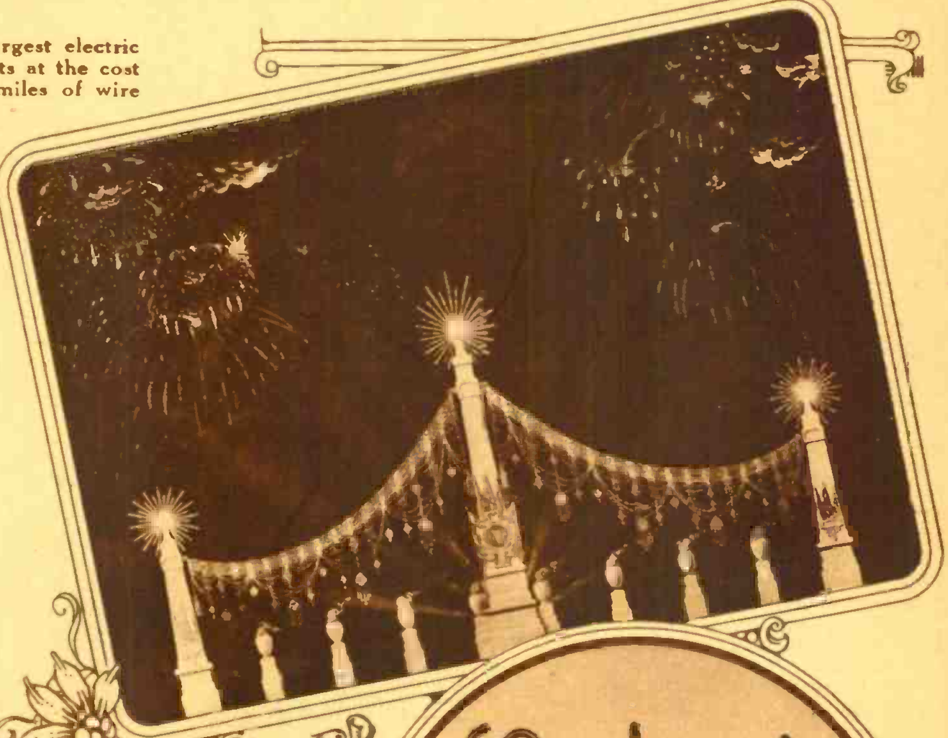
The illustration shows the metal plates in the streets. Four are used at each crossing and placed at the right-hand side of the road. Both signs are operated when a car passes over any one of the plates.

The advantage of this apparatus is that the signal catches the eye of the automobilist by its sudden appearance in front, whenever a car passes over the contact plate. The word "Danger" flashes in front at a sufficient distance to give him time to slacken speed, and a similar sign appears on the transverse road, warning anyone approaching from that direction.

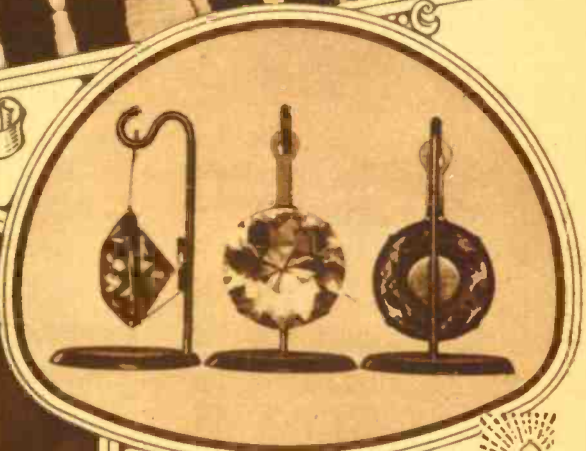
The experiments at Bordeaux have been found inexpensive and the system is likely to be used in other parts of France, especially at crossings in villages and small towns.

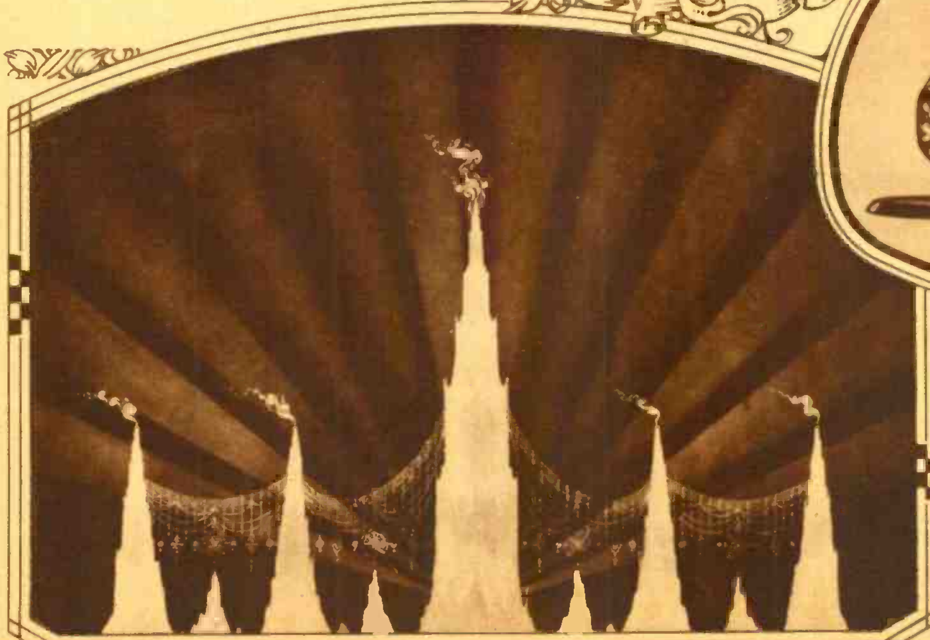
There is plenty of "ginger" in the largest electric sign on Broadway that achieves its effects at the cost of 19,000 lamps supplied through 21 miles of wire and with the consumption of over 300 horsepower. It is over 200 feet long. The jovial smoker of Prince Albert tobacco at the right is burning 2,775 electric lamps and using about 60 horsepower.

Spectacular Electrical Effects



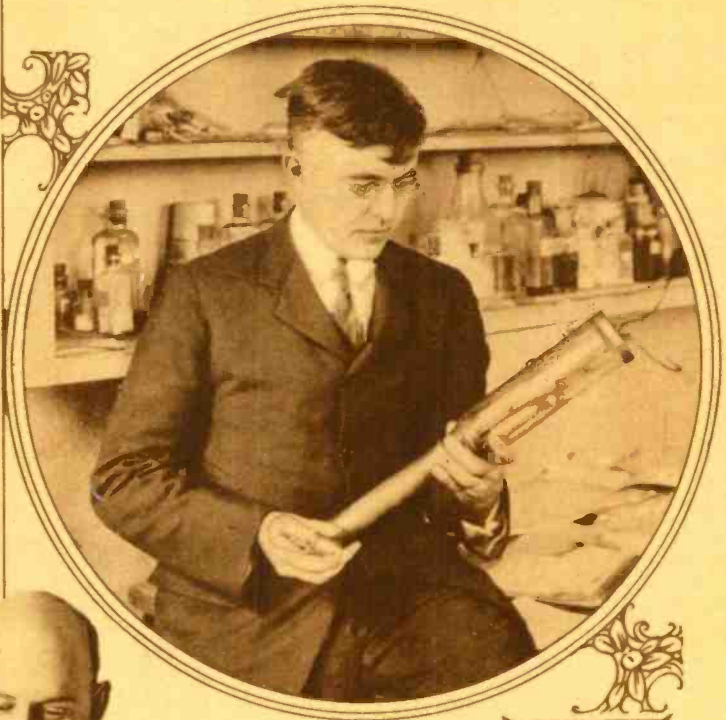
All the jewels of the Arabian Nights could not equal these galaxies produced at the State Fairs in Syracuse, N. Y., and Brockton, Mass., by the display of 30,000 cut-glass crystals in each design, illuminated by electric flood light.





Views of the crystals used in the Syracuse and Brockton State Fairs. It cost $150,000 to produce 30,000 of these carefully cut and hand-polished trinkets. The realistic effects of huge diamonds are accomplished through the refraction and internal and external reflections of the special glass used in their making.

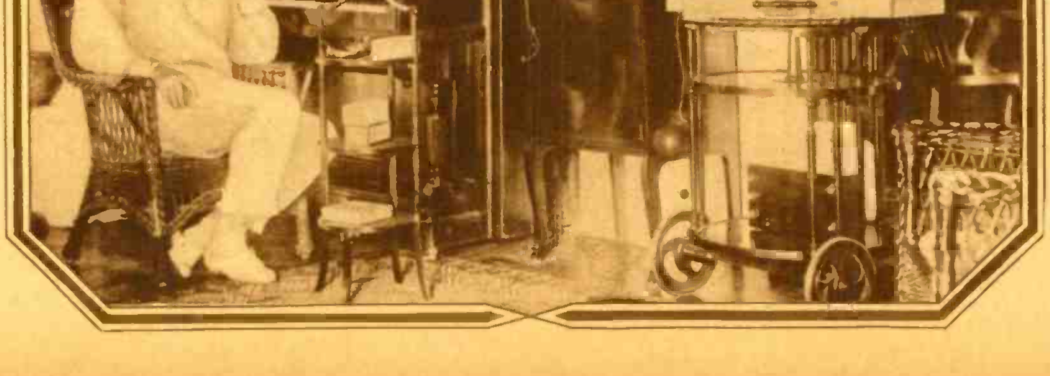
What Experimenters



Underground and undersea radio communication has been experimented with by Dr. James Harris Rogers of Hyattsville, Md., where he has a well 15 feet deep in which he places his antenna. The well is encased in copper at the upper part, to cut off sliding waves.

"Harnessing the electrons for heavy duty," is the keynote of Dr. Irving Langmuir's recent experiments in high power vacuum tubes, such as the 20-kilowatt tube shown above. Marconi predicts that these tubes will replace the gigantic alternators now used for long distance work.

A voyage to the moon — once a dream — bids fair to become a reality — but there will be no passenger. Professor Goddard has developed a high altitude rocket at Clark University which, some think, promises ultimate success in overcoming gravitation and conquering inter-stellar space.

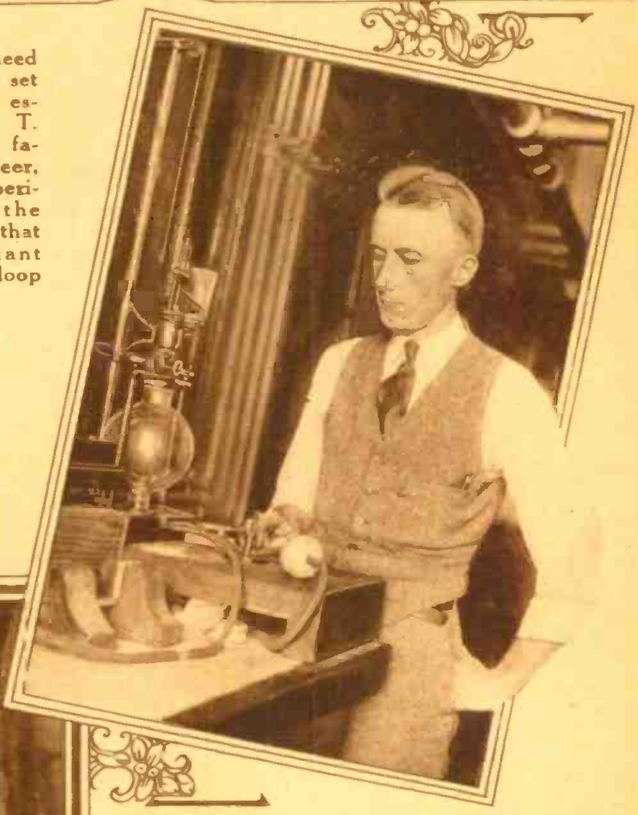


Professor Reginald A. Fessenden has invented a receiver which brings into use the piano and violin. He gets rid of disagreeable noises and it is said to be free from static and from interference. Our experimenters should try to do this.

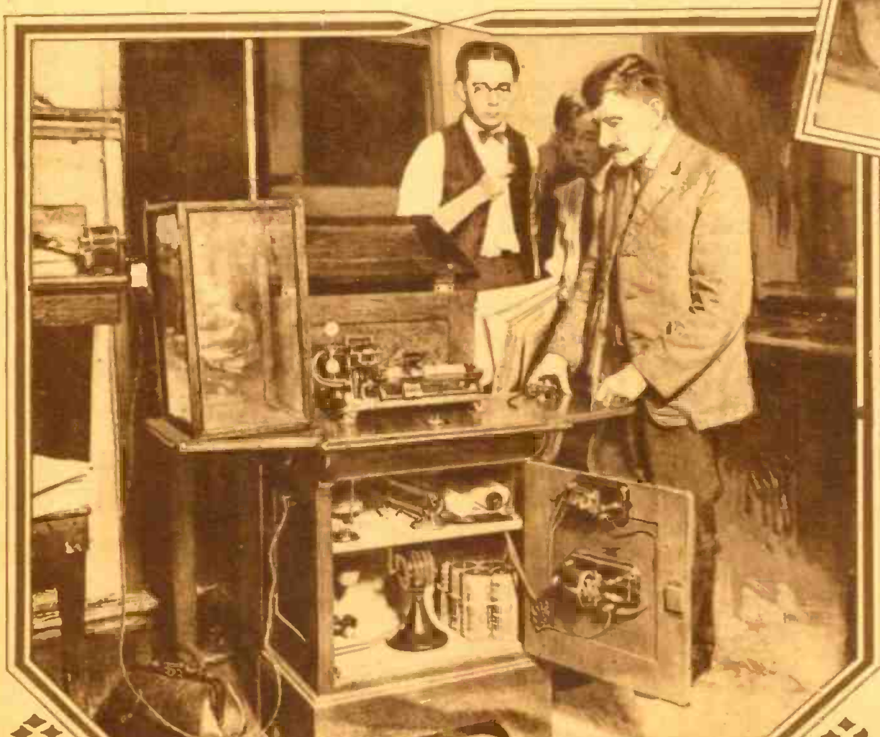
Are Doing

No radio fan need spurn a one-tube set after the record established by B. T. Flewelling, the famous radio engineer, shown above experimenting with the one-tube set that picked up distant Wales on a loop aerial.

There is a Japanese species of the radio bug! And New York is exhibiting its appreciation of it in the person of Hiroshi Ando, one of the early Japanese radio students, who is shown above experimenting with his latest radio invention, to be exhibited at Madison Square Garden, New York.



Explosive quality of dust-laden air forms the object of the important experiments of Professor H. W. Levert, chemist of the U. S. Department of Agriculture. The frequent occurrence of explosions in flour mills due to ignited dust make such investigations imperative.



A form of telephotography was achieved twenty years ago by F. A. Hummel of St. Paul, Minn., with the device shown at left, upon which recent experiments resulted in the successful transmission of photographs by telegraph.

" 'All six of you doped?' 'All of us, Mr. Boon, and what's more—it looks like everybody in the district had been doped——' "

The Ark of the Covenant

By Victor MacClure

CHAPTER ONE

The Coming of the Mystery

I

A HAND was laid on my shoulder. I woke up. My father stood by my bedside, with that in his look which drove sleepiness out of me and brought me quickly to my feet beside him.

"What's the matter, dad?"

"The bank, son," he said, quietly—"the bank has been robbed. How soon do you think you can land me at the Battery?"

It was all I could do to refrain from spluttering out a string of questions. Had it not been for the grimness of the old man's expression, I should have thought then that he was walking in his sleep. But there was no mistaking that he was clean awake and in deadly earnest.

What I did was to put a hand under the pillow for my watch. I said nothing. I was not going to be beaten in coolness by my own father, but I did some quick thinking. My roadster was in the garage, so the five miles between the house and my hangar on the beach was a small detail. I had to decide at once if I should risk taking the old man across Long Island on the only machine I had ready for the air that chilly morning. This was an ancient seaplane, built in 1925, and now held together by pieces of string and tin tacks. In a series of experiments on stability I had pared her wing area down to the absolute minimum, and she asked for a deal of handling.

WITH this issue we are beginning one of the most interesting and daring scientific fiction stories that we have ever ran. Only a few weeks ago Major-General George L. Squier, before a meeting of world-renowned scientists attending the Century Celebration of the Franklin Institute at Philadelphia, prophesied that in the next war "there would be used a new war engine capable of anesthizing a whole country with gas that would put the entire population to sleep for 48 hours."

Mr. MacClure in this narrative has anticipated not only this, but many more important future discoveries. He also shows us what the diabolical ray may do to us during the next few years.

This story will run during the next ten months. There will not be a single installment that will fail to keep you interested. It is one of the great stories of the year and we heartily recommend it to our readers —EDITOR.

As I reached for my watch, I kept my eyes on my father's face. It was as placidly grim as could be, but I saw that he was betting on me to get him over to his old bank in quick time. So, almost before I had seen on my watch that the time was half past six, I had decided to risk his neck and mine on the ancient bus.

"Get the hangar on the phone, dad," I told him. "Ask Milliken to warm up the *Sieve* right away, and have her run out in less than ten minutes. Then put on some thick clothing, while I get into overalls and pull out the roadster. You'll find me outside. I'll have you at the Battery inside forty minutes."

The old man took his orders like a soldier.

"The *Sieve*," he repeated. "Right!"

Off he went, while I got into my flying kit. I went down to the garage, and had the car out on the drive with her engine turning over prettily before he joined me again.

"Good man, that mechanic of yours, son," he grunted in approval; "doesn't waste time in talk——"

Once out on the turnpike, I let the car full out, and we were alongside the hangar well inside ten minutes. Milliken already had the old seaplane in the water, and when I saw afresh how stubby her wings were, I had to stifle my misgivings all over again. She looked terribly inadequate to carry the only father I have. But before I had time to express my qualms, even if I had wanted to, the old man was out of the car and down on the jetty. With a nod to Milliken, he climbed into the cockpit, and there was nothing to do but follow him.

The Seaplane

Milliken swung the propeller to contact, and I knew at once that, however patchy the structure of the *Sieve* might be, her heart was as sound as ever. The note of her engine was good to hear. When I felt the strain was right, I dropped the signal to the mechanic. Milliken released the patent mooring, and we shot out to sea with a muttered "fluff-flufter-fluff!" from the floats, as of big pebbles skimmed over the water. Then I pulled the stick, and the old bus took to the air like a bird. I let her climb east just far enough for the turn, then swung her into a dead course for the New York Battery, a hundred and thirty kilometers away.

It was the first time my father had flown with me, though I must say he had always shown an interest in my aeronautical research work and, before the sale of a few patents of mine had made me independent of him, had always been ready to dip his hands deep in his pockets to help me. In the years since the European War, where I suppose as a cub flyer I got the flying germ into my blood, my father had never tried me out as a pilot, and I had often wondered what opinion he had of me. But as I thought, that gray March morning, of the certainty with which he had depended on my help and of the way he had gone about the business, I couldn't help growing chesty as I realized how clearly he took my skill for granted.

As soon as we were properly set on our course, I took a look back at the old fellow. He was sitting humped up in the passenger's seat, with only his eyes and the tip of his nose showing through his voluminous wraps. A grim calm was eloquent even in those features. He caught my eye when I looked back at him, and he nodded serenely. I don't know how it was, but it dawned on me just then that I had a large-sized affection for my sometimes irascible sire, and I turned my attention to getting all I could out of the old bus for him. We flattened out to a nifty two hundred and fifty kilometers the hour.

I hadn't wasted any of the old man's time by asking him questions, but I'll confess that the robbery of the bank had roused in me a lively curiosity. The roar of the unsilenced engine put all conversation clean out of possibility, and I did not want to have him unwrap in that cold rush of air to put on the headpiece of the phone. So I had to keep mumchance and speculate about the affair.

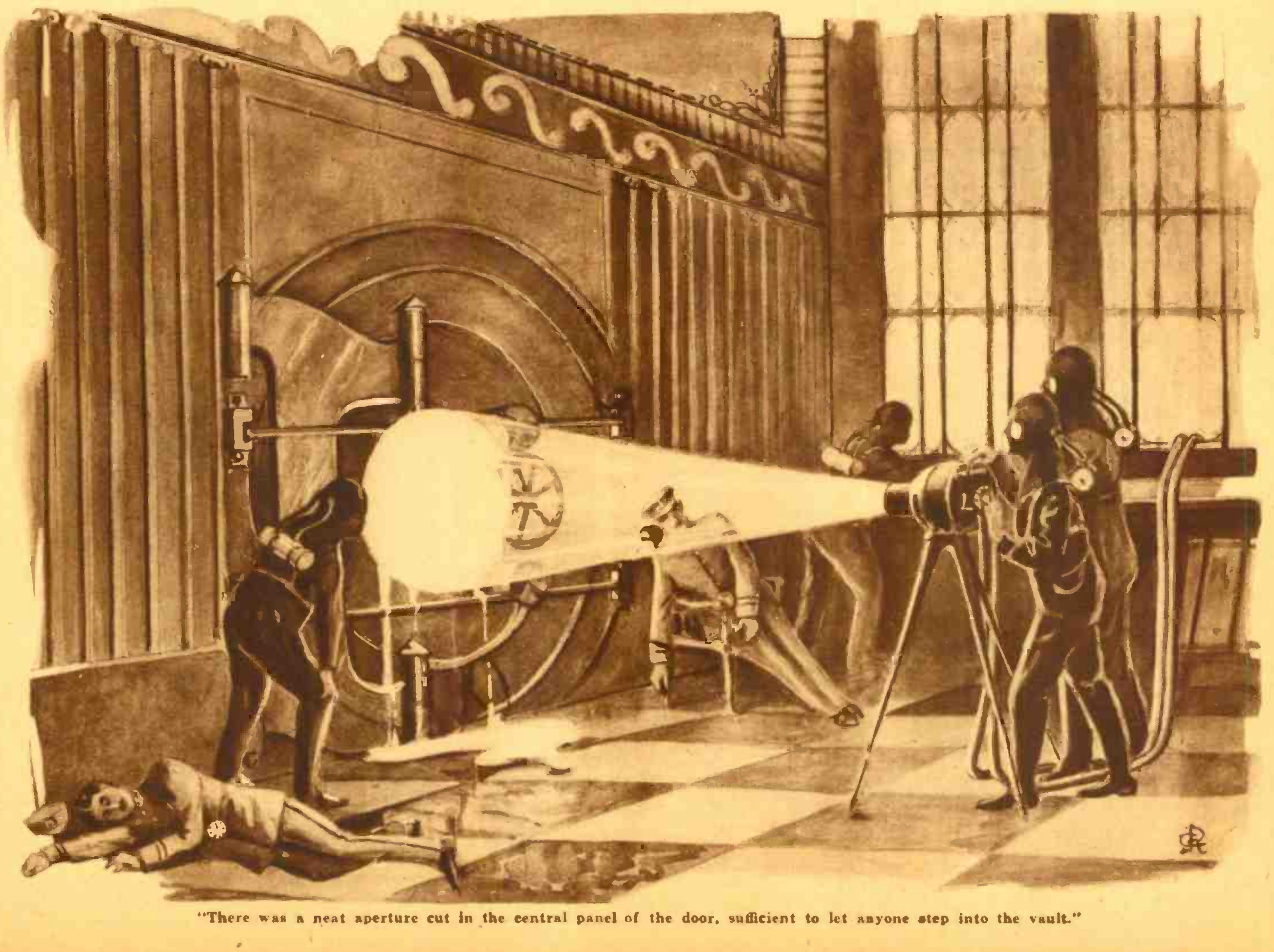
The Motive for the Trip?

There was enough material for speculation. The premises of the National Metallurgical, of which my father was president, were generally believed to be absolutely burglar-proof. The building on Broadway was comparatively new. Its safes and strong-rooms were supposed to be the last word in appliances for the thwarting of cracksmen, and the president was immensely proud of them. Altogether, I came to the conclusion that this sudden flight toward the Battery and Wall Street was the result of some swindle by a forger or by a dishonest official, rather than of burglary. I knew it must have been something big to put the old man in such a hurry, but I was far from realizing then, with the old *Sieve* flattened out and roaring above the misty trees of Long Island, just how big a thing I was headed for. My father has since admitted that at the time his conception, too, of what the future held came little nearer the truth than my own.

I must explain at this point in my story that what I write in the following pages can only be a personal version of a bewildering run of events that have since become history. I had the luck to be close to many of these happenings from the start—as the world saw it—and also to be in at the death. This must be my excuse, if any is needed, for trying to put together a connected story of what befell in a quick-moving and epoch-making period of six months. Nobody will deny that for this space the world was badly scared, and, now that the terror is past, and everybody breathes freely again, I can do no harm by telling what I know. I may even do a little good. The flight with my father that chilly Monday morning in March was the beginning of my participation in a conflict that for clash of intellect, mystery, romance, and far-reaching consequences has made the World War of 1914-18 look by comparison like a rough-and-tumble in a back street.

As we droned along above the island, I had little but my thoughts to occupy me. The seaplane was behaving splendidly, and I had none of the trouble I had expected with her, if I leave out a little maneuvering that came when we hit a pocket in the air. In about twenty-five minutes Woolworth Building loomed upon the horizon, dead ahead, and I swung a point or two south, so that its shape fell on the starboard bow. Next minute I had circled and was dropping northerly into the upper New York Bay, with Battery Park in front. Under forty minutes after

(Continued on page 58)



"There was a neat aperture cut in the central panel of the door, sufficient to let anyone step into the vault."

The Radio Controlled

By Hugo Gernsback.

LAST year on a visit to Washington the writer visited the laboratories of C. Francis Jenkins, the well known experimenter of international reputation. It was Mr. Jenkins who perfected the shutter that made our present day motion pictures possible. He was paid over $1,000,000 for this invention.

Of late he has been experimenting with television and has already obtained astonishing results. At the time of the writer's visit Mr. Jenkins demonstrated his television machine before a number of Government representatives, including the General of the Signal Corps. At that time the writer actually saw his waving hand projected by radio over a distance of some 30 feet, the shadow of the waving hand being transmitted to a screen at that distance. Every motion made by the writer's hand was faithfully reproduced on the distant screen. Opaque substances, such as a cross, knife, pencil, etc., were also successfully transmitted and projected by the Jenkins Television machine. While admittedly in a crude state, the machine will no doubt be developed and it is the writer's opinion that within two or three years it will be possible for a man in New York to listen over his radio to a ball game 500 miles away and *see* the players on a screen before him at the same time. Whether it will be the Jenkins machine or some other machine that will achieve this result is of little consequence. The main thing is that experimenters all over the world are working frantically on television and sooner or later the problem will be solved.

An entirely new age will then be opened up and it is not necessary for the writer to expatiate at length on this phase as it has been exploited by him in his past writings and by others for some time.

In this article we concern ourselves with the radio controlled television plane which will come into being immediately the minute the television problem is put on a practical basis. It should not be construed that the radio television plane is merely a monstrous war machine, but it also has its uses during peace time, as will be explained. At the present time it costs much effort, time and aviators' lives in order to train our perfect flyers.

A radio controlled airplane has already been demonstrated by the French Government, and it flew for a lengthy period without anyone on board. The entire control was from the ground while the machine was aloft. The plane arose, cut figure eight's, volplaned, ascended, descended and went through all the ordinary evolutions, the control being entirely and solely by radio. The same kind of a machine is also being experimented with successfully by our own Government and it may be said therefore that the radio controlled airplane has passed the experimental stages and has become practical.

But the great trouble with radio-controlled airplanes is that the operator must see the plane. If his machine were to make a landing at a great distance he might land the airplane on top of a building or in a river, or it might collide with a mountain.

A Plane Which Sees

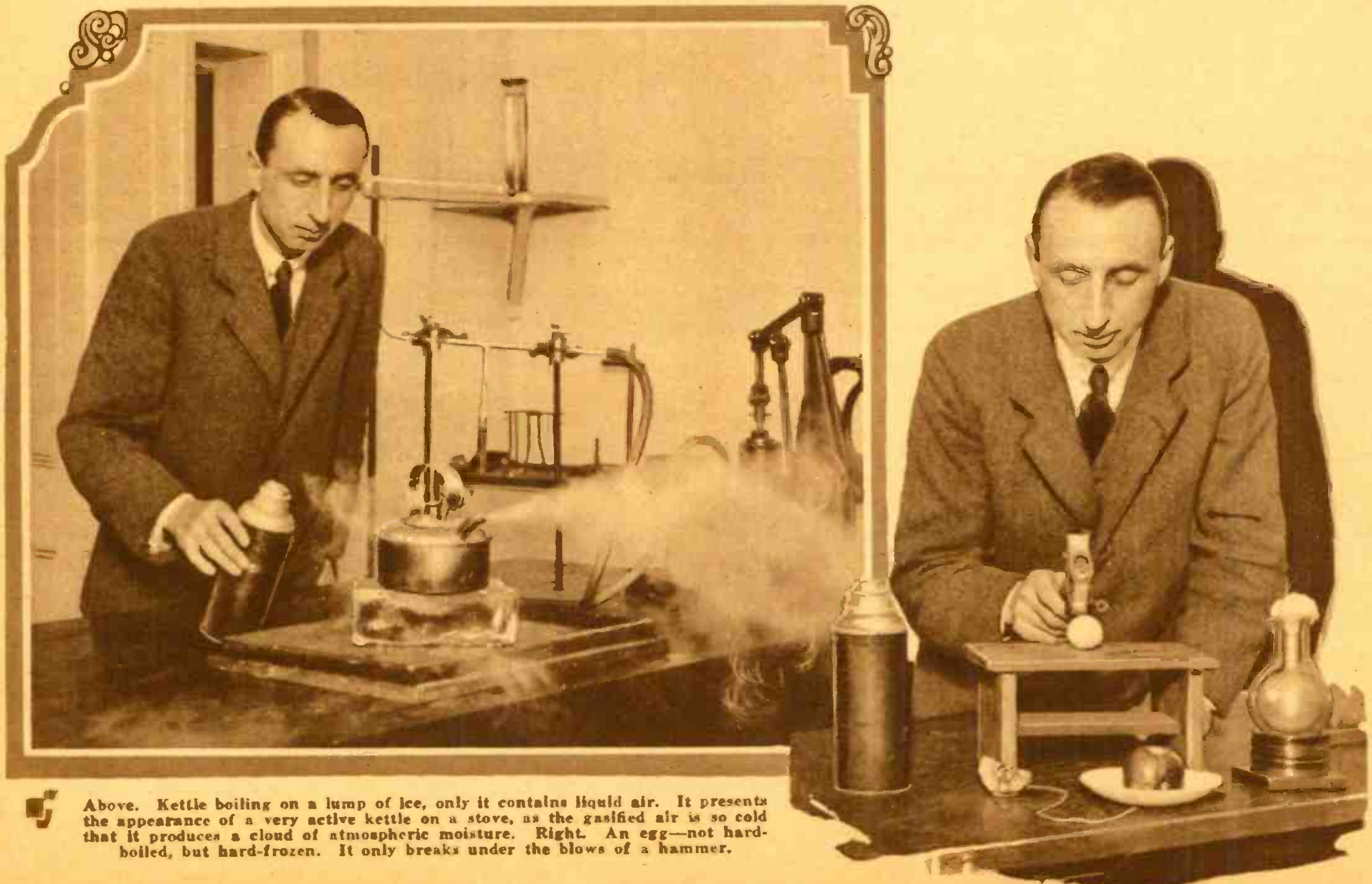
Imagine now a radio controlled airplane also being equipped with electrical eyes, which eyes transmit the impulses—or rather what these eyes see by radio—to the distant control operator on the ground. Our illustration on the opposite page, which shows a war machine, depicts this phase. Here we have a radio controlled airplane equipped with a number of lenses which gather in the light from six different directions, namely, north, south, east, west, up and down. The impulses are sent to the operator on the ground, who has in front of him six screens labeled north, south, east, west, up and down. Each screen corresponds to one of the electric eyes attached firmly to the body of the airplane as shown in the illustration.

Let us now see what happens. The airplane is started from the ground and is sent over the enemy territory. During every second of its flight the control operator, although 50, 100 or 500 miles away *will see exactly what goes on around the plane just the same as if he himself were seated in the cockpit*, with the further advantage that sitting before a screen he can take in six directions all at once which no aviator can do. If for instance an enemy airplane suddenly comes out of a cloud and starts dropping bombs on our machine below, the control operator sees this enemy machine quicker 500 miles away, than if an aviator sat in the cockpit one-quarter of a mile away from the enemy bomber. The control operator will immediately disengage a smoke screen from his radio television machine, hiding his craft in smoke. He can also make it turn about if such operation should be necessary, or he can increase its speed if it is desired to escape.

If he outdistances, or otherwise eludes the enemy, the radio controlled television airplane can then be directed to the spot

(Continued on page 62)

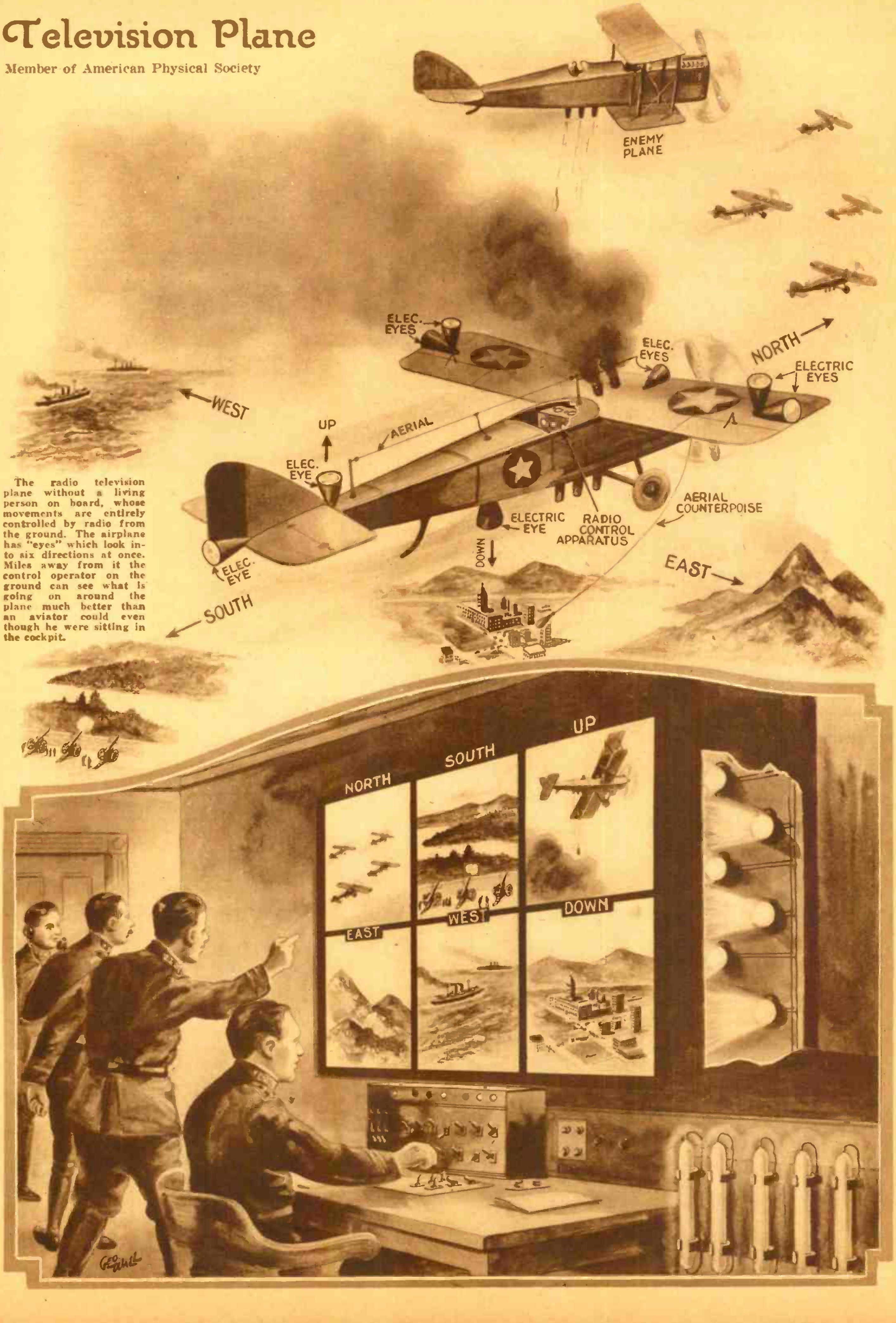
Wonders of Liquid Air



Above. Kettle boiling on a lump of ice, only it contains liquid air. It presents the appearance of a very active kettle on a stove, as the gasified air is so cold that it produces a cloud of atmospheric moisture. Right. An egg—not hard-boiled, but hard-frozen. It only breaks under the blows of a hammer.

Television Plane

Member of American Physical Society



The radio television plane without a living person on board, whose movements are entirely controlled by radio from the ground. The airplane has "eyes" which look into six directions at once. Miles away from it the control operator on the ground can see what is going on around the plane much better than an aviator could even though he were sitting in the cockpit.

Microphone Used in Water Finding

By C. A. Oldroyd

TO detect underground streams and hidden springs, an Australian scientist made use of very sensitive microphones buried in the ground. (Fig. 1.) A small pit was dug a few feet deep, and a board was placed at the bottom of the pit. A large hole was cut through the wood, and over this hole a sensitive microphone was placed.

To protect the apparatus from the soil, a deep box-lid was placed over the microphone, and the pit was filled up again with soil. Cables from the microphone led to a battery and to a set of head-phones. To locate the hidden springs, the operator listened in at night when there were no external noises.

The sound made by the running water many feet from the ground surface was conducted to the microphone and reproduced very much stronger in the head-phones. By trying several positions of the microphone, a place was soon discovered where the sounds were strongest, and here a well was dug or boring operations begun. A great many springs and underground streams were tapped in this fashion, although these experiments were conducted a long time ago, when instruments were not as sensitive as they are nowadays.

It is rather interesting to compare this system with the methods employed by the Indians to find water; they used to lie down on the ground and apply the ear to the earth, and frequently succeeded in finding water in this fashion.

A very much more sensitive and far easier handled instrument of the writer's design is shown above. A steel rod or tube is driven into the soil for a few feet, and to the top a receiver is attached. Manipulation is much facilitated, as the receiver part is detachable, and can be fitted to a number of rods which have been driven into the soil in advance. Neither can the driving-in upset the adjustment of the delicate microphone, for the receiver is only put in position after the rod has been driven down.

For portable outfits, and where low weight is of importance, a steel tube fitted with a hardened steel spike might be used instead of the solid rod. A sectional view of the receiver is also given.

The body of the receiver consists of a short length of steel tube which easily fits over the rod driven into the soil. About two inches from its bottom, a stop-piece is screwed into the tube, to prevent the receiver tube sliding down the rod.

On the left hand side of the receiver tube a sensitive microphone is attached by a brass strip; between tube and microphone body a rubber disc is clamped to cut off external noises. A small pin just touches the diaphragm of the microphone; this pin is carried in a flat spring secured to the stop piece. The flat spring can be brought nearer the diaphragm or further away from it by an adjusting screw passing through the tube wall.

The operation is exceedingly simple: First of all, the rod is driven into the soil, and the receiver is placed on the top. The microphone is then connected to the battery and the head-telephones and the pin is brought up to the diaphragm, by means of the adjusting screw, until a click is heard in the phones; that means until the pin just touches the diaphragm.

Afterwards, the operator listens in for sounds that might be caused by running underground water.

As the receiver is in metallic connection with the steel rod, the faintest sounds will be transmitted to the microphone, and heard with far greater intensity in the head-phones. Still better results might be obtained if an amplifier is incorporated in the circuit.

Such an instrument could be readily constructed by the experimenter, and might be used for other purposes besides water finding.

A suggestive example is given. A mine drift, driven close to the surface, has partly collapsed, imprisoning the workers inside. Without any delay, the best possible position for a rescue shaft is to be determined. For this purpose, the receiver is placed in various positions above the drift, and at numerous points the operator will hear the hammering of the imprisoned miners, attempting to signal to their comrades.

Where the signals are heard loudest, the receiver will be nearest to the imprisoned miners, and here the rescue shaft must be sunk.

If no complete apparatus is handy, a microphone alone might be used, and placed on the ground in various positions. In this manner, a simple rescue apparatus can be improvised in a very short time.

Another application is shown. A buried water pipe line has sunk and been broken, so that the water leaks out. The

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EXPERIMENTAL articles dealing with electricity, radio and chemistry. We pay 1 cent a word for articles of the usual type and as high as 3 cents a word for important or original articles that have not been described heretofore. Articles with good photographs particularly desired.

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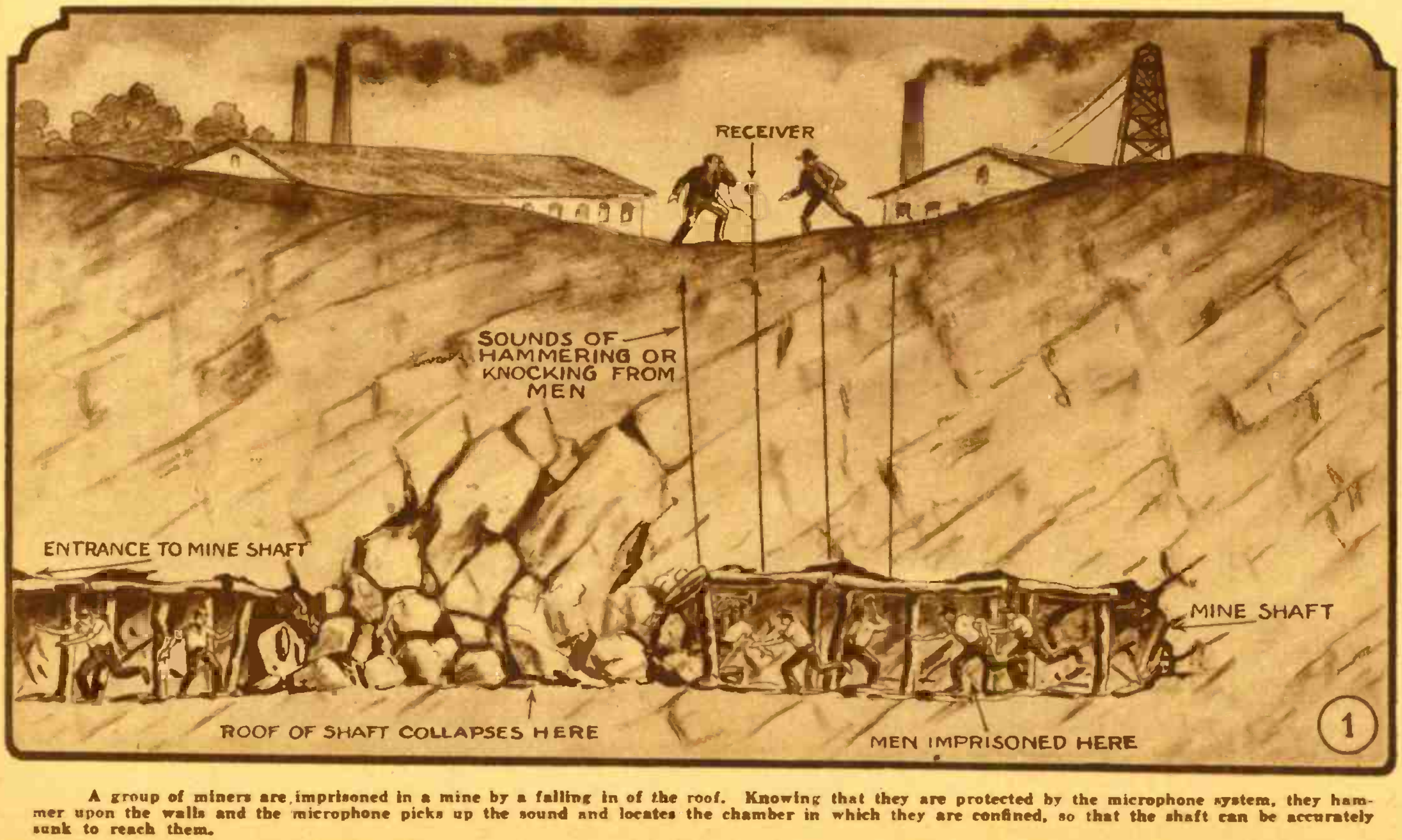
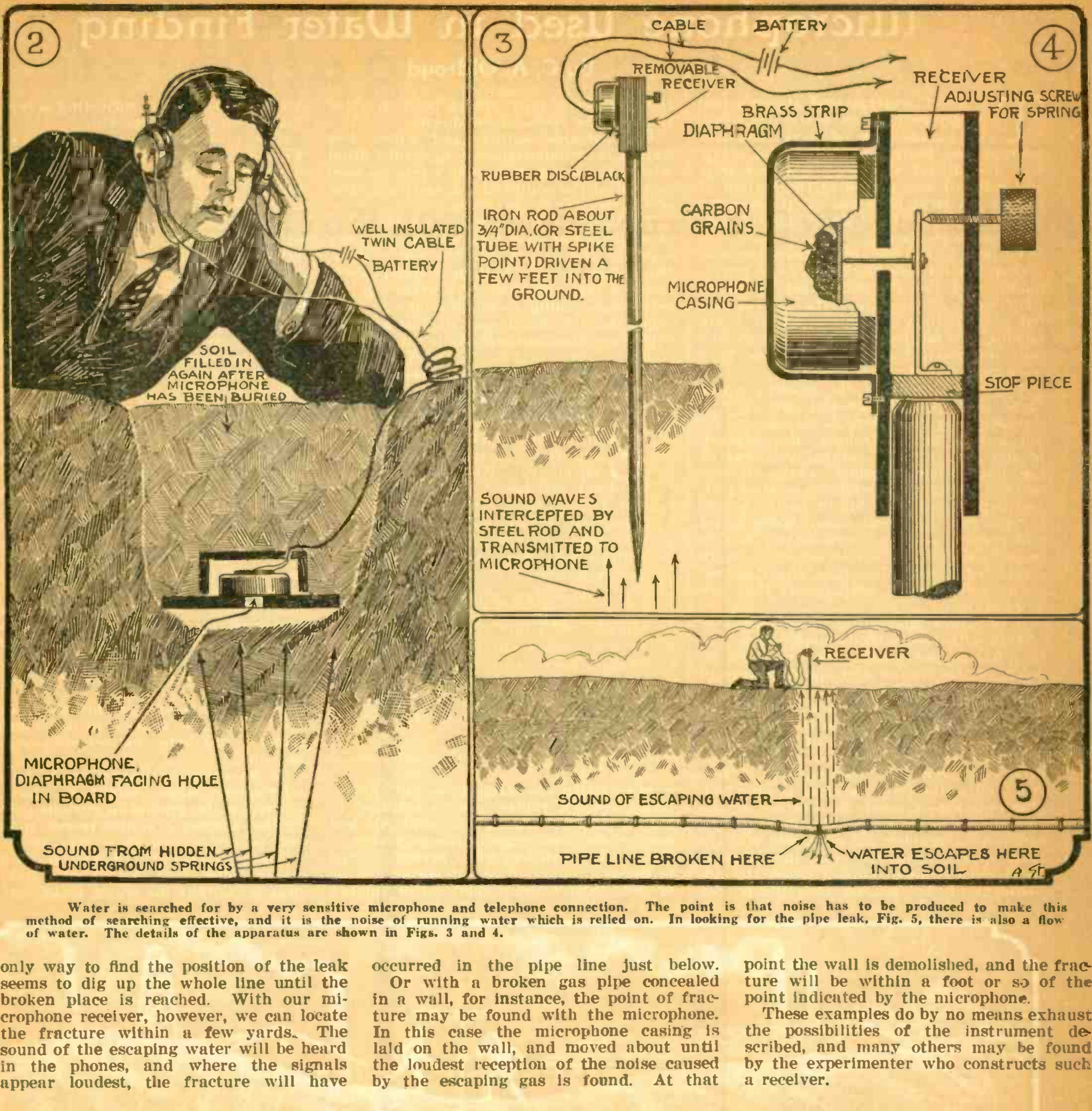


A group of miners are imprisoned in a mine by a falling in of the roof. Knowing that they are protected by the microphone system, they hammer upon the walls and the microphone picks up the sound and locates the chamber in which they are confined, so that the shaft can be accurately sunk to reach them.



Water is searched for by a very sensitive microphone and telephone connection. The point is that noise has to be produced to make this method of searching effective, and it is the noise of running water which is relied on. In looking for the pipe leak, Fig. 5, there is also a flow of water. The details of the apparatus are shown in Figs. 3 and 4.

only way to find the position of the leak seems to dig up the whole line until the broken place is reached. With our microphone receiver, however, we can locate the fracture within a few yards. The sound of the escaping water will be heard in the phones, and where the signals appear loudest, the fracture will have occurred in the pipe line just below.

Or with a broken gas pipe concealed in a wall, for instance, the point of fracture may be found with the microphone. In this case the microphone casing is laid on the wall, and moved about until the loudest reception of the noise caused by the escaping gas is found. At that point the wall is demolished, and the fracture will be within a foot or so of the point indicated by the microphone.

These examples do by no means exhaust the possibilities of the instrument described, and many others may be found by the experimenter who constructs such a receiver.

Walking Stick for the Deaf

THE old-fashioned ear trumpet for the use of the deaf is impossible for use on the streets. The new microphones for the deaf with their division into microphone, resonating plate and battery, are very awkward to carry about. The ear trumpet on a walking stick puts the telephone for the deaf in a better shape and in a form which will be less conspicuous in use.

The microphone is contained in the knob, whose sensitiveness can be adjusted by a little screw accessible from outside. Below the microphone there is a dry cell which is connected as in a pocket flashlight. The battery can be got at by unscrewing the knob along with the upper part of the stick proper.

The screw presses against the contact surface in the knob. The resonating plate is a small, saucer-shaped expansion of the stick. Our author says that the elegant instrument will be desired by many a deaf person on the street.

A convenient form of microphone for the deaf. Within the walking stick everything is contained, including a flashlight battery, so that the user does not have the trouble, or what to some would be the mortification, of carrying a clumsy apparatus about with him.

Many appliances have been devised for assisting the deaf to hear. One of the best known sufferers from the affliction is Thomas A. Edison. He can hardly hear if the words are shouted into his ear. He told the writer recently that he had an apparatus in his laboratory embodying two vacuum tubes with which he could hear a spider walk.

Of course, in the existence of so much idle talk deafness is not altogether an affliction, and the story is that the great inventor has upheld some such theory. But it would never be taken as a matter of choice, and the electricians have done much to improve the fate of the deaf.

EXPERIMENTAL RADIO

Single-Tube Reflex Experiments with the Hook-Up Board

By Clyde J. Fitch

GETTING the most out of tubes has been the problem of all radio experimenters. Although a single tube regenerative receiver gives very good results, the tube is not worked to its full output when used as detector only. Before the war experiments were conducted in this country and abroad in trying to make the tube perform two functions simultaneously, that of amplifying radio frequency currents, which in broadcast reception range from 500,000 to 1,500,000 cycles per second, and at the same time amplify audio frequency currents ranging from 200 to 5,000 cycles per second.

With this arrangement, called *reflexing*, the radio frequency signal currents received by the antenna are amplified by the tube, rectified by a crystal detector, and the audio frequency currents from the crystal are amplified by the same tube. Very encouraging results were obtained with this method, but it was found that the instruments used must be of correct design in order to work in unison; that is, a change of one of the instruments may affect the action of the others, and it may be necessary to change them also. As there are hundreds of reflex combinations it is best to connect the instruments up temporarily before building the complete set, and in order to try the various circuits an "EXPERIMENTAL HOOK-UP BOARD" should be constructed.

The following apparatus was used in experimenting with the single tube reflex circuits. The experimenter should procure instruments of this type for making his experiments.

- 1 Standard vacuum tube socket
- 1 *General Radio* 400-ohm potentiometer
- 1 Standard 30-ohm rheostat
- 1 *Daven* condenser mounting
- 1 *Daven* grid leak mounting
- Assortment of Daven fixed condensers and grid leaks
- 1 "*All American*" 10 to 1 ratio transformer
- 2 "*X*" *Laboratories* 23-plate variable condensers
- 1 *Gen-Win* 3-circuit tuning coil
- 1 *Gen-Win* reflex coil
- 1 *Rasco* galena detector
- 5 Single *Fahnestock* clips
- 10 Double *Fahnestock* clips
- 36 *Rasco* phone cord tips
- 36 *Rasco* clips
- 24 feet *Rasco* flexible silk-covered wire
- 1 baseboard 10 by 20 by ½ inches
- *Rasco* name-plates, angles for mounting, wood screws, bus-bar wire, spaghetti insulation, etc.

The Hook-Up Board

The hook-up board is a board on which are mounted various radio instruments with spring binding posts so arranged that by means of a number of flexible connections with terminals on each end different circuits can easily and quickly be tried out. The illustrations show such a board built in THE EXPERIMENTER laboratory. Although this board was constructed for trying out single tube reflex circuits it may be used for other purposes. It is ten inches wide, twenty inches long and one-half inch thick and fitted with cleats to prevent warping. On one end are mounted a vacuum tube socket, 30-ohm filament rheostat, and a 400-ohm potentiometer. The filament connections, including the potentiometer and rheostat, are wired permanently, as these connections are standard and will be the same in all circuits. (A) shows the details of the complete board, giving the locations of the spring binding posts and other instruments, such as variable condensers, transformers, etc. The permanent filament connections are also indicated in this illustration. "Rasco" blank name-plates are used, and lettered in with India ink.

The two condensers are of the 23-plate type, which type is suitable for practically all circuits. These are mounted permanently with "Rasco" angles and the connections left free so that they can be used in different parts of the circuit. A crystal detector is also mounted on the board, with spring binding posts for connections. The "Rasco Baby" galena detector was used on account of its small size. It is mounted on a shock-proof sponge rubber base. The audio frequency transformer used in various circuits is also mounted permanently. As this transformer is used mostly in connection with the crystal, a high ratio one should be used, of about 10 to 1 ratio. Although a high ratio transformer causes much distortion when used between vacuum tubes, the distortion is not noticeable when used between a crystal and a tube as the impedance of the crystal is very low and the primary of the transformer should match this impedance, whereas the secondary, connected to a vacuum tube of high impedance, should have a high impedance.

The variocoupler or tuning coil shown at the left may be home-made or any standard variocoupler designed for broadcast wave-lengths may be used in many of the circuits. A good double slide tuning coil will also be found convenient for trying different circuits. The tuning coil should have primary, secondary and tickler windings, and the tickler winding should be on the rotor so that the coupling between this and the secondary can be varied.

Those who desire to wind their own tuning coil may make it according to Fig. 13. This is of simpler construction than the one shown in the other illustrations, and this coil will be found suitable for practically all circuits. It consists of three windings with separate binding posts, so that either one, two or all three windings can be used. The outer tube is 3⅛ inches in diameter by 3½ inches long and has a 3/32-inch wall. The primary consists of 15 turns of No. 20 D. C. C. wire, the secondary of 40 turns of No. 24 D. C. C. wire and the tickler is also wound with 40 turns of No. 24 wire. This is mounted on a suitable shaft so as to control the coupling. With the aid of the reproduced photographs and the drawing A, but little difficulty should be experienced in building the hook-up board, and then when the papers come out with a new-fangled circuit that is supposed to operate a loud speaker on a crystal detector the circuit can be quickly tried out before investing time and money in the complete receiver.

A number of flexible lead wires of various lengths should be made up for connecting the instruments. Some should be fitted with telephone cord tips and some

The Hook-Up Board

By HUGO GERNSBACK

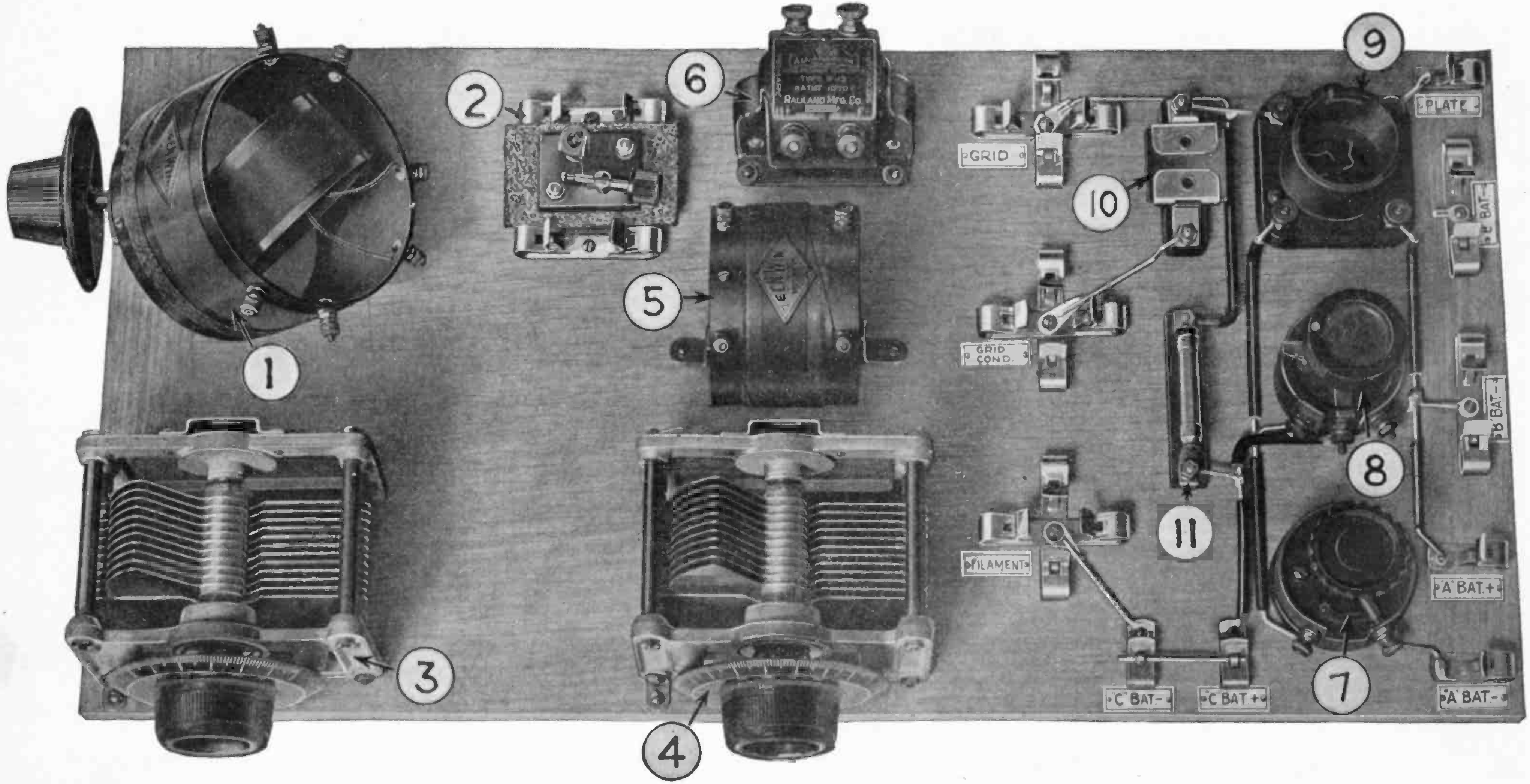
HERE is a new idea for the radio experimenter. Heretofore when experimenting with different circuits you placed your parts haphazard on a table and connected the instruments with wires. Every time you wanted to change from one circuit to another it took long and tedious work to accomplish this.

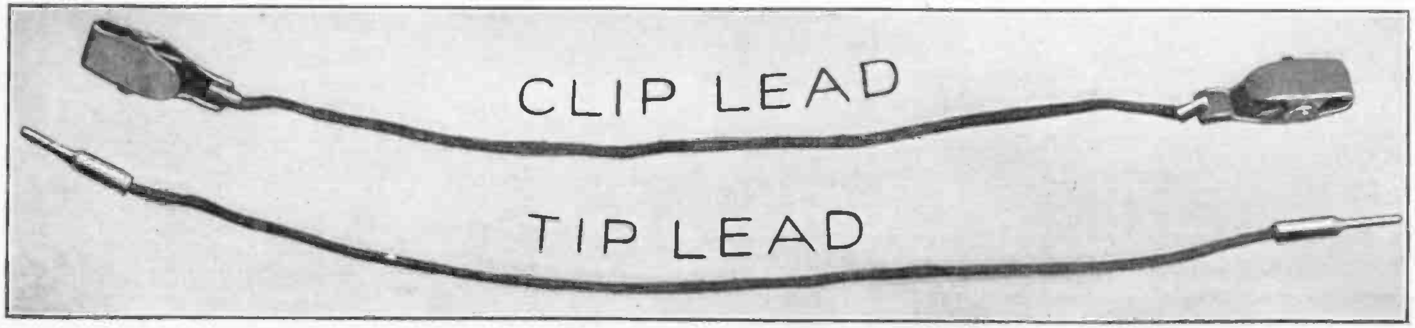
All this is a thing of the past. The writer has worked out an entirely new arrangement which will be known to the radio fraternity hereafter as the HOOK-UP BOARD. By means of this arrangement it is possible to hook up different circuits in a minimum of time. Nor do you have to screw and unscrew nuts and binding posts to accomplish this. We now use CLIP LEADS and TIP LEADS, which are merely short pieces of flexible wire, to the ends of which have been soldered either spring clips or otherwise telephone cord tips. By means of this arrangement connections can be hooked up or unhooked in fractions of a second. The hook-up board is arranged in such a manner that by using spring binding posts in great numbers the most intricate connections can be made in the shortest of time.

The noteworthy improvements in this system are immediately apparent to anyone. However, the most important feature of the new system is that loose connections are practically impossible now. How often have you hooked up a set according to directions and after you played with it for hours without result, you have found that there was a loose connection, or a broken wire held together by its insulation.

All these irritating annoyances are now a thing of the past, thanks to the hook-up board, experimenting now becomes a pleasure and a pastime, where heretofore it was tedious and unpleasant work.

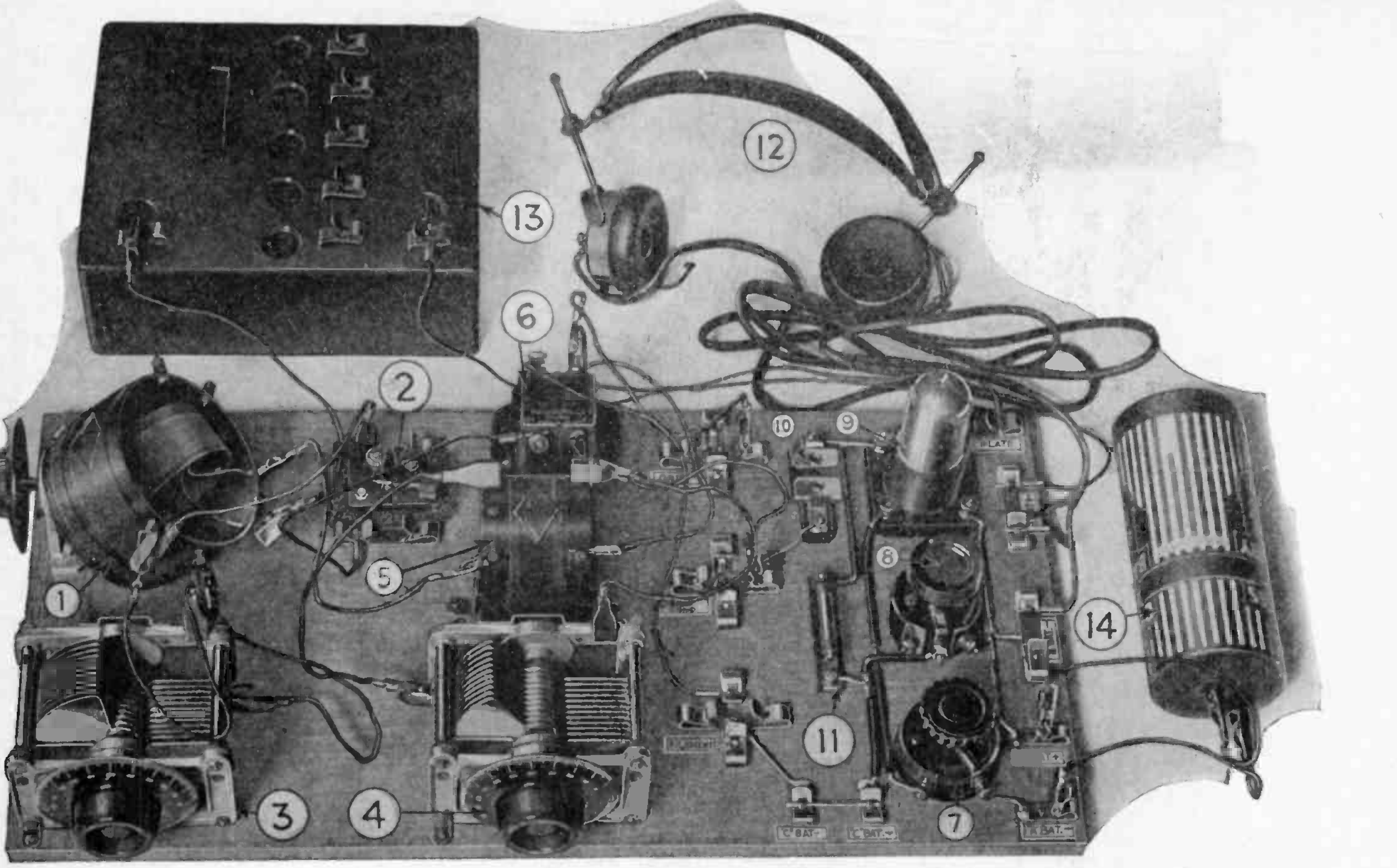
The Hook-Up Board





The hook-up board is shown above. Note the convenient arrangement of instruments and the large number of terminals allowing the various experimental circuits to be hooked up in a jiffy. The instruments mounted on the board are as follows: (1) Tuning coil; (2) crystal detector; (3) and (4) variable condensers; (5) radio frequency transformer; (6) audio frequency transformer; (7) rheostat; (8) potentiometer; (9) socket. These numbers correspond with those in the other illustrations.

At the left are shown a Clip Lead and a Tip Lead, used for making the connections. The Clip Lead, with its spring jaws, insures excellent contact when attached to terminals or binding posts. The Tip Lead is used for connecting to the spring Fahnestock binding posts.



This shows how the apparatus looks after one of the experimental circuits shown on the opposite page have been hooked up. Note how conveniently the tip leads and clip leads have been applied for making the connections. In addition to the instruments mounted on the board we have (12) telephone head-set, (13) "B" battery, and (14) "A" battery. These instruments are numbered accordingly in the diagrams. This represents hook-up 6-B on the opposite page.

with spring clips. These will be known hereafter as "TIP LEADS" and "CLIP LEADS." These should be securely soldered in place.

We are showing in Fig. 14 a clip-lead and a tip-lead. These leads should be made up in 9-inch and 15-inch lengths. It is well to make up six of each in 9-inch lengths, six of each in 15-inch length, and six combination leads, 9-inch and 15-inch lengths, each of the last having a clip on one end and a tip on the other. This will make 24 leads, which will be sufficient for practically all single tube circuits. Some leads should be made with wire, having red-colored insulation and some with green, as the different colors help in tracing connections. For example, it is well to use the red leads for the positive "A" and "B" battery connections.

The cord tips on the head-set should be removed and two clips soldered in their place. The clips will be found more convenient as the head-set can then be connected to all kinds of binding posts.

When a number of these connectors have been made and the hook-up board completed the apparatus is ready for trying the various circuits. A UV or C-201A, UV or C-199, or WD or C-12 tubes should be used. It is well to have a "B" battery of 45 volts with a number of taps for different voltages. A 4½-volt "C" battery is also used in some circuits, and when not used the binding posts for this battery are shorted. A good number of fixed condensers of various values should also be available.

The experimenter can now try out the various crystal-tube hook-ups, and as a starter we are showing 12 scientifically sound circuits that give good results. It is not advisable to connect these circuits exactly as shown; if a .0005 fixed condenser is called for on the diagram, try various sizes, or leave it out entirely, as conditions are different in each individual set and the values of the instruments may be changed accordingly. Each of the 12 circuits shown here are basic, have been tried out and all work. No freak arrangements are shown. There are several variations that may be made in each circuit, and it is up to the experimenter to devise different combinations and try them out. The 12 circuits will now be described. All of these circuits are not reflex circuits; many are simple crystal-tube combinations.

In the following circuits reference numbers are used. These numbers correspond with those on the photographs. The reference numbers will be a great help in trying out the circuits, as the instruments are shown diagrammatically.

Crystal Receiver

Fig. 1 shows a simple crystal receiver circuit. The advantage of this circuit is that it is inexpensive. It requires no batteries. A tuning coil, comprising primary and secondary, a variable condenser, crystal detector and head-set are all that are needed. Sometimes a fixed condenser connected across the head-set improves the results. The average range of this receiver is about 50 miles, but occasionally greater distances can be covered. This circuit should be tried with the aerial and ground connected directly across the secondary coil instead of the primary, and the condenser may be connected in series with the aerial lead. A 50 to 75 foot single wire aerial suspended 20 feet or more above ground makes a suitable antenna for all these circuits. Any standard variocoupler may be used for the tuning coil. Local stations will be received very loud and clear on this circuit, but not strong enough to operate a loud speaker.

Crystal Receiver with Amplifier

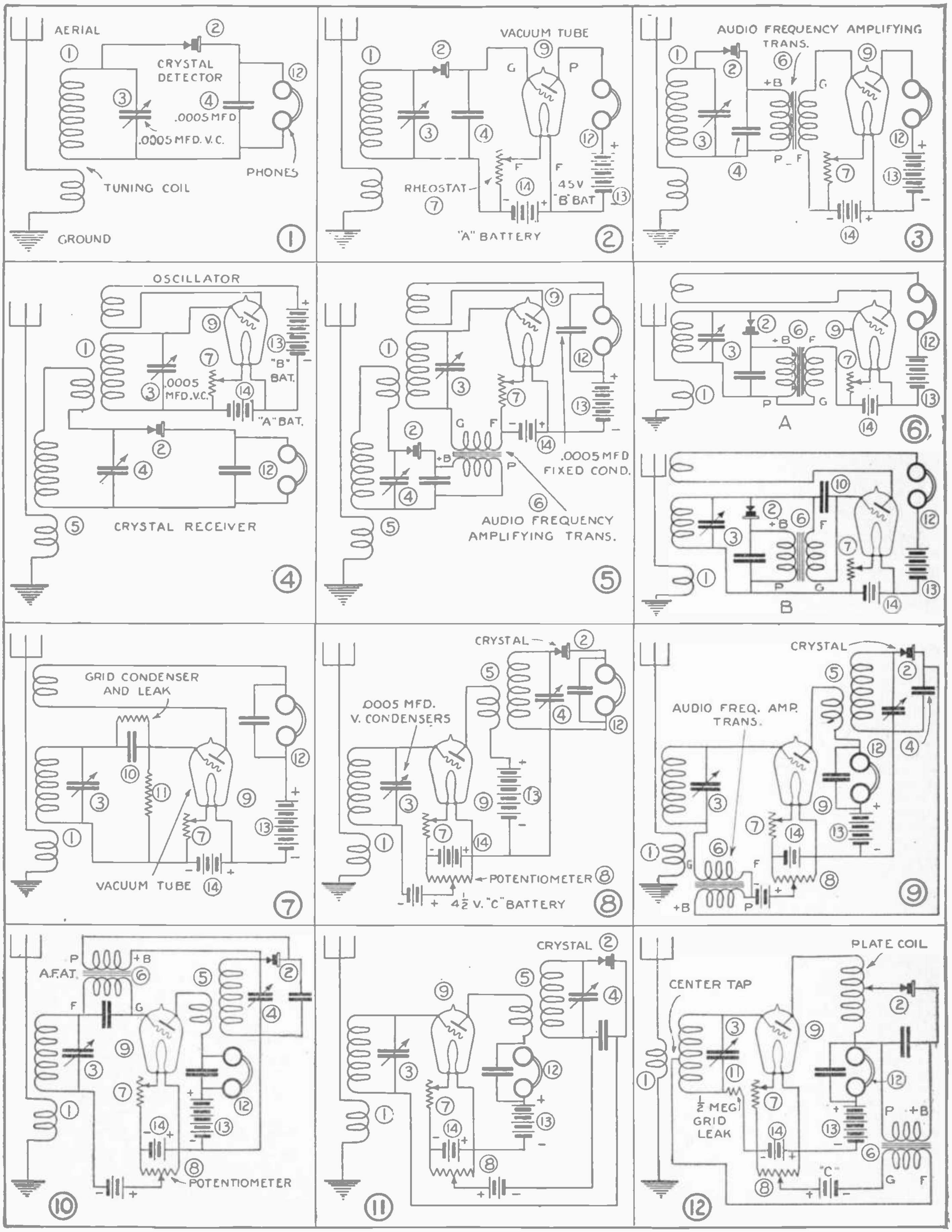
After various combinations of the circuit Fig. 1 have been tried and the one that gives the best results left connected, the vacuum tube may be connected to amplify the received concerts. A WD-12 or UV-201A tube may be used, with the proper filament battery. Fig. 2 shows the simplest connections for the amplifier. The grid and filament of the tube are connected to the crystal receiver in place of the head-set and the head-set is connected in the plate circuit of the tube. The signals will be much louder, due to the relay action of the tube. The potentiometer and "C" battery are not required in this circuit, although it is well to try both of them. As the symbols used in all these circuits are the same, the instruments are not labeled in each one. The reference numbers are sufficient. With this circuit the signals received on the crystal, Fig. 1, will be amplified about six times, the amplification constant of the tube.

Transformer Coupled Amplifier

As a vacuum tube is a voltage-operated device, it is well to step-up the voltage of the received signals by means of a step-up transformer before applying it to the grid and filament of the tube. This will give greater amplification. Fig. 3 shows the connections with the step-up transformer, which is the same as Fig. 2, except that an audio frequency amplifying transformer is placed between the crystal receiver and the tube. Local broadcast stations, five to ten miles distant, will be received loud enough to operate a loud speaker with this hook-up. The circuit is not very selective and distant stations cannot be received when local stations are operating. If the transformer ratio is 10 to 1, and the amplification factor of the tube 6, the signals received on the crystal will be amplified about 60 times.

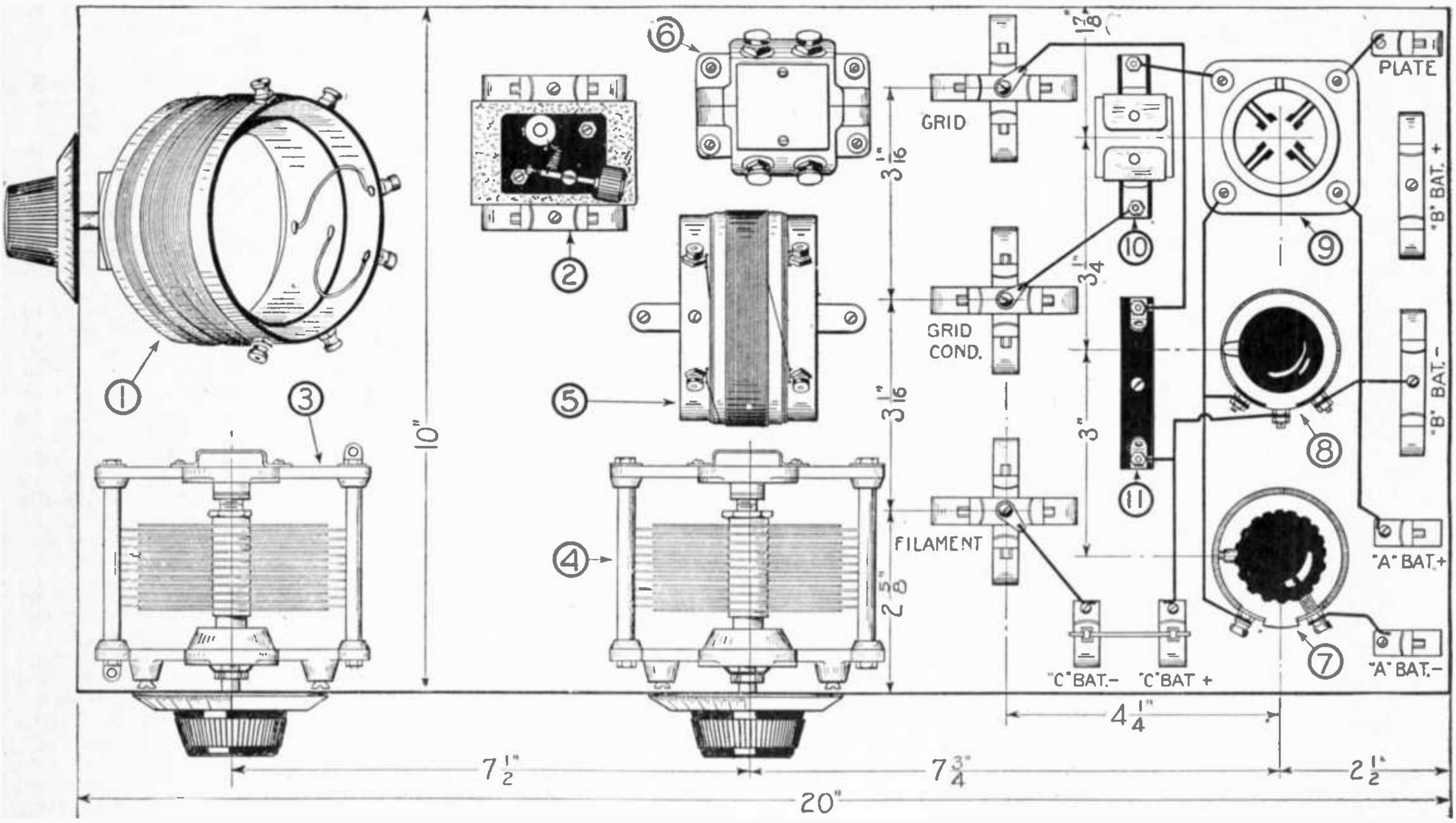
Crystal-Heterodyne Receiver

In Fig. 4 we have the crystal receiver connected as shown in Fig. 1. In addition to this a vacuum tube oscillator is connected so as to generate a radio frequency current, the frequency of which is varied by means of the oscillator condenser. An ordinary variocoupler with a variable condenser may be used for the oscillator cir-



These circuits and all other crystal and single tube hook-ups are easily tried out by using the hook-up board. Some very interesting circuits are shown, some giving loud speaker volume on a single tube. They are not all reflex circuits; they are as follows: (1) Crystal receiver; (2) crystal receiver with amplifier; (3) transformer coupled amplifier; (4) crystal-heterodyne receiver; (5) combination heterodyne and audio amplifier; (6) regenerative crystal and audio amplifier; (7) one tube regenerative receiver; (8) amplifier and crystal detector; (9) standard reflex circuit; (10) another reflex circuit; (11) simplified reflex; (12) improved reflex.

cuit, and the connections are simple, as shown. About two turns of wire are wound around the outside of the secondary winding and included in the crystal tuning circuit. With this combination, the signals can be heterodyned, giving the familiar squeal, and continuous wave signals can be received. By adjusting the the crystal tuning circuit and amplify the signals. With these two hook-ups local stations will be received loud enough to operate a loud speaker, and, due to the regenerative amplification of the tube, DX stations can be received. It is circuit 6A that is shown connected up on the experimental board in one of the reproduced taps. When working properly this circuit will give a greater range than the previous ones, but the signals will be no louder. There are many iron core R. F. transformers on the market that may be used which cover the entire broadcast range without tuning. By a combination of regeneration and R. F. amplification



This drawing will enable the experimenter to construct the hook-up board. All dimensions are given, and the instruments are numbered according to the numbers on the photographs. The various parts are mounted permanently with all binding posts accessible so that connections can be easily made to them. Note how the double spring binding posts are crossed for four separate connections.

oscillator so that it is just about to oscillate, regenerative amplification takes place which has the effect of reducing the antenna resistance. Although local stations are not made much louder, the range of the receiver is increased to 1,000 miles or more. Very weak distant stations are amplified about 100 to 200 times. The amplification of local stations is very slight.

Combination Heterodyne and Audio Amplifier

After circuit 4, which requires considerable experimenting, has been finally worked out to its maximum efficiency, we can combine this with circuit 3 and use the separate oscillator also as an audio frequency amplifier. The hook-up is shown in Fig. 5. This combination, giving the 1,000 mile range of circuit 4 with the amplification of circuit 3, makes about the best crystal-tube combination possible, and many stations will be powerful enough to operate a loud speaker. There is a wide field for experimenting with this combination circuit, and after the correct hook-up and constants of the circuit have been worked out a very efficient single tube receiver can be built. Distant stations will be amplified about 100 × 10 × 6, or 6,000 times, and loud local stations about 10 × 6, or 60 times.

Regenerative Crystal and Audio Amplifier

By carefully working out circuit 5 we can simplify and develop circuits A and B, Fig. 6. Only one tuning coil, comprising primary, secondary and tickler is required. The connections are similar to those of Fig. 3, except that the vacuum tube is connected so as to regenerate into photographs. The amplification of this circuit is about the same as that of circuit 5. It is well to try all these circuits with a "C" battery and potentiometer.

One Tube Regenerative Receiver

Before trying out standard reflex circuits it is well to connect up a single tube receiver as shown in Fig. 7 and experiment with it until the action and operation is fully understood. This is a standard circuit and is hard to be improved upon. A set using this circuit is very easy to build and always works. Although it will not give loud speaker volume it will receive over as great distances as any multi-tube receivers. The amplification due to regeneration will be about 100 times on weak stations and less on strong stations.

R. F. Amplifier and Crystal Detector

Fig. 8 shows the tube connected as a radio frequency amplifier with a crystal detector used to rectify the amplified radio frequency currents. It is well to use both the potentiometer and a "C" battery when trying this circuit. The antenna tuning coil may be the standard variocoupler. A convenient tuned radio frequency transformer for the plate circuit can be made by winding 60 turns of No. 24 wire on a 2¾-inch diameter tube two inches long, and directly over this, with a few layers of varnished paper insulation between, wind 35 turns of the same size wire. See Fig. 15. This makes the secondary and primary coils, the secondary being tuned by a .0005 mfd. variable condenser. The experimenter can make various sizes and styles of coils and try them out. Sometimes it is best to tap the secondary winding and connect the crystal to one of the the weak signals will be amplified about 150 times.

Standard Reflex Circuit

Fig. 9 shows the standard reflex circuit. This is the same as circuit 8 except that the current from the crystal is passed through a step-up transformer and amplified by the tube. The head-set is included in the plate circuit of the tube. A "C" battery and potentiometer are recommended in this circuit while experimenting, but may be dispensed with when the correct values are obtained. The action of this circuit is as follows: The radio frequency currents received by the antenna are amplified by the tube, detected by the crystal, and amplified by the same tube at audio frequency, giving the same results that would be obtained from a set using a one stage R. F. amplifier, detector, and one stage A. F. amplifier. Instead of using a tuned radio frequency transformer as shown in the diagram an un-tuned iron core transformer may be used. There are various types on the market that will give good results. The amplification that this circuit gives depends largely upon the crystal detector and the values of the fixed condensers and other instruments.

Another Reflex Circuit

Somewhat better results are claimed for the circuit, Fig. 10. In this hook-up the secondary of the audio amplifying transformer is connected to the grid side of the tuning circuit and not to the filament side. Of course there are many other connections that may be tried, such as grounding the filament, connecting the crystal across the primary coil instead of the secondary coil, etc. When working properly a good

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Some Little-Known Methods of Producing Oscillations

By Robert E. Lacault, A. M. I. R. E.

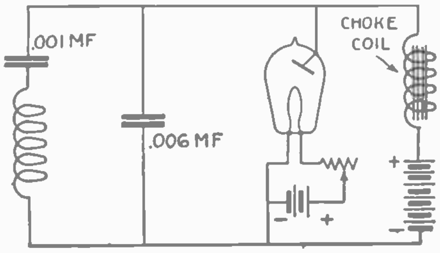

FIG. 1

Circuit of a two-electrode tube for the production of audio frequency oscillations.

THE production of undamped oscillations at radio frequency was the aim of engineers at the beginning of the development. It was soon found that not only were continuous waves more efficient for radio transmission, but that they could be used for a great many other applications.

The first practical generators of such oscillations were the Poulsen and Duddell arcs which were used in the first radio telephone experiments, then came the high frequency alternators. But these machines cannot produce directly very high frequencies on account of mechanical difficulties encountered in their construction. Then Dr. de Forest invented the vacuum tube which is undoubtedly the most versatile apparatus known in the science today. With vacuum tubes oscillations of almost any frequencies may be produced. And the latest type of oscillator is the zincite crystal detector which when connected in the proper circuit produces undamped oscillations.

The four systems described above are what might be called standard. But aside from them are some other instruments which may also be used for the production of continuous waves and are very little known to experimenters, although they are interesting to investigate.

Two Electrode Tube Oscillator

It is possible to produce oscillations with a two electrode vacuum tube containing only a plate and a filament provided the vacuum is not too high. The diagram Fig. 1 shows the circuit of such an oscillator. For a two electrode tube, a gas content vacuum tube such as the UV-200, with the grid and plate connected together to form the anode may be used. A battery supplies the necessary voltage to the tube through a choke coil which prevents the oscillations from flowing through the supply circuit, and a stabilizing condenser is connected across the tube. The oscillating circuit proper is composed of a condenser and coil the value of which depends upon the frequency of the oscillations to be generated. Fig. 2 shows another possible arrangement of the oscillating circuit, but in this case a stopping condenser must be used to prevent the inductance from short circuiting the tube. In order to measure the current in the circuit a sensitive thermo-ammeter may be connected in series with the inductance, but if audio frequency oscillations are produced they may be detected directly by connecting a pair of telephone receivers to a large coil coupled to the inductance of the oscillating circuit. To start the tube to oscillating the plate voltage should be varied from about 20 to 100 volts or more until the tube glows blue. The voltage should then be adjusted closely to the point where the tube just starts to glow blue.

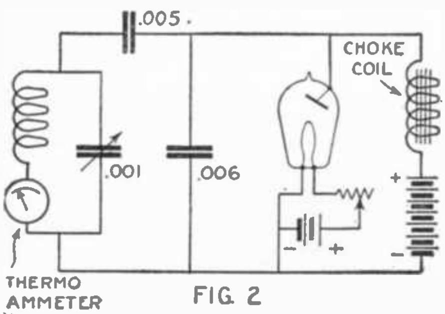

FIG 2

Circuit of a two-electrode tube for the production of radio frequency oscillations.

Dynatron Oscillator

Oscillations of any frequency may also be obtained in an ordinary vacuum tube by making use of the second emission phenomenon. When oscillations are produced by this method, the oscillating circuit is very simple and does not require any feed-back coil or condenser in order to oscillate. Fig. 3 shows the circuit of a dynatron oscillator which functions on account of the negative characteristics of the system. In this circuit the high voltage or B battery of about 100 volts is connected to the grid direct, while the plate of the tube is connected through the oscillating circuit to a tap on the battery. This tap is found by experiment and varies with the different tubes.

Under these conditions the plate is at a lower voltage than the grid and is bombarded by electrons which are attracted by the highly positive grid but pass through its mesh to the plate. On account of the very high velocity of these electrons

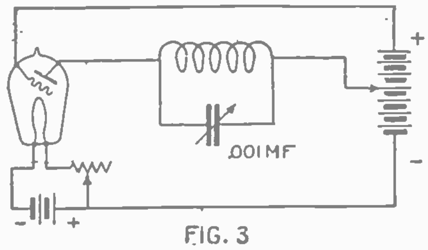

FIG. 3

A dynatron oscillator. The inductance may be a honeycomb coil or any other suitable inductor.

the metal surface of the plate liberates what are known as secondary electrons when struck.

Each primary or original electron knocks out from 10 to 20 secondary electrons from the plate, and since the grid is highly positive it attracts these secondary electrons. In this case the plate acts as another filament, producing electrons, and when measured it is found that the plate current is small because the plate is losing electrons and that an increase of voltage on the plate produces a decrease in current. In other words, it does not obey the Ohm's law. Any device having such characteristic is called a negative resistance and may produce oscillations when used in the proper circuits. The arc and zincite crystal with a steel contact have such characteristics. This is why they oscillate.

We may explain the negative resistance effect in the dynatron circuit as follows: When the voltage on the plate is increased the velocity of the electrons striking it also increases. This greater velocity results in more secondary electrons being liberated from the metal of the plate to be attracted by the grid. For each electron attracted to the plate several are liberated from it, the effect being a decrease of current in the plate circuit. The curve illustrating this is shown in Fig. 4.

In the negatron oscillator the frequency of the oscillations is determined by the

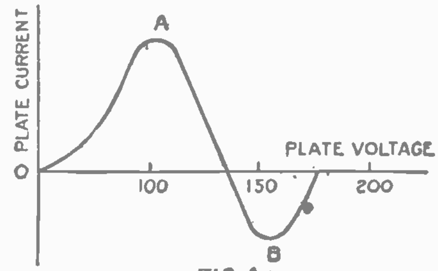

FIG.4/

Curve of a dynatron oscillator. Oscillations take place when the voltage is adjusted between the values (A) and (B).

size of the coil and condenser composing the oscillating circuit, but no matter what their size is, the resistance of the circuit is so reduced that oscillations take place.

On account of this phenomenon we may also produce oscillations by connecting the oscillating circuit in the grid circuit, and varying the plate and grid voltage until the grid characteristic curve falls as shown in Fig. 5. The circuit to be used in this case is illustrated in Fig. 6.

Neon Tube Oscillator

Another instrument which may be used to produce oscillations is the neon tube. This type of tube has no filament, but is merely composed of two metallic electrodes inclosed in a glass bulb filled with neon gas. Such tubes are now used for advertising purposes, producing a beautiful pink glow, which is used to light some window displays. They are also used as lightning arresters on radio antennae.

Neon tubes, when connected across a battery of sufficient voltage, glow suddenly and remain lit until the current is switched off. The peculiarity which makes these tubes suitable for the production of oscillation is that they require a certain voltage to start glowing, but keep going, after they are once lit, even when the voltage is reduced below the flashing point. This is illustrated by the curve Fig. 7. Showing that at a potential of about 175 volts the tube lights, and a current of a few milliamperes flows through it. This current increases as the voltage across the tube is raised and decreases as the voltage is lowered, but the tube still glows even when less than 175 volts are applied to the tube, and the current decreases slowly to zero as the tension is reduced to about 150 volts or less. It should be noted that different tubes have very different characteristics, due probably to the different value of gas pressure in each one of them.

By using the property explained above it is possible to produce oscillations by connecting the neon tube as shown in Fig. 8. This circuit acts as follows: The current flows slowly through the high resistance and charges the condenser; when the voltage across the condenser reaches the flashing point, the tube glows until the voltage drops to the cut-out value.

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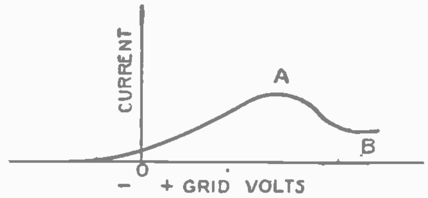
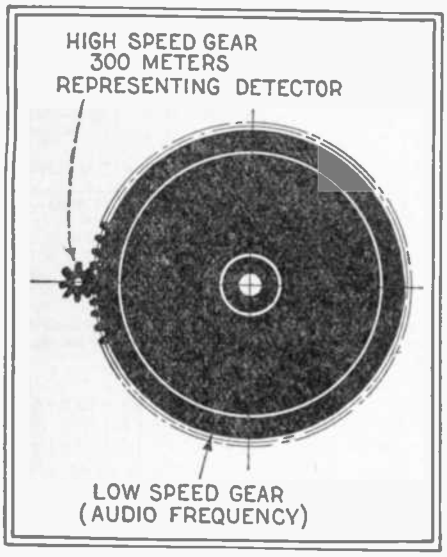


FIG. 5

Curve showing how a negative resistance effect may be produced in the grid circuit of a vacuum tube.

Simple Super-heterodyne Analogy



A simple detector analogy in which the energy of the small high-speed gear representing the radio frequency currents is transferred to the large low-speed gear representing audio frequency currents.

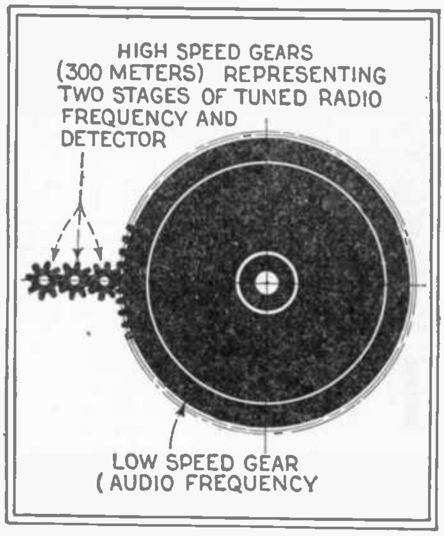
THE action of the super-heterodyne has puzzled many. When we say that the intermediate amplifier tunes to a wave length of 6,000 meters, many ask why this was not designed to receive the broadcast wave lengths. Evidently they do not understand the action of the receiver.

If we liken this receiver to a chain of gears, the action is more easily explained. If we represent the wave length by the diameter of the gear, a very small gear would represent a short wave length (300 meters) and a very large gear would represent a long wave length (6,000 meters) and a much larger gear would represent the audio frequencies of extremely long wave length. The speed of the gears is analogous to the frequency of the waves.

In Fig. 1 we show a small gear rotating at high speed representing the 300 meter wave received by the set. This gear rotates so fast that we cannot see the motion of the teeth, and the wave received by the set is of such high frequency that we cannot hear the sounds. By meshing this gear to a large diameter gear representing the audio frequency, this large gear will rotate slowly and we can see the motion of the teeth. By means of the detector in the set the 300 meter wave, which is one of high frequency (so-called high frequency current), produces low frequency currents that give sounds in the telephones. It is evident that in tuning the set to different wave lengths we change the size of the small gear.

In a tuned radio frequency receiver, where we have two stages of tuned radio frequency and detector, we require three tuning dials, and we show three small high-speed gears in Fig. 2 representing this circuit. It is evident that with three high-speed gears the losses are higher on account of greater friction on the bearings, and tuning to different wave lengths means changing three dials on the set or changing three gears in our analogy. If additional stages are required the system is considerably complicated.

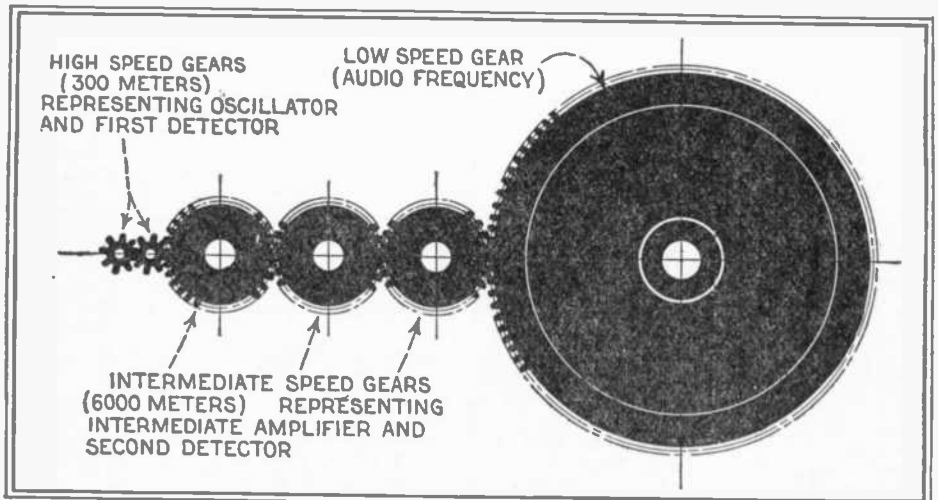
The complication is overcome in the super-heterodyne in which an intermediate amplifier is used, represented by a set of intermediate gears in our analogy. The size of the intermediate gears never change. They represent a certain fixed wave length of say 6,000 meters. Each one represents a stage of amplification, and as many stages as desired can be added without complicating the tuning. For tuning in different wave lengths it is only necessary to change two dial settings, or two gears in our analogy, representing the tuner and oscillator dials.



In this analogy the small high-speed gears represent two stages of tuned radio frequency amplification and detector. Note that wherever there is a change in the size of the gears detection occurs.

Wherever the sizes of gears change, detection takes place in the set, so that in the super-heterodyne two detectors are used, called first and second detector. As the intermediate gears travel at comparatively low speed the frictional losses are much lower than if a train of small high-speed gears were used. In radio receivers short wave amplifiers are not as efficient as long wave amplifiers. The intermediate gears still travel too fast to be seen by the eye and the frequency of the intermediate amplifier is too high to be heard by the ear.

Although the peripheral speed of the large gear is the same as that of the small ones, the outline of its teeth can easily be followed by the eye.



Greater efficiency is obtained in the super-heterodyne by employing an intermediate frequency amplifier, which in our analogy is represented by a train of intermediate gears. Note that as the size of gears change twice, two detectors are required.

"Reaching Out" With a Crystal Detector

By John Underhill House

THAT crystal detectors will not operate successfully over a greater distance than thirty or forty miles is a generally accepted fact, and the perusal of any book on radio, and particularly of the correspondence columns of radio magazines, will confirm this impression.

Of course there is the exceptional set, which for some reason or other occasionally is able to reach out to a greater distance, but generally on investigation it will be found that such an outfit is located in the vicinity of a vacuum tube station, and is benefited by the regenerative energy, emanated to a greater or lesser extent by the vacuum tube receiving apparatus.

Until very recently the writer held this view without question and was content to enjoy the entertainment broadcast from the local stations.

It is no secret that, for radio reception, the small inexpensive crystal set may outshine the most elaborate tube outfit and it was this superiority as regards clearness of tone, absence of foreign noises and simplicity of operation which gave me the incentive to experiment along the lines of reaching out for more.

The main cause of the insensitiveness of the ordinary crystal detector can be attributed to the bluntness of the point of wire making contact with the crystal, or putting it inversely, the smaller and finer the point making contact the greater the sensitivity to the radio waves.

With the ordinary phosphor-bronze or other wire usually provided on crystal sets it is impossible, even with careful cutting or filing to produce a really fine point and consequently there is always a much greater surface of wire in contact with the crystal than is necessary for efficient rectification.

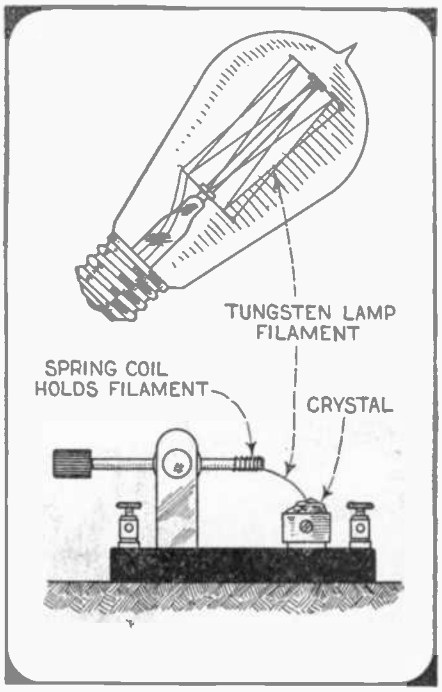
Taking the finest of steel sewing needles, forcing it between the coiled wire at the end of the detector arm, and using this point as a detector, I was greatly surprised on my first trial to hear the faintest of musical sounds, and knowing that the nearest out-of-town broadcasting station was 200 miles away, I realized that I had made a step forward in the right direction. By carefully determining the most sensitive spot on the crystal by means of the buzzer test, fair results may always be obtained in this way.

I was not completely satisfied, however, with what I had accomplished and continued my experiments further along these lines. The results that I am now getting from a crystal set are nothing short of marvelous, and others who have adopted my idea are equally astonished at what may be accomplished.

I believe that hereafter every owner of a crystal set who follows out my suggestion will be able to receive over at least a distance of 100 to 200 miles, and those who are fortunate enough to possess a first-class aerial and are located in favorable surroundings may obtain results hitherto thought to be impossible.

The key to this great improvement in crystal reception is contained within the bulb of a Mazda lamp, viz., the tungsten filament. This extremely fine wire used as a detector contact is the magic wand to bring in the entertainment from distant stations. It is used exactly as any detector wire, the means of fastening it to the rod depending on the ingenuity of the individual.

In those detectors having a coiled wire around the end of the rod, the fastening on of a short length of tungsten filament is easily accomplished. First removing the wire coil, then partially inserting the length of filament and replacing the coil on the rod will result in the small wire being held in place by the pressure of the coil on the rod. The length of filament now projecting should be about one-half inch. For best results the tungsten should be bent so that it touches the crystal at right angles.



Remarkable results are claimed from this crystal detector when using an extremely fine cat-whisker such as a portion of a tungsten lamp filament. This is a good suggestion for other experimenters.

Before breaking the bulb, the tip should be first snipped off so as to destroy the vacuum. This also reduces the noise and shattering effect when the glass is smashed. Care must be taken in handling the filament as it is extremely fragile, but after a trial or two a short section of the metal should be safely obtained and affixed to the detector arm. It might be mentioned here that with still greater care and patience the filament from a burned-out or broken bulb is equally as effective as that from a new one, the only drawback being the greater brittleness of the wire.

Greater care must be used in determining the most sensitive spot when using this wire than with the wire of the ordinary cat-whisker, but once found there is opened to the operator a broader and much more enjoyable field of entertainment than was hitherto thought possible with the little crystal detector outfit.

Loop Aerial

By Elvin Tilton

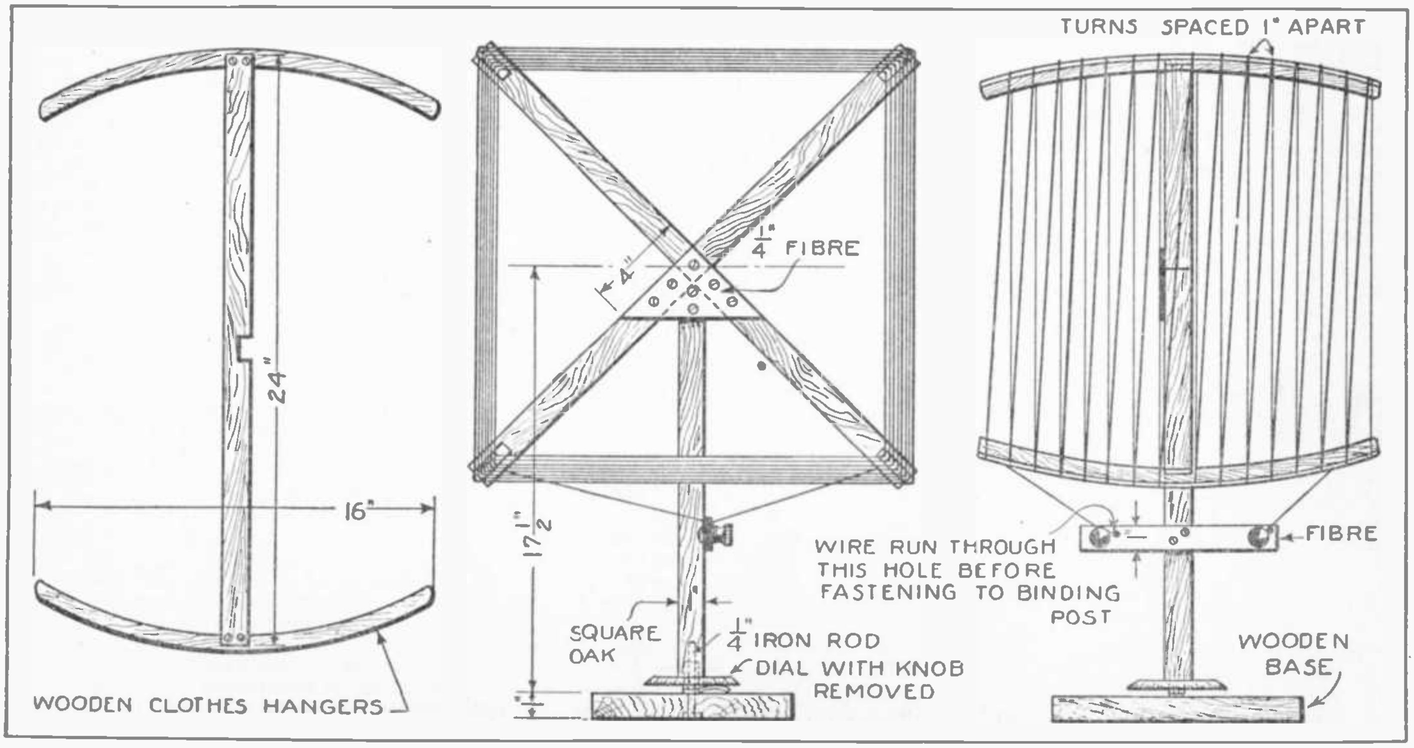
SEVERAL articles on loop aerials have been published, but I have failed to find an article which goes into sufficient detail to enable the amateur to build his own without asking innumerable questions as to size, shape, etc.

The accompanying diagram shows the arrangement and sizes. The cross-arms and supports were made from a strip of oak one inch square. An oak clothes prop such as is handled by department stores is the proper size and one prop is sufficient for all three pieces.

The wire supports are made from thin wooden coat hangers from which the hooks have been removed. Slots are cut in the cross-arm ends to hold the coat hangers. These are glued and screwed in place. The cross-arms are dove-tailed at the center as shown and then fastened securely to the standard by a piece of one-quarter inch fiber or wood cut in the form of a right triangle measuring four inches on the legs.

The base of the standard is equipped with a dial for noting direction. This was made from an old dial with the bakelite knob removed, leaving a brass bushing projecting from the dial. A one-quarter inch hole is drilled in the oak standard and then followed with a larger drill of sufficient size and to a depth to hold the brass bushing of the dial.

A piece of one-quarter inch rod, threaded on one end, was inserted through the wooden base as shown. This rod is held in place by an old rheostat arm equipped with a small set screw. This arm presses lightly against the dial when in place and holds the loop in any desired position. The wire is wound as shown in the drawing. Excellent results were obtained using stranded bare copper wire and also with No. 14 S. C. copper wire. The arms were notched to hold the wire in place, the turns being spaced one inch apart. Fifteen turns of wire are used, requiring about 120 feet. This loop will cover the broadcast wave length's range when used with a .0005 mfd. variable condenser.



It has been observed that the slightly ball-shaped loop aerial with the turns well spaced is the most efficient type. This experimental loop is easily constructed by using four coat hangers for holding the wire.

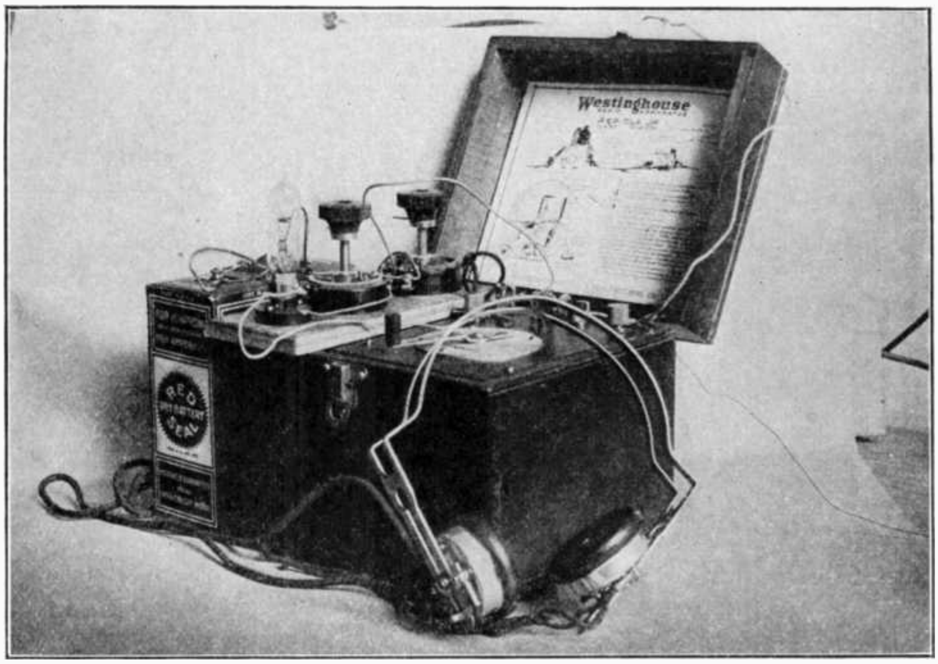
How to Use a Two-Element Vacuum Tube

By Harold B. Turner

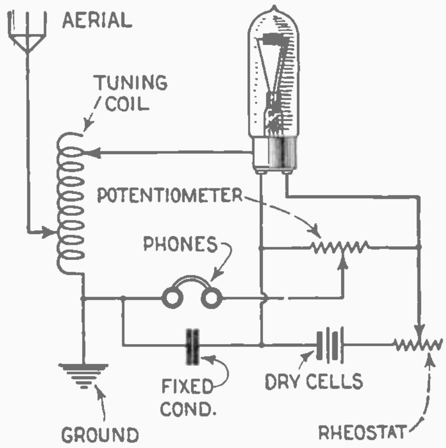
EVERYONE who builds their own radio outfit desires to receive over a maximum distance with a minimum expenditure. The writer recently constructed a receiver which is far more sensitive than a crystal outfit and more economical and reliable in its operation. In fact, the writer's results have been so pleasing that he thought he would let his brother fans know how to do the same.

Nowadays everyone wants a vacuum tube set and yet everyone cannot afford to invest in the necessary storage battery, "B" battery, and the other accessories that go to make up receivers of this type. While shopping around recently, the writer came across a Fleming valve type vacuum tube which he purchased complete with all accessories for $2.50. This was a two-element tube operating from dry cells. The receiver circuit outlined in the diagram was set up and perfect reception was made possible. Previous to the purchase of this tube a crystal receiver was used. With the vacuum tube in question stations were picked up that were never heard before, and the quality of reception was every bit as good as that obtainable with a good crystal set, and there was an entire absence of circuit noises and howling. In fact, one cannot make the two-element tube howl no matter how he tries.

The writer had such good results with this vacuum tube that one of his friends asked him to change his crystal set over into a vacuum tube set employing this same type of tube. It was not found necessary to completely demolish his crystal set to make the necessary changes. In fact, use was made of all of the instruments of the old crystal set with the exception of the crystal.



Showing how a two-element vacuum tube was experimentally connected to a standard crystal receiver. Although a dry cell was required to light the filament, the increased efficiency was found well worth the additional expense.



The connections of the two-element tube are clearly shown. By careful adjustments of the potentiometer and rheostat exceptional sensitivity is obtained. Note how simply this tube may be adapted to the standard crystal circuit.

The rheostat is carefully adjusted until the signals are loudest. When the rheostat was placed at the proper point further adjustment was unnecessary and the tube retained its same degree of sensitivity for several hours. It is evident that it would not be advisable to operate these tubes without a rheostat, as that would allow too much current to pass through the filament from the battery and the life of the tube would be shortened.

The advantage of permanent adjustment of this arrangement will appeal strongly to those who have had trouble with crystal detectors. Crystal detectors are fine, but they do get out of adjustment and here is something that gives us just as good quality, greater distance and no trouble in adjustments.

In the way of experimenting the writer set up a second circuit, using a 200-ohm potentiometer. This allowed him to make the filament negative or positive. By the use of this arrangement the results were found to be a little bit better, but those who cannot afford the addition of the potentiometer can be assured that they will get good results by using the other circuit.

We crystal users are hard birds to please, as we are generally stickers for quality. Here, however, the writer has found something that he can unqualifiedly endorse to those who want to bring their outfits rung up the ladder of perfection.

There are now on the market a few two-electrode tubes, but if the experimenter cannot obtain one he may try a double filament auto lamp, using one filament for the plate.

Single-Control Receivers

By Marius Logan

WITH the constant advances being made in radio the trend is more and more toward the single-control receiver. The experimenters have, from time to time, developed circuits which proved extremely selective and efficient and at the same time were most simple in control.

It is the idea of this article to give a number of lines along which developments may be made. The subject is one that has hardly been touched, leaving large fields for original work. It has been stated many times by those in the high places of radio that the set of the future will be one of single control. And all experimenters know that a good part of the present-day design in radio equipment and style was developed by the amateur.

Among the single-tube sets using a single control probably the most important field of endeavor has been along the line of using the primary, which functions in an aperiodic aerial circuit, as the tickler for feed-back from the plate (Fig. 1).

In such a circuit control of regeneration devolves to a great extent upon the rheostat in the "A" battery circuit. However, it may not be considered a separate control since it is by no means critical in its adjustment. In fact, a vernier instrument is not necessary for adequate control. The ordinary type serves very well.

A fixed condenser is connected between the grid return end of the secondary and the ground. This condenser helps greatly in stabilization and a number of capacities may have to be tried before the set is brought to its best operation. The capacity will depend largely upon the constants of the apparatus used and the style and type of aerial and ground system. All considered, however, this circuit is simple and little trouble will be experienced in bringing it to a fair efficiency.

A more profitable field of investigation, in so far as exceptional results are concerned, is that of capacity feed-back of the plate current for regeneration.

Since the laws governing this particular branch of electrical activity are a bit complicated, the experimenter will have to show extreme care in keeping circuits employing it from getting out of hand. He will have to do some really original work. More than in any other type of circuit, design must have very close and

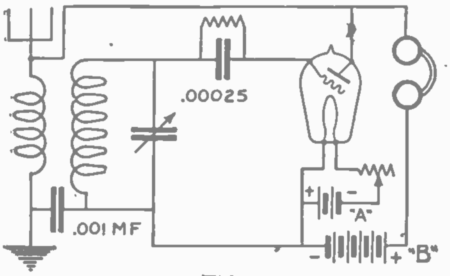


FIG. 1

One form of single control circuit in which regeneration is obtained through the aerial or primary coil. By proper design and a little experimenting the circuit may be adjusted so as to hold the maximum value of regeneration throughout the entire tuning range.

careful consideration. The improper position of a coil or too close proximity between a condenser and a lead may have a far-reaching effect in the final results.

One of the more elementary circuits incorporating capacity feed-back is shown at Fig. 2. Separate aerial and secondary circuits are again used with the aperiodic principle employed in the primary. As with most other circuits of this type, extreme care will be necessitated in the selection of the apparatus used. Some experimenting will be needed in the selection of the number of turns of wire for the secondary tuning inductance. Also the amount of coupling between it and the primary is of more importance than might be thought at first glance.

When making tests great care should be given the adjustment of the rheostat. It might be interesting to note the relation between the stability of the circuit, the amount of current in the filament of the tube and the characteristic of the tube employed. Hard tubes are suggested, although soft ones may be tried.

If results are not forthcoming with the circuit as shown in the illustration, another fixed capacity may be added in the feed-back lead. Different values must be tried and the proper one depends entirely upon the band of waves covered and the constants of the apparatus used. Of course it is unnecessary to say that the results obtained from the circuits shown will be much more gratifying if standard low loss equipment is used throughout than would be the case employing nondescript commercial or ill-constructed home-made apparatus.

For some unknown reason variometers have not recently enjoyed extreme popularity. Circuits employing them have come to the fore from time to time, but that great collection of experimenters who usually fall, with avidity, on every piece of apparatus as it comes from the hands of the inventor, seem never to have taken any great interest in this useful instrument.

The circuit shown at Fig. 3, employing a variometer with a split winding, seems to hold forth great promise in the ranks of the single-control receivers. The present arrangement may not prove extremely handsome from the final results, but the writer has a strong premonition that the future will bring forth a really noteworthy one-control arrangement employing just some such an adaptation of the variometer.

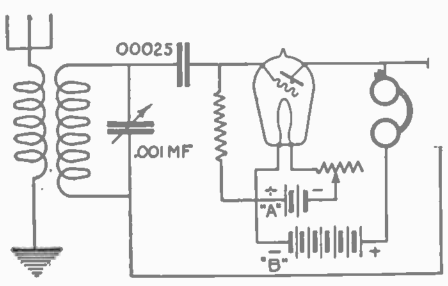


FIG. 2

The ultra-audion type of single control circuit. Although no provision is made for controlling regeneration, with little experimenting the circuit may be adjusted to the point of maximum sensitivity without setting up oscillations.

In the present circuit one winding on the stator is employed as the primary. (Here we might say that it seems utterly useless to tune the primary of the ordinary set. So very little is gained—absolutely nothing, in the great majority of cases—that it seems both a waste of material and an entirely useless complication of an otherwise good set to add the extra control necessary. There are losses, too, in connection with the usual condenser or taps, which more than compensate for whatever added selectivity may be gained. If the set is designed with any degree of care and proper attention paid to the losses in the instruments and the resistance of the various circuits almost the identical selectivity may be gained without the tuned primary as can be obtained with it.) One half of the rotor is used in the plate circuit as a tickler. The other section of the stator and rotor are connected together and employed as the secondary of the tuner.

Trial will designate the proper number of turns to be employed in the various circuits. The secondary or stator winding will very possibly stand as it is. Changes

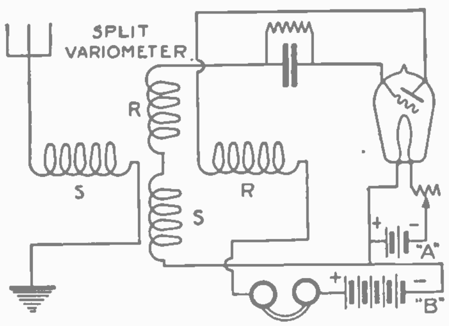


FIG. 3

By using a split variometer a very good degree of both wave length and regeneration control is obtained with one knob. The efficiency of the circuit depends entirely upon the design of the variometer.

may be necessitated in the rotor windings, however. Spacing between the two halves will have to be regulated.

This is an entirely new field and the experimenter is relied upon to produce some circuit worthy of note.

By a little study several hook-ups needing only one control should suggest themselves in the field of the ultra-audion or super-regenerator. One such is shown herewith in Fig. 4. The heart of the tuning apparatus is the honeycomb coil and the variable condenser. The former is of the 35 or 50 turn type, depending upon the size of the antenna system. In this case, as in some of those previously shown, regeneration is partially controlled by the rheostat in the "A" battery circuit. The condenser has a capacity of .001 mfd. (43 plates). The use of a hard tube is advised in this circuit, although a soft tube may be used with fair success.

The usual note of caution is hardly necessary in connection with a super-circuit. The experimenters who have had experience with them know their constant idiosyncracies and those who have not will, immediately they begin working with them. For the inexperienced, however, it might be said that they are extremely soft on the trigger. (Looking at them too directly will often set such a circuit into the most violent contortions in the form of oscillation.)

Another line which will prove profitable to the experimenter searching for the best in a single-control circuit is the incorporation of the tickler coil into a loop. This

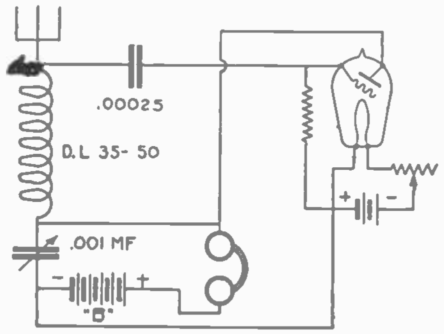


FIG. 4

Another form of ultra-audion single control circuit. With the proper size honeycomb coil and variable condenser very good results may be obtained.

has been done on several occasions, up to the present, no accurate data are available. The dimensions of the loop will, of course, be regular. The placement and size of the tickler are optional. The characteristics of the circuit and the "B" battery voltage will determine the number of turns in the coil, and after a preliminary adjustment the final control of regeneration will depend upon the rheostat. In those cases which have been tried, results have been all that could be expected and operation was by no means critical. With one tube, five miles from a broadcast station, such an arrangement gave good results on phones with a surprising freedom from static (the experiment was made during July) and interference. The sharpness of the set was remarkable as compared with the same instruments used in an ordinary three-circuit regenerator.

With the addition of a couple of stages of radio frequency and the deletion of regeneration a noted commercial one-control set results. In fact, the addition of two stages of audio frequency amplification to the set shown in Fig. 6 results in an extremely good set.

In connection with the control of regeneration a great possibility is evident in the proper balancing of the feed-back arrangement so it may be operated from the same shaft and knob as is used to adjust the tuning.

One such attempt was made, with a fair degree of success, through the use of an extension shaft on the secondary condenser controlling the tickler coil. Of course, it is technically possible to select such gears as would maintain a ratio between the wave length of the oscillatory circuit and the amount of coupling between the plate coil and the secondary. However, in the practical field a number of difficulties are met that quickly discourage the builder of such an arrangement. A variometer used in connection with a condenser might possibly give the desired results *if* the proper variometer could be designed and constructed. The

(*Continued on page 65*)

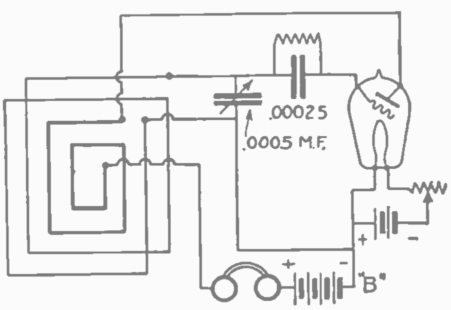


FIG. 5

This circuit, worked out by Marius Logan, has very good possibilities. A tickler coil is incorporated in the loop, giving the desired degree of regeneration. Experiments so far conducted prove the circuit very efficient.

Converting the Single Circuit Tuner

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

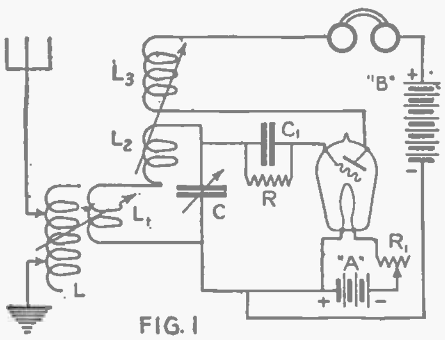


FIG. I

This shows how Mr. Peck's feed-back coupler is connected to a single-circuit tuner so as to form a double circuit. Experiments with this arrangement indicate that the receiver is made more selective and radiation is decreased.

MUCH has been written and said by the radio fraternity regarding the poor offending so-called single circuit tuner, and if the wishes of some of those who oppose the use of that tuner were followed each and every instrument capable of being used in a single circuit receiver would be junked. However, in the writer's experience, the single circuit tuner can be changed in form so that it will reduce radiation, and retain most of its simplicity of tuning, which will be much sharper.

The idea underlying this change is to separate the grid and the antenna circuits so that they are inductively instead of conductively coupled, as they are in the garden variety of single circuit tuners. This change does more than reduce the radiation from the set when it oscillates. It sharpens the tuning considerably and allows the use of the set in congested districts where an ordinary single circuit tuner is a menace and sometimes as broad as a house in tuning.

The finished set is also less critical in adjustment even though more selective. With it the difference between critical and sharp tuning becomes a vivid reality. A critical tuner may be far from sharp, as the tube may spill over into oscillation just at the point that the wanted station comes in best. Sharp tuning, on the other hand, is found when the set will really separate two stations, and will not spill over just when it is not wanted to.

When making this change over from your old "squealer" you can use all of its parts, and the only necessary addition is the special feedback coupler. This is built as shown in Fig. 2, although any form of coupler may be used. The builder may use his own judgment here and if desired may wind the coils on an old coupler form, it only being necessary to adhere to the winding data quite closely. This has been figured out, however, so that the cores or tubes used are of the size that is usually employed in the construction of couplers and will therefore be easy to obtain.

The constants of the coils are as follows:

Coil L2 is wound on a 4-inch tube that may be of any convenient length. It consists of eight turns of No. 18 or No. 20 D.C.C. wire, wound four turns on each side of the center as shown. The center part that is left free for the shaft is three-eighths of an inch wide. Space should be left on either end of the tube for the two mounting brackets. These allow the coupler to be mounted on the panel in any position desired.

The coil L3 may be wound on a standard 3⅝ inch ball rotor, and consists of about 60 turns of No. 22 D.C.C. or S.C.C. wire. This amount may have to be varied somewhat and the exact number of turns can best be determined by experiment. The figures given will, however, usually produce good results.

The construction of one coupler made by the writer is given in Fig. 2. Brass washers that just fitted the shaft were clinched in the stator tube to serve as bearings and they gave perfect satisfaction. Tubing was used for the shaft and the rotor pigtails were brought out through it. The shaft may be in one piece; hole drilled through will allow the pigtails to pass out through the end as illustrated.

The circuit to be used with the single circuit instruments and the feedback coupler is shown in Fig. 1. The coupler that was formerly used to tune the antenna and grid circuits as well as to provide regeneration by the feedback method is now used as a so-called two-circuit tuner. The stator tunes the antenna, while the rotor, in connection with a variable condenser, tunes the grid circuit. This variable condenser may be the one that was formerly connected in series with the antenna, as it will not be necessary in that position, if the antenna coupler is tapped in units and tens.

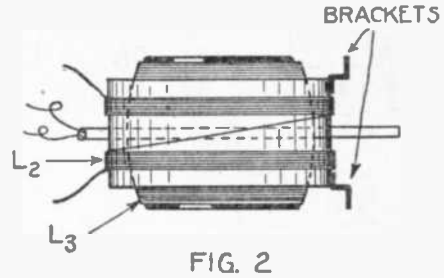


FIG. 2

Showing the construction of the feed-back coupler, the details of which are given in the text. As it consists of two separate windings, it will be found useful in a variety of experimental circuits.

The lettering on the diagram has the following significance:

(L)—Stator of the single circuit tuner coupler.
(L¹)—Rotor of the same.
(L²)—Stator of the feedback coupler.
(L³)—Rotor of the feedback coupler.
(C)—Variable condenser—.005 mf.
(C¹)—Grid condenser—.00025 mf.
(R)—Grid leak—½ to 2 megohms.
(R¹)—Rheostat, resistance depending on the tube used.
(A) and (B)—A and B batteries, respectively.

The tuning of this set will be found very simple. The rotor of the antenna coupler may always be kept at full coupling, unless it is desired to sharpen the tuning. Then the coupling may be loosened until it is found that by retuning the unwanted station may be eliminated. The feedback coupler rotor should be kept at or near zero coupling until a station is tuned in by manipulating the variable condenser and the tap switches. The coupling of this instrument is then tightened until the greatest amplification without distortion is obtained. Never advance the coupling until the set squeals, as such advancing will cause the set to radiate somewhat, but by no means as much as an ordinary single circuit tuner. Practically any set will radiate to some extent if not handled properly, and the set described above will measure up well for its non-radiating qualities when tuned as described above.

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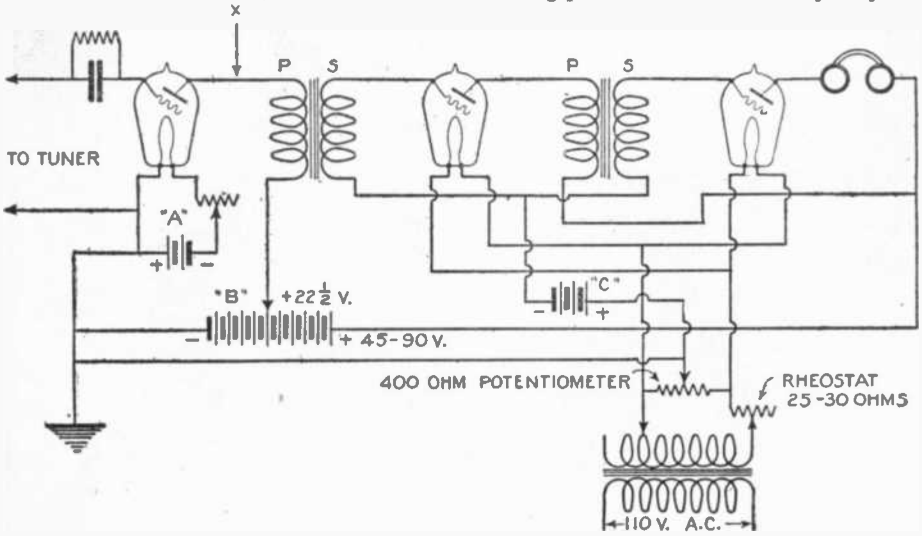
In order to be eligible for a prize the manuscript must deal ONLY with the experimental phase of radio, somewhat along the following lines: Radio *experimental* wrinkles. Short cuts for the *experimenter*. Simple devices to help radio *experimenters* in their work are wanted particularly.

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.

A. C. Lights Amplifier Tubes

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

EVER try to light the filaments of your tubes from the house lighting circuits? And did you ever burn out any tubes doing so? I have known several experimenters who through lack of knowledge or for some other reasons have helped the manufacturers of vacuum tubes greatly by attempting to use that current. However, do not get the idea that it is impossible. In this article you are going to learn just how it can be done in a very simple manner and with apparatus that should not cost you more than five dollars. Of course, the system described will only light the filaments of the amplifier tubes. Experiments with detector tubes have been very discouraging so far because of the audible hum generated.



The experimenter may dispense with the cumbersome storage battery by employing a toy transformer shunted by a potentiometer for lighting the amplifier tubes. Note that a 1½-volt dry cell tube is used for the detector with separate "A" battery in order to eliminate the A. C. hum.

Let us consider for a moment the detector tube in the arrangement that we are going to use. Notice the diagram herewith. You will see that the filament of the detector tube is heated by an "A" battery. Here is a complication, but it can be most easily disposed of by using a 1½-volt tube and one dry cell. One cell is much cheaper than the several that you use when the house current is not employed for the amplifier. And then, if the dry cell should go bad, a crystal detector can be substituted for the tube and by rearranging the connections somewhat you can go right on receiving. These details are so simple that I will leave them to you to work out and will go on with the A. C. problem.

About regeneration. No method for obtaining it is shown in the diagram. That does not mean that it cannot be used, but that we did not know what kind of a tuner you are going to use with the circuit. A tickler coil or a tuned plate circuit may be placed at the point indicated by (X) in the diagram. In fact, by a little simple reasoning the circuit herewith can be adapted to any tuner.

Of course A. C. has been used before for lighting the filaments of vacuum tubes, and even sometimes for supplying the plate current. However, most of the methods heretofore described have made use of massive transformers and expensive rectifiers that have put the proposition beyond the reach of the average experimenter. Some of the methods, furthermore, could be applied only to those sets using five or more tubes, and then a crystal detector had to be employed. This latter was for the purpose of cutting down the 60-cycle hum. In the procedure described here this is done by using a regular "A" battery for the detector and a "C" battery in the amplifier circuit.

Now as to the actual apparatus necessary for using the alternating current. A step-down transformer of the type known as a "toy transformer," a standard rheostat, and a potentiometer are all that is required in addition to the regular radio set. If your present set is equipped with binding posts for the "C" battery very few changes will have to be made in it to adapt it for use on A. C. It will only be necessary to provide separate terminals for the "A" battery to the detector and to connect the negative lead of the "B" battery to the positive of the detector (A) and to the positive of the "C" battery as well as to the ground. Otherwise the connections may be left as they are.

You will undoubtedly want to make a separate unit of the "A" battery A. C. supply unit. It can very well be placed in a cabinet with the rheostat and potentiometer mounted on the front panel. Let us sound a note of warning here relative to the transformer to be used. If you use tubes of the 199 type any transformer will do. If, however, you use the WD or the A type be sure that the transformer that you buy will supply at least one-half ampere at the required voltage. Most of these transformers are tapped for various voltages from two to twelve. After you connect everything up, and before you place the tubes in the sockets, be sure that the switch arm on the transformer is on the right point or that the connections are made to the right binding posts according to the type of transformer used, and the type of tubes to be lighted by the current.

Not only is the use of a "C" battery recommended, but it is imperative. This little source of power prevents hum in the amplifier circuit. It should be about 3 to 6 volts and may consist of flashlight cells. One battery will take care of the grids of both of the amplifier tubes when connected in the manner shown.

The actual operation of the current supply apparatus is simplicity in itself. The rheostat and potentiometer settings need never be changed for any pair of tubes after they are once determined. Only when tubes are changed should the settings be moved slightly. However, there is no trick to setting the two instruments. Here's how. Connect the transformer to the lighting circuit, and turn on the current at the socket. Place the potentiometer at one end of the winding and, with the detector tube lighted, turn the amplifier rheostat on until a loud hum is heard in the loud speaker. Then adjust the potentiometer until the hum disappears.

When a signal is tuned in make small adjustments of both the amplifier rheostat and the potentiometer until the best operating positions are found. Then, when through using the set, turn off the amplifier current at the socket, and that's all there is to it. In a few months' time you will find that the cost of constructing this apparatus will more than pay for itself in the saving of the cost of new "A" batteries, and you will also be partially free from the fear that your "A" battery may give out just when you need it. Experiments are now being made with a device for smoothing out the current sufficiently for use on a detector tube. When complete the results, if satisfactory, will be presented in this magazine.

Using the system described herewith, there will be practically no hum. If any at all is present, it will be so low as to be negligible.

Some manufacturers are advertising that A. C. battery supply units are dangerous to use and may result in fire if they are used. In this case at least disregard such warnings.

"A" Battery Switch

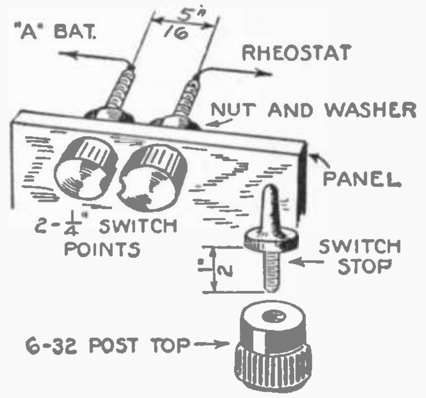
I HAVE constructed several radio sets for friends and one of these friends came to me with his set one Sunday morning to have an "A" battery switch put into the set.

I had no switch and none could be obtained. After a little hard thinking I evolved a good idea; with two ¼-inch switch points, one switch stop and the top of a binding post a neat-looking battery switch was made which cost about five cents and a few minutes' time. This is shown in the illustration.

The two switch points are fastened to the panel one-sixteenth inch apart, or five-sixteenths inch between centers, and a suitable hole is drilled between the two points to fit the switch stop tightly.

Many readers will find this interesting and a help in making a cheap but good "A" battery switch.

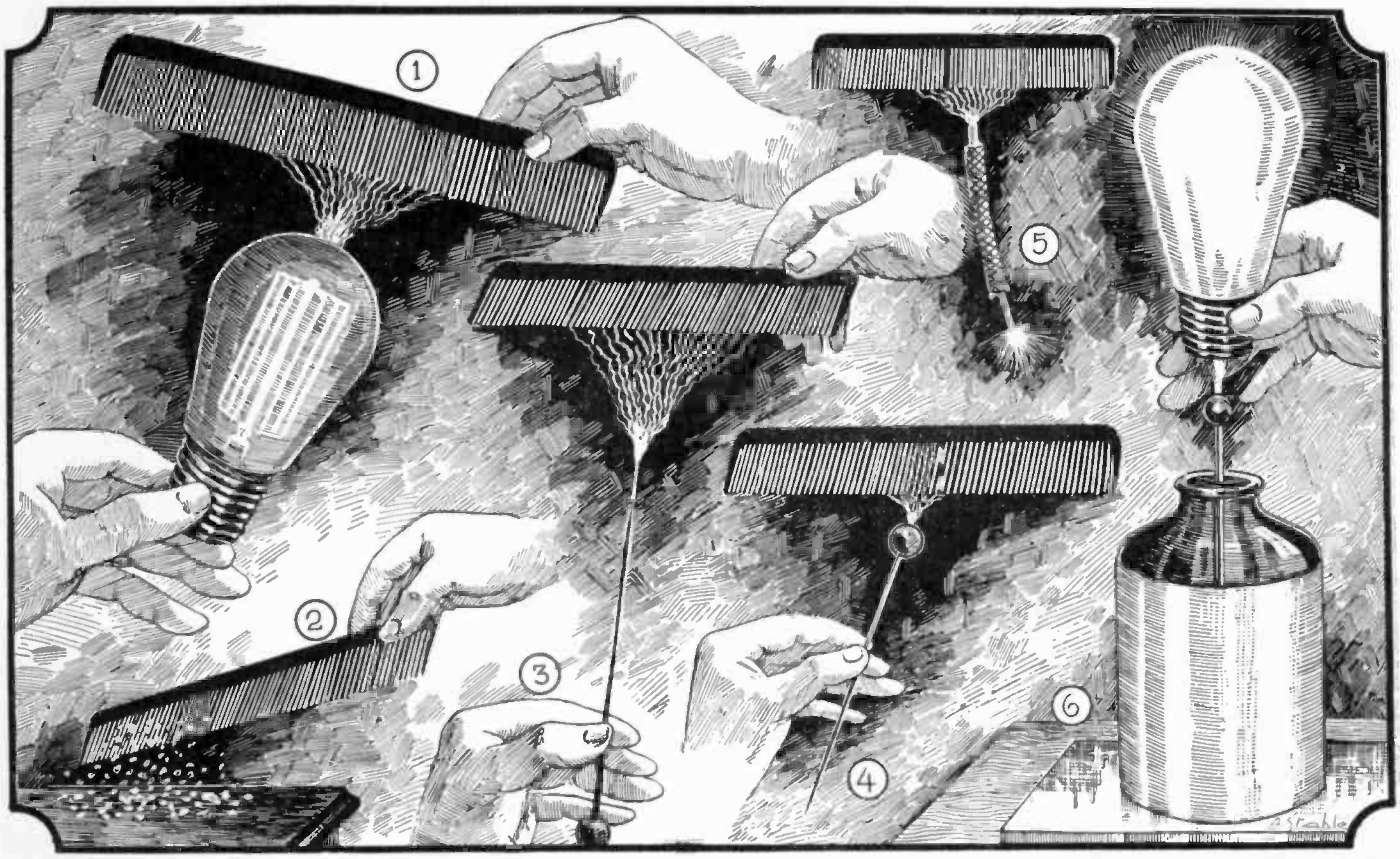
Contributed by Jos. M. Loeffler.



By attaching a binding post cap to a switch stop and plugging it between two grooved switch points this experimenter made a very simple filament switch.

Bulbs and Their Resistance

By Robert J. Smith



The lack of a Whimshurst machine need disturb no amateur. Here are some experiments in spectacular statics for the amateur with unlimited aspirations but woefully limited means. Yet it was such experiments as that shown in Fig. 2 which gave its name to electricity. Amber, in Greek "elektron," was used by the ancients for this experiment; "elektron" is the origin of the word electricity.

THE paper magnet, which draws up paper, sticks to walls, jumps after the hand and near objects, is well known, but the magnet which picks up bits of tinfoil is not generally familiar to all.

This is really an unmagnetic problem, but is involved in the experiments described here. The well-known hard rubber comb in itself has furnished many a trick. The spaces between the teeth, if wedged apart enough, will give a good condenser, with air as the dielectric.

When the comb is passed through hair (such as a dog's or even our own), if dry and free of oil the comb will receive enough charge to act across a gap five inches from a pointed instrument and one-half inch from a rounded instrument (this can only be perceived in the dark). When charged it will have the power to draw distant objects, such as particles of tinfoil, toward itself, but as the objects draw near the comb the discharge will send them off in speedy departure.

Upon further examination with the comb it will be found to have the power of delivering its charge into a Leyden jar by placing the comb one-half an inch from the terminal. The jar must be very well insulated from the ground. Glass is about the best for the purpose, all things considered.

Coming back to the comb again, it will be noted that when an insulated wire is placed above the comb the discharge will go in at one end and out of the other.

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, 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.

Take an incandescent lamp bulb; it may be for 220 or 6 volts, colored or not, carbon or tungsten filament. Charge the comb and place it at the lamp terminals. It will be found that the spark is forced into the wires of the bulb, thence fades away into the inner portion of the glass. Despite the number of bulbs, the makes, the sizes, every bulb produces a different effect. This is due to the settings of the wires which control the whole affair.

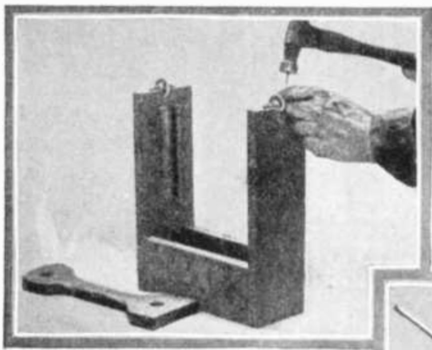
If the comb is again charged and held at the point of the glass it will light the glass stem, and give a beautiful light. Turning to the Leyden jar again, draw the comb through the hair and place at the jar, thus charging it. Repeat several times, then place the bulb at the discharge terminal of the jar. The result will be an increase in brilliancy, compared with the "comb and bulb" affair. This is due to the fact that several times the original amount of static charge is released at once.

The general rule to be followed out in the so-called frictional generation of electricity is to rub animal and vegetable substances together. The very name of electricity is derived from the Greek word *elektron*, meaning amber. This was observed to attract small objects when rubbed. Amber is a fossil resin and therefore vegetable and if rubbed with silk or wool, both animal, it will show static excitation. The same applies to our comb, which is vegetable in origin. In 1 it draws a discharge from a lamp; in 2 it picks up little bits of paper; in 3 a bonnet pin gives sparks; in 5 a bit of insulated wire, and in 6 a Leyden jar effect is illustrated.

The human hair is animal, the comb of hard india rubber is vegetable, so the conditions are present for static excitation.

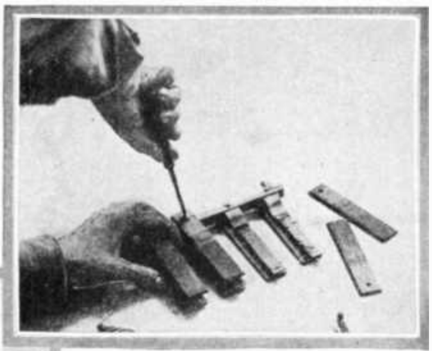
Small and Powerful Battery

By Dr. E. Bade



The two cuts on the left show the frame of this battery with pulleys, so as to constitute a plunge battery in which the plates hold their positions in or out of the solution.

On the right the operation of attaching the plates to the central bar of the battery is shown. This bar with attached plates is raised up and down and stays in position on account of the counterweights.



The mixing of the solution using a medicine measure or graduate and an extemporized wash bottle, are shown directly above and the portability of the battery and its great convenience are shown by the figure carrying it like an ordinary bundle.

THE simplest and easiest battery to make is the plunge battery and at the same time it is one of the most powerful primary elements we have. In power it is only exceeded by the storage battery. The plunge battery is especially adapted for that kind of work which requires a powerful current for a comparatively short time, say an hour or so.

Four of these elements are to be made, and as each gives 1.8 volts, the four, which will be connected in series, give 7.2 volts. Such a battery is strong enough for almost every purpose as it will run electric motors, spark coils and light six-volt radio tubes.

Each cell consists of two carbon electrodes which are positive, and one zinc plate between the carbons which is negative. The solution used is sodium bichromate, four ounces dissolved in eight ounces of water, to which one ounce of sulphuric acid is added. Five or six ounce graduates full of this solution added to each cell, which is first nearly filled with ordinary water, will run the battery for about one hour.

The containers used are small pint jars and four are required. These are placed into a wooden container as illustrated. The two long sides are from two to three inches high, the narrow sides are two and one-half times the size of the jar in height. Now take a piece of wood one-half inch thick and one inch wide and about one-eighth inch shorter than the inside length of the box. Fasten an eye on each end, attach a piece of twine, fasten two rollers on the top of the box, place the twine over the rollers and mark the place where the rod slides. Here two guides are attached on each side so that the rod slides easily.

Remove the rod; in the center bore a hole so that it lies exactly over each jar. Through these four holes the zinc is bolted. The zinc is just as wide as the carbon, about one inch, and the same length, about six inches. Punch or bore a hole through the zinc near one end. Just beyond the hole bend at right angles; a half an inch down it is again bent slightly, while half an inch below it is slightly bent in the opposite direction, so that the zinc now lies in the exact center of the wooden rod.

Making Gold

Synthetic gold can now be made. Professor Miethe of Berlin, Germany, has discovered how to make real gold, using a mercury vapor lamp.

While at the present time the method is too expensive to do it economically, still it opens the way for future practical work along these lines.

Read all about it in the November issue of SCIENCE AND INVENTION.

Electrical Articles to Appear in November Science and Invention

Rotating Floors for Houses.
X-ray Finger Prints.
Oil-Electric Switching Locomotive.
Cheap Radio Primary Cell—How to Make it.
By Dr. Ernest Bade.
The Latest Solodyne and Crystodyne Circuits.
How to Build a Good Short Wave Set.
By A. R. Marcy.
Neutralizing Methods.
By Leon L. Adelman, 2 A.F.S.
Radio Oracle.

The carbons are cut from flat plates about one-quarter inch thick and they are six inches long and one inch wide. The carbons taken from dry cells can also be used, but take up more room, and if they are to be used, then very wide jars must be employed. One-half inch or, better still, one-quarter inch from the top a hole is bored in each carbon.

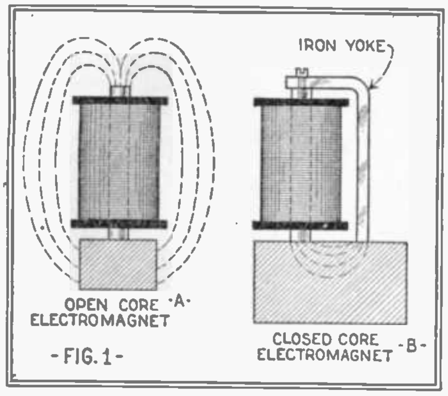
Now take a piece of copper wire, either Nos. 18, 20 or 22, about six inches in length, bend the center into a loop, do the same with each end, and attach the ends to the carbon by passing a short round-headed screw through the loop, then through the carbon, and screw to the wooden rod opposite the zinc. Each side of the zinc receives one of these carbon plates. Remember that the zinc must not touch the carbon in any part as this will short circuit the cell and it therefore will not function.

Connect the first pair of carbons to the second zinc by means of the bolt holding the zinc in position. The second pair of carbons connect to the third zinc, the third pair of carbons connect to the last zinc. The last pair of carbons form the positive pole of the battery, the first zinc forms the negative pole of the battery. Now lift the wooden rod with its burden of zinc and carbons and lead the twine over the rollers. Attach weights to the end of the strings so that the rod is balanced and remains in any position in which it may be placed.

Then attach the handle. This is the top board and is shaped so that it can be carried conveniently. Nail or screw firmly in place, but take care to see that the rollers do not bind. Fill the jars three-quarters full of water, use tap water, and add, with a medicine dropper, the concentrated bichromate and sulphuric acid mixture. When the bar holding the carbons and zincs is lowered into the solution, the current flows and stops only when the liquid is exhausted or when the plates are raised out of the jars. Therefore lower the bar only when the current is required and lift as soon as finished, for the zinc will be eaten away whether current is taken from the cell or not when it remains in the solution. The carbon will remain good for years, the zinc must be renewed when it is eaten away.

Practical Hints and Data for Building Electromagnets

By H. Winfield Secor
Associate Member, A. I. E. E.



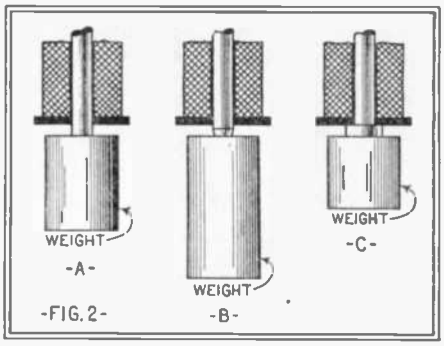
Open cored and closed cored electromagnet showing the paths of the lines of force. Observe how they vary in the two.

ELECTROMAGNETS serve many purposes in mechanical and electrical fields, and are extensively used for experimental apparatus. A few interesting hints of practical value in regard to electromagnets are the subjects of Figs. 1, 2 and 3.

In Fig. 1-A is shown a single-pole, open-core electromagnet, with the magnet flux from one pole returning through the air to the opposite pole and an iron weight being lifted. As becomes evident, this is the most inefficient form of electro or permanent steel magnet, due to the high reluctance of the magnetic path, the magnetizing coil having to produce a force sufficient to pass the magnetic flux along the path through the air from one pole to the other.

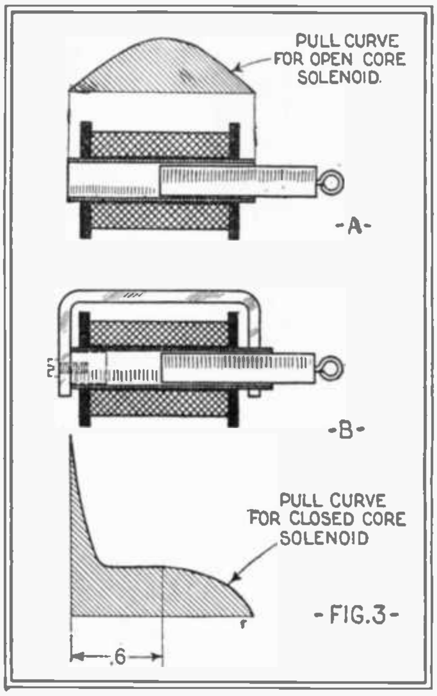
The way to overcome this excessive loss and resulting inefficiency is shown in Fig. 1-B. A piece of iron forming a yoke is screwed or bolted securely to the core in the manner shown. The only path through the air where the flux has to jump is at the two infinitesimal gaps at the two pole-faces in contact with the iron block being lifted. As the picture shows, the gain in efficiency with the same identical magnet coil and core is about 200 to 300 per cent. In other words, by simply providing an iron return core or yoke, a weight can be lifted two and one-half to three times, and sometimes more than that where a simple open-core magnet is used.

In Fig. 2, (A), (B) and (C), the importance of the shape of the pole-face in contact with the weight to be lifted or armature is demonstrated. At (A) consider the size of the weight being lifted in contact with the pole-face, whose diameter is the same as the core of the electromagnet. At (B) we see that a greater weight is lifted by reducing the area of the pole-face; the reason for this increase in lift is due to the fact that the flux density in lines per square inch is here increased, and by consulting a table of lifting power for different flux densities it is obvious why this is so. The higher the flux density per square inch the greater the lifting power in pounds. Fig. 2-C shows that a lesser weight is lifted when the pole-face is made of greater diameter than the core carrying the magnetizing coil.



Examples of weights sustained by magnets with different shaped pole ends. For each case there is a certain shaped end which will give the greatest tractive power.

Solenoids, or suction type electromagnets, are very useful and necessary in many classes of work, and Fig. 3 shows two highly important characteristics of solenoids. At (A) we see how the average pull curve looks for a simple open-core solenoid without any return yoke. The maximum pull is obtained at the center, and in any case it is, of course, weak compared to the excellent results obtained with the iron-clad solenoid shown at Fig. 3-B. With this class of solenoid, provided with a return yoke of one form or another, the efficient pull of the solenoid on the moving core is six-tenths the distance from the rear of the solenoid. The curve also shows that the average pull is extended over a greater distance, while a very powerful and rapid increase in the pull occurs as the moving core approaches the end of the stroke.

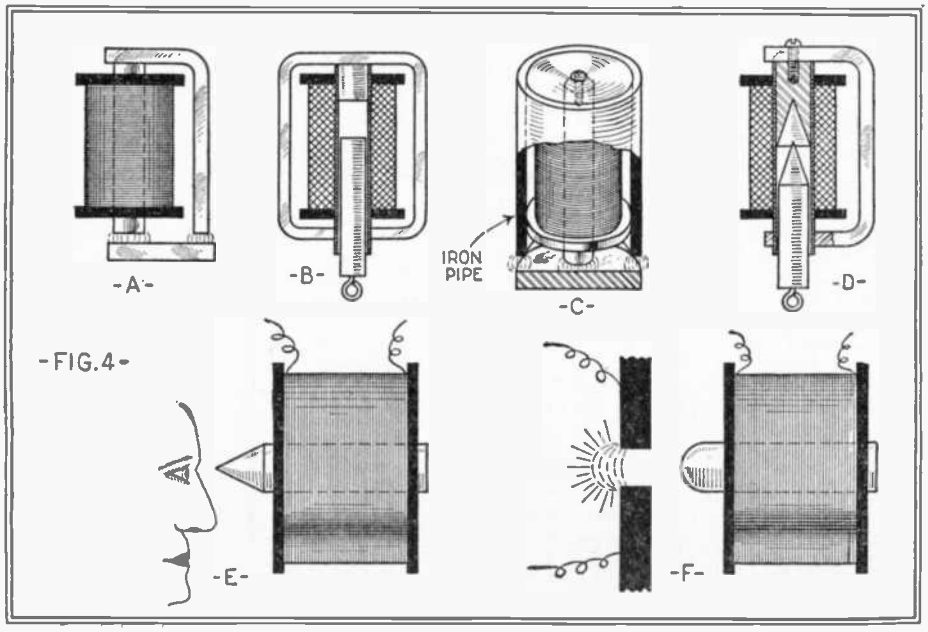


Curves of solenoids, both open core and closed core types.

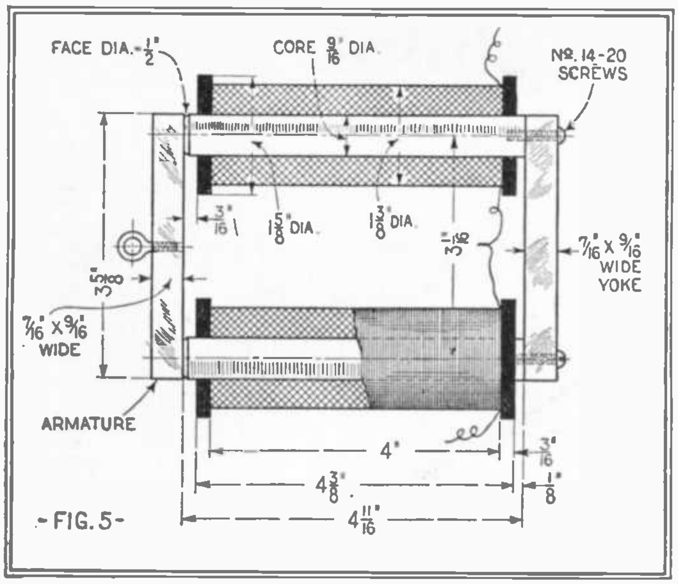
If you already have an open-core solenoid it will prove very interesting to provide it with an iron return yoke, and see how greatly the pull in pounds is increased. The increase will amount to 200 to 300 per cent, and sometimes a great deal more, depending upon several factors.

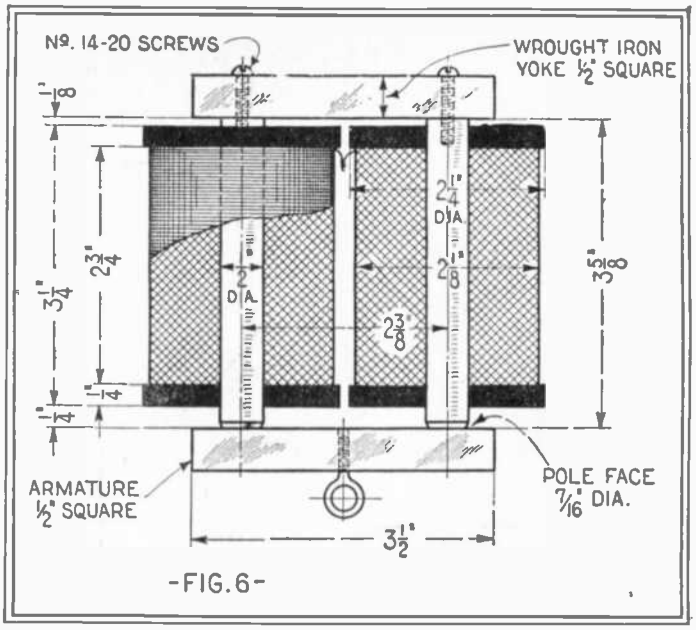
Several interesting facts concerning solenoids and electromagnets in general are shown in Fig. 4. At (A) is shown the simplest method of greatly increasing the pull of an open-core electromagnet by providing it with an iron yoke to return the flux to the opposite pole. At (B) is shown an iron-clad solenoid having a double iron yoke. At (C) is shown an iron-clad solenoid, the yoke being formed of a piece of iron pipe provided with an iron plug at the end, which is rigidly secured to the core. This form of magnet gives a very powerful pull. For providing a more uniform pull over a given distance in a suction type magnet or solenoid the cone-shaped core and stop shown at Fig. 4-D proves very valuable. Those interested in the method of extending the uniformity of the pull of a solenoid, utilizing this cone feature, will find the matter discussed in books on electromagnet design, such as Underhill's.

The typical "eye" magnet employed by physicians for removing iron or steel particles lodged in the eye is shown at Fig. 4-E. The pole-faces of these eye magnets are invariably made of conical form. The reason for this is to conserve the flux as much as possible, and to provide a maximum magnetic pull at the small point at the



Various examples of electromagnets, including the very interesting eye magnet, which is of use in machine shops for withdrawing particles of iron or steel from the workman's eye. A jacketed magnet and an interesting example of the solenoid type may be specially observed.





Dimensions with views are given of two powerful electromagnets, the first to be operated by a battery current, and the other one by a 110-volt D. C. lighting circuit. The first one, small as it is, can lift nearly 30 pounds.

end of the cone, which is very desirable for the purpose of attracting the small particle which may be lodged in the eye. The round-shaped pole-face on the core of the electromagnet shown at (F) is frequently utilized where a magnetic blow-out is required for switches and circuit-breakers, the magnetic field blowing out the arc as the circuit is broken.

Powerful Battery Electromagnet

One of the most useful electromagnets that the writer has encountered is shown at Fig. 5. It can be wound when necessary with finer wire for 110-volt D. C. operation. This tractive type of bipolar electromagnet is constructed at slight cost, and when excited by ten dry cells, or 15 volts, with a current consumption of but .95 ampere, lifts fifty pounds. The lifting power varies with the number of dry cells used.

The iron cores, yoke and armature are made of soft annealed wrought iron, or mild cold rolled steel may be employed if the wrought iron is not available. The cores are 4 11/16 inches long by 9/16 inch in diameter. Two No. 14-20 iron machine bolts hold the yoke to the cores, the rear ends of the cores being drilled and tapped to accommodate the screws. The dimensions of the armature and yoke are given in the drawing. The pole-faces of the cores in contact with the armature are tapered slightly to make the face diameter one-half inch; this increases the flux density at the point of contact with the armature and consequently increases the pull in pounds.

For operation on dry cells each coil is wound with 14 even layers of No. 22 B. & S. gauge single cotton-covered magnet wire. The cores are first insulated with several layers of paper or oiled linen. The two coils are connected in series, care being taken that the two resultant poles are north and south, respectively. This is easily ascertained by means of a small compass, or also by the fact that when the two coils are connected, so as to "buck," the resultant strength of the magnet is nil; while when properly connected a very powerful pull results.

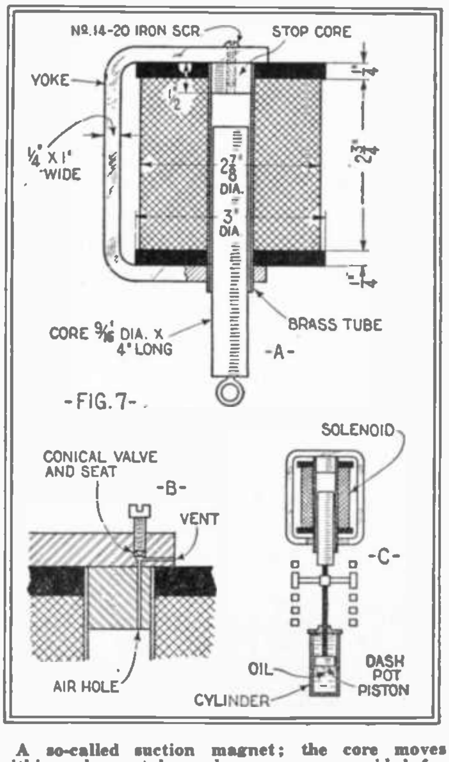
110-Volt D. C. Lifting Magnet

The double-pole lifting magnet shown in Fig. 6 will be found useful for many purposes. It can be used in a variety of ways, and changes can be made in the general arrangement of the armature for the purpose of operating new and peculiar mechanical devices. This bipolar magnet is very efficient and consumes but .1 ampere on 110 volts D. C. With this slight current consumption it has a lifting power of 28.5 pounds by actual test.

In Fig. 6 the principal mechanical dimensions are given, and each coil is wound with approximately 1.65 pounds of No. 30 B. & S. gauge enameled magnet wire. Each coil has a resistance of about 550 ohms, a total resistance of 1,100 ohms. The successive layers of wire on the coils should be wound as evenly as possible, and a layer of thin paper put on occasionally as required to keep the layers even.

The iron cores, yoke and armature are made of annealed wrought iron, or if this is not available, mild cold rolled steel may be used. Several layers of oiled linen or well shellacked paper should be wound around the cores before any wire is wound on. Suitable holes may be drilled through the fibre bobbin ends, through which to bring the leads from the inner and outer layers, respectively. The pole-faces in contact with the armature are tapered off, so as to have a contact diameter of 7/16 inch to increase the flux density at this point, and consequently the pull.

Care should be taken in connecting the coils in series so that north and south poles result at the two free core ends in juxtaposition to the armature. This is tested as described above.



A so-called suction magnet; the core moves within a brass tube and means are provided for obtaining a dashpot action.

110-Volt D. C. Suction Magnet

For operating some pieces of mechanical mechanism solenoids or suction type electromagnets are very desirable. Quite a powerful one is described here and is shown in detail at Fig. 7. This solenoid consumes but .3 ampere on 110 volts D. C., and gives a pull of 2.5 pounds at ¾-inch stroke; 2¼ pounds at ⅞-inch stroke; 1.8 pounds at 1¼-inch stroke, and 1 pound at 2-inch stroke. By referring to the pull curve in Fig. 3-D it will be seen how the pull in pounds on a solenoid core increases as the core moves into the brass tube within the magnetizing coil until it reaches the point of greatest traction. The bobbin is formed of two fibre discs fitting tightly on a brass tube having a wall about 1/16 inch thick, as shown in the drawing, Fig. 7. This tube must be made of brass, copper or other non-magnetic material, preferably metal, so as to obviate warping. The tube, as the drawing shows, rests against the rear end of the yoke, but extends through the front end of the yoke, so that the sliding core is not in contact with the iron at any point during its movement, which would cause sticking.

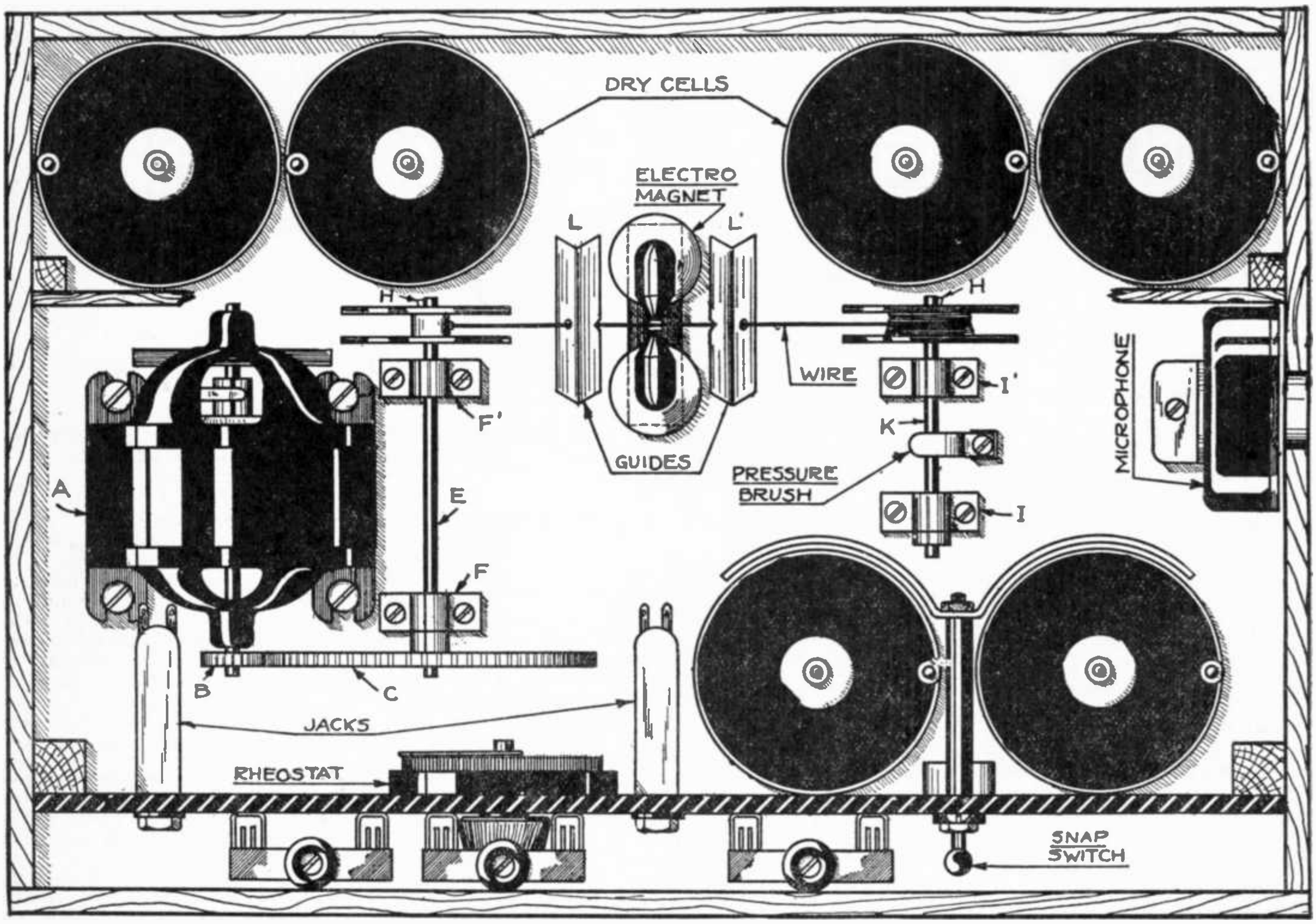
The core and the yoke are made of annealed wrought iron, or else cold rolled machine steel may be substituted. The magnetizing coil is composed of approximately three pounds of No. 28 B. & S. gauge enameled magnet wire, giving a total resistance of about 366 ohms. An iron "stop" core about ½ inch long is secured in position in the inner end of the brass tube, as shown, the practice of using these short stop cores serving to increase the pull of the solenoid core at the end of the stroke.

One thing to be remembered in building electromagnets, no matter whether large or small, is to get the greatest number of turns of wire possible in the most compact space, and as near to the iron core as possible. The data given for the magnets and solenoids above is from the

(Continued on page 69)

Simple Telegraphone

By Roy C. Hunter



The telegraphone, the invention of Poulsen, the Danish Edison, embodies an electromagnetic phonograph in which a steel wire represents the disc, receives the message and delivers it over and over again if desired. The wire is seen towards the upper part of the illustration, passing between the poles of an electromagnet, which impresses the message and receives it again.

THIS apparatus is not a toy, but a real telegraphone, and can be used whenever a regular dictaphone or dictagraph is used. It is excellent for office work, for dictation, and it has the advantage that the same wire for recording messages can be used over and over again.

The message recorded on the wire will stay indefinitely and can be reproduced at will. The speech or music recorded on this telegraphone when reproduced has none of the scratching noises commonly heard in the phonograph.

The most important part of the apparatus is the recording magnet. It is shown in Fig. 1. The cores are soft iron bars five-eighths inch in diameter and 6 inches long. One end of each is sharpened to a fine point and bent at right angles, so that when they are screwed into the bottom piece or yoke the points will almost touch. The sharper the points are the better will they operate.

The yoke is a soft iron bar one inch by three-eighths inch and four inches long. Holes are drilled in it and threaded for the two cores. Two holes are drilled in it for screws. This work can be done at a blacksmith or machine shop. Fibre tubes, with rims on each end, that will just slip on the cores, come next, or wooden spools can be used instead. These are two inches long and the rims are 1½ inches in diameter. A coil of No. 24 B. and S. gauge enameled copper wire is wound on each of the spools. Each coil should have 10 ohms resistance. One pound of wire will be needed.

A carbon granule microphone will be needed. A signal corps microphone was used by the writer, and it has the advantage that it has a handle which will serve for mounting it.

A microphone transformer is used to connect the microphone to the recording magnet. The core is four inches long and three-eighths inch in diameter, and is composed of a bundle of soft iron wires. Circular wooden discs are driven on its ends to hold the coil. Several layers of paper are wound on the core and the secondary is wound on. It is composed of No. 28 enameled copper wire. About 350 feet will be needed. It must have 20 ohms resistance or the same as the recording magnet.

The secondary and primary are separated by several layers of paper and the primary wound on, for which No. 26 enameled wire is used. It must have a resistance equal to the average resistance of the microphone. As this differs in different microphones no stated amount can be set, but it will have to be measured while in service.

The current used by the magnet is furnished by four dry cells, which are carried in the box. They are connected in series. Two others are provided, the use of which will be explained later. No. 30 B. and S. gauge steel wire or No. 1 piano wire is used to record the sound on. As it must move between the pointed poles of the secondary magnet a small electric motor is required; so small as to be scarcely larger than a toy. It is shown at (A).

(B) is a ½-inch cogwheel, which is geared to the motor shaft and drives the large gear wheel (C). The upright bearings (F) and (F') hold a shaft with the wooden spool (D), the one the wire is wound on when speech is being recorded or reproduced. Spool (G) holds the wire. The spools are each 2½ inches in diameter and one-half inch in the center. The slot where the wire is wound is one-quarter inch wide.

A small wire brad is driven in the spool to hold the end of the wire. (D) and (G) are mounted so they can be slipped off the end of their shafts. A slot is cut in the shaft and a wedge-shaped key (H) slipped in it to hold the spools. The shafts are three-sixteenths inch in diameter. (I) and (I') are upright bearings which hold the shaft (K). The guides (L) and (L') are heavy brass strips, two inches wide and two inches long, bent down the center at right angles. A ¼-inch hole is drilled in one side and on the other side in line; a V-shaped slot is cut to guide the wire between the poles of the electromagnet. They are mounted on blocks in line with the poles.

The whole apparatus is mounted in a box, which is 12½ inches by 8½ inches area and 7 inches high, inside dimensions. A 1-inch hole is cut in one end and a bezel placed in it and the microphone mounted behind it. The top should be held on with screws and one side hinged to provide access to the inside. The other side is hinged to give access to the switchboard. The switchboard is a regular radio panel, 12½ inches by 7 inches. It is screwed to slats which are screwed to the ends of the box on the inside. One double-pole double-throw knife switch, two double-pole single-throw knife switches and a snap switch are mounted on the panel. They are connected as shown in the hook-up. The snap switch is the kind used in radio to cut the filament on and off.

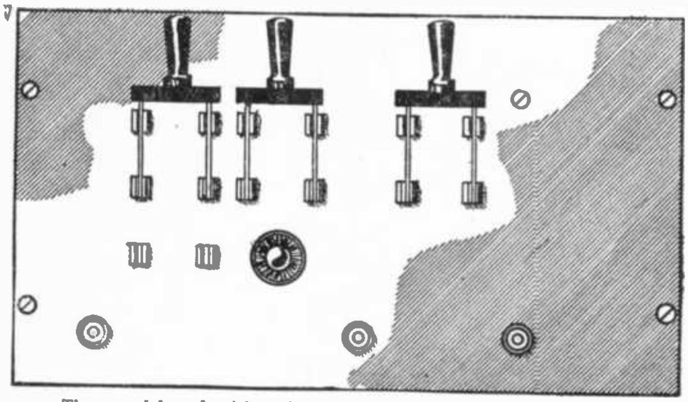
Two radio jacks are mounted on the panel. One, a single-circuit jack, is connected so the phones can be plugged in, and the other, a two-circuit jack, is connected as shown. When the plug is removed from the jack, the microphone in the box is connected in the circuit. But when another microphone is connected to a plug and placed in the jack it is placed in the circuit and the other one is cut out. This is to allow a distant microphone to be used. The dry cells are placed in the box as shown and iron rails run across them to hold them in place.

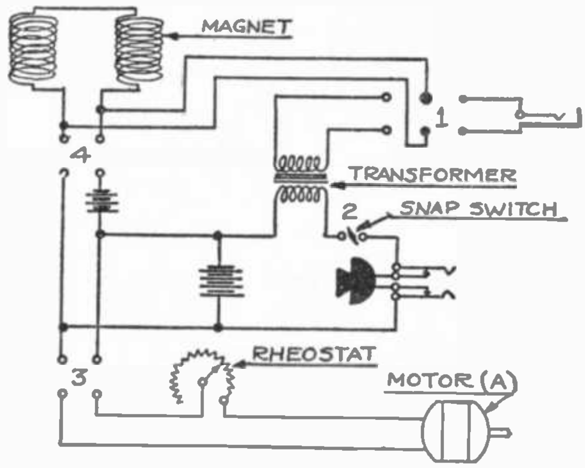
The recording magnet and motor are mounted in the box as shown. The magnet is screwed to the bottom of the box. The motor is placed on soft rubber blocks and then screwed to the box. This is so the motor will not cause noises in the microphone by vibration. If it does it will be necessary to use a microphone placed outside of the box. It may take a little experimenting to get the parts lined up so the recording wire will pass accurately between the poles of the magnet. It will not hurt if the wire touches them. A rheostat is mounted on the panel to regulate the speed of the motor. A stiff brass spring is mounted so that it rubs against the shaft (K) to prevent it from turning too easily. This keeps proper tension on the wire.

To use the telegraphone, the wire on which the sound is to be recorded is wound on its spool and slipped on the shaft (K), the key is inserted and the end of the wire, with a little loop in it, is fixed to the spool keyed on the shaft (E). Switch 4 is opened and switch 3 is closed. When the motor is brought up to speed, the switches 1 and 2 are closed and it is ready for recording sound. Switch 1 is placed to the (A) position. Before the recorded sound is listened to it will be necessary to wind it back on the other spool.

This is done by changing the places of the spools and opening switches 2 and 1. Switch 4 is already open. Switch 3 is closed and the wire is wound back. To listen to the recorded sound, switch 3 is closed and switch 1 thrown to the (B) position. The phones are plugged in and it is ready to be listened to. If it is desired to remove the message from the wire so as to be used again for a different message, it is run between the magnets with switches 1 and 2 opened and 3 and 4 closed.

If desired, the box may be stained and a leather handle attached to make it portable.





The panel board with switches of this telegraphone, designed to be constructed by the experimenter.
Right—Diagram of the connections of the telegraphone, giving the entire hook-up.

The apparatus operates as follows: When the microphone is talked into it changes the resistance of the circuit and consequently the recording magnet gets more or less current. As the strength of the magnet is varied a corresponding variation is made in the strength of the magnetism in the wire. These magnetic changes are retained by the wire and when the wire is moved by the magnet for reproduction it induces current in the magnet windings. As the windings are connected to the telephone receivers, a change in them will cause a change in the receivers and the original sound is heard.

When the message is to be removed from the wire, the batteries are connected so the electromagnet is getting more current and has a stronger field. As the wire is moved between the poles of the electromagnet the extra strength of it will remove all magnetic irregularities and the wire can be used again. It is as if a phonograph record were planed off for a second imprinting.

Plug Resistances

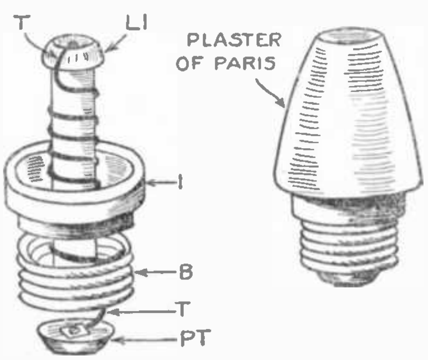
By Raymond B. Wailes

A LAMP bank resistance has been used by many experimenters in obtaining varying current strengths, especially from 110 volt D. C. circuits, for charging storage batteries. By screwing lamps of various wattage into sockets connected in parallel, any amperage can be obtained.

For instance, if the lamps are connected in parallel and their total wattage is 400, then 400 divided by 110 would be the amperage, or about 3.6 amperes. The disadvantage of this system is that the experimenter has to have on hand a supply of lamps of varying wattages and then, he may only get the approximate amperage desired, and it is very wasteful of energy.

Instead of using lamps, home-made resistance units can easily be made from burned out fuses. As shown in the illustration, an ordinary short porcelain lead-in or tubular insulator is used as the winding form. This fits into the porcelain upper of a blown fuse which has its brass cap removed.

It is best to use nichrome resistance wire for the unit. The wire should be wound about the porcelain tube, with one end fastened to the little brass projection of the threaded part (B.) The other end of the wire should be led through the insulator and connected to the brass lug (T) on the base portion of the fuse (PT). The connections should be made with a pair of pliers. Soldering will be of no value as it will melt off when the unit is used. A coat of plaster-of-Paris should be given the whole unit as shown.



A resistance made from a burnt-out fuse, lead-in or tubular insulator. A nichrome wire is wound around this and the whole is then set in plaster of Paris. The brass thread of the original plug is utilized.

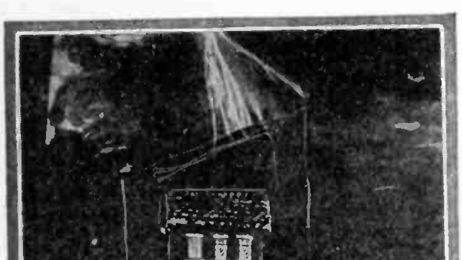
A scheme of connections is shown. One wire from the 110 volt system connects the sockets on one side. The other side of the sockets are connected to the source to be controlled or supplied with varying amperage of current and the remaining wire of the lighting system leads to the remaining terminal of the device to be operated. The resistance is controlled by simply screwing the proper resistance units into the sockets. The beauty of the units is that they are easily made, strong, and can be wound to any resistance.

Constructing a Tesla High Frequency Resonator

By Kenneth M. Swezey

Experiments with a Tesla coil, the construction of which is comparatively simple although some nicety of management is required in the winding. The author obtained very wonderful results from his home-made apparatus.

ONE of the greatest advances which the future may know undoubtedly lies within the realm of high frequency currents of electricity. Wireless telegraphy and telephony have already blossomed forth, and wireless power transmission is soon to follow. By learning all the whys and wherefores of the electrical waves that are propagated through space, science may yet discover the nature of the medium through which they travel—whether it be an "ether" or something else—and that may lead on to still greater discoveries in the regions of light- and thought-waves and the utilization of atomic energy.



A model of a house is exposed to a Tesla coil discharge to simulate lightning. A little aerial protects it, and no harm is done.

Perhaps some original discoveries in this field may be made by amateur experimenters or technical students in the schools, and primarily for the assistance of these worthy fellows there is described the construction of a high frequency oscillator exceptionally well adapted to the home or school laboratory, and with which hundreds of highly instructive experiments may be performed.

This coil is of the uni-polar Tesla type, in which the lower end of the secondary wire is attached to the inner turn of the primary, and sometimes grounded. The sparks from such a coil are not as long for a given voltage impressed upon the primary, as are those of the horizontal two-terminal coil, but the amperage is greater and some of the heavier and more spectacular experiments can be performed. The writer has one which he operates from a transformer with a secondary potential of 15,000 volts and a variable adjustment of either, one-quarter, one-half, or one kilowatt, and with the middle rating can secure a flaming spark about 15 inches long.

The secondary cone will probably have to be built up for the occasion, as these are rather difficult and expensive to obtain on the market. It should be 12 inches in diameter at the bottom, 5 inches in diameter at the top, and 14 inches high.

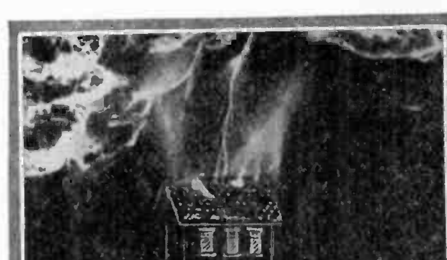
It may be constructed of heavy wrapping paper, built up layer upon layer, and cemented together with insulating varnish, until the desired thickness is obtained. Some sort of form or mandrel is necessary, over which to wrap the paper, and an inexpensive one may be made by the local tinsmith out of sheet iron. Have him cut the iron so that the completed sheet iron cone will be slightly less in diameter than the sizes mentioned, to allow for the thickness of the paper walls. A few rivets are sufficient to hold the edges together.

Procure some sheets of good stout wrapping paper, and cut it either the way the tinsmith cut the iron, or simply wrap the sheets around the cone and trim the edges off later. Be particularly careful about the first layer. See that it fits snug, and that no varnish is on the inner side, for if there is, and it is allowed to dry, it will be almost impossible to remove the core from the paper. Coat each layer with the varnish, and wrap the following layer tightly over it. About ten or twelve layers will suffice.

When the last layer has been put on, the iron core is to be removed and the paper cone impregnated with the varnish, to stiffen it, to help it resist moisture, and to improve its insulating qualities. This may be easily done by pouring some varnish into a long shallow pan, and rotating the cone in it until the paper has soaked up as much of the varnish as possible. Then it may be put aside to dry. This may take many days, on account of the thickness of the paper, but it is best to leave it until the drying is complete.

Insulation is an all important factor in a coil of this type, as the voltages to be encountered are tremendous — rising at times to several thousand volts between next turns of wire. And as the varnish is the chief medium for the insulation, it should be selected carefully. It must have high insulating quality, low attraction for moisture, and as low a dielectric constant as is commensurate with the first quality. Ordinary shellac will not do. Some of the better armature and radio varnishes are excellent.

When the coil is thoroughly dry, the

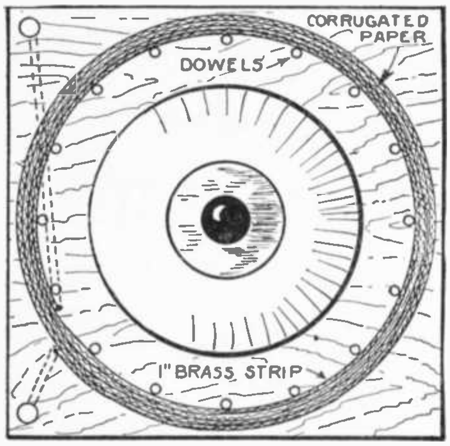


The same house, unprotected by an aerial, absolutely struck by lightning, by the use of this coil.

iron core may again be inserted, to stiffen it, and the winding may be begun. Use No. 30 double cotton-covered wire, and wind closely and evenly to within a half inch of each end—of course, you must begin at the small end. This wire is very fine—almost like a fine cotton thread—and ordinary winding by hand takes a great deal of patience. If you have a lathe, it is best to use it; and if not, it is second best to conjure up some sort of a winding rig. The writer took the more laborious method (by hand), and twelve hours were consumed in the actual winding.

Punch a small hole through the paper

cone with a needle, about a half inch from the edge, at the small end, and pass six inches of the wire through this to anchor



TOP VIEW OF CONE AND BASE

The lay-out of the Tesla coil seen from above. The illustration on column two shows the baseboard and dowels seen here in plan.

it. Then put on a coating of varnish extending about an inch up the tube. When this becomes "tacky" carefully start the winding. After about five turns, give them a good coating of varnish and allow to dry thoroughly. This measure is important, as otherwise the turns would have a tendency to slide off the end.

Apply the varnish in little bits as you go along, and allow sections about an inch long to dry before proceeding, for the wire is so fine and the varnish so slippery when it is wet that one turn tries to climb up on top of the turn preceding it.

When the winding has been completed, it should be given four or five coats of the varnish; not too thin, either, for thin varnish tends to soften that which is already on.

Next come the wooden parts. The kind of wood does not matter so much as the fact that it should be well seasoned. All of the parts should be given at least three coats of the varnish.

The base should be an inch thick and 19 inches square, with a quarter-inch bevel around the edge to improve its appearance.

Two disks, each three-quarters of an inch thick, should be made to fit the ends of the cone, with shoulders cut as shown. If you have no lathe, the cheapest and best alternative is to have them made by a wood-turner. With home-made cones the dimensions may vary slightly, so it is well to measure very carefully before giving the woodworker your order.

From the center of the baseboard describe a circle 16 inches in diameter. On this, drill 16 three-eighth inch holes, at equi-distant points, each about three-eighth inch deep. In these holes insert wood dowels 1¼ inches long, securing them with glue.

Then cut 4 two-inch lengths from a wooden rod 1½ inches in diameter, also four lengths one inch long. The long ones are to serve as the feet for the base, and the short ones as the feet for the large disk which surmounts the base. Metal screws may be used on the base legs, if they are countersunk at least an inch. Dowels had better be used to secure the feet on the cone base.

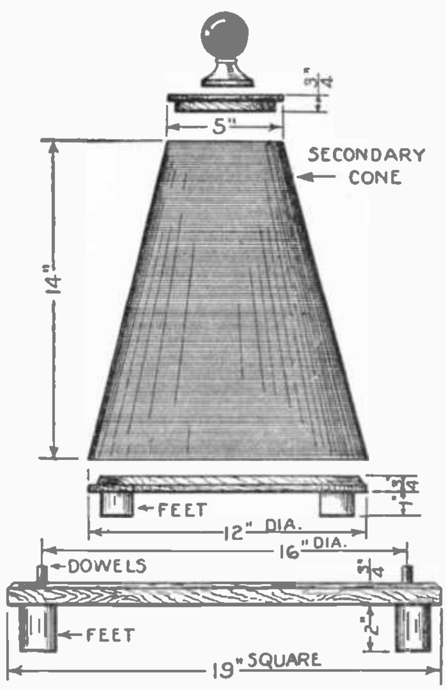
The primary winding consists of five turns of one inch brass strip, wound about the circle of dowels, and the turns separated by strips of corrugated paper that have first been impregnated with the insulating varnish. Several turns of tape will bind the ends together.

Two large binding posts, connected under the base by two brass strips to the two ends of the primary complete the work on the base, except, perhaps, that a wire may be led from the inner turn to a binding post located near the center of the disk, so that the lower end of the secondary can be conveniently connected.

If the disks fit the cone tightly, no other support will be needed, and the whole apparatus can be set up or dismantled readily; but if they do not, or if a more rigid support is desired, one or two bakelite rods, threaded at the ends, and passing through the center of the cone, may serve to hold the ends together.

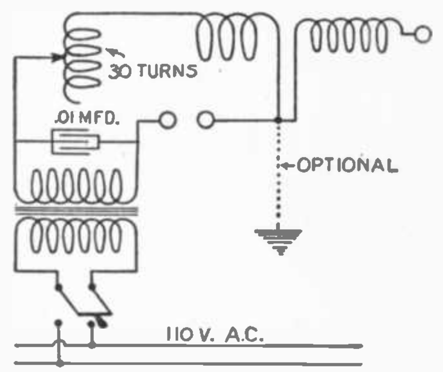
The ball on the top may be from 2 to 4 inches in diameter, and is of the type found on bed-posts, brass railings, and andirons; the larger sizes are quite difficult to obtain by honest means. It is connected by a wire to the upper end of the secondary winding.

If the preceding instructions have been followed carefully, the resonator is now in workable shape, and you are ready to consider the auxiliary apparatus needed for its proper operation.



The elevation of the Tesla coil, showing the cone wound with wire and the circular base with its supporting feet and dowels.

The transformer may range from one-quarter to one kilowatt, and may have a secondary rating of from 10,000 to 20,000 volts. The higher voltage will obviously produce a greater voltage in the resonator secondary. It is preferable that the trans-



How the Tesla coil is wired, the location of the spark-gap and condenser and the optional grounding.

former have some sort of magnetic leakage, to keep the gap from wastefully arcing under full load.

For best results, the condenser should have a capacity of about .01 mfd., and should be fully capable of withstanding the power you use. Mica condensers are ideal, for strength and compactness, and glass plate condensers come next. The author built one of photographic plates, the units being connected in series-multiple, which has withstood the strain well. Before that, while experimenting with different condensers, eight single units of the glass plate type were crashed within two minutes each.

The energy that can be put into the oscillator primary depends upon three things: the voltage of the transformer secondary, the capacity of the condenser, and the frequency of charge and discharge. These bear an intimate relationship, so none should be overlooked.

The spark gap is a very important factor. The chief essential is that it shall not allow the spark to arc, and that means that it must be kept cool. A rotary or a quenched gap is ideal. But an ordinary straight gap may be used providing a fan blows continuously upon it. With my apparatus the fan increased the high frequency spark length eleven inches! The gap must be opened as far as possible, without putting too much strain on the transformer secondary or the condenser.

It is essential that the resonator be tuned, for it is really nothing more or less than a type of oscillation transformer. And for this purpose a tuning inductance of about thirty turns of heavy wire or brass ribbon, is needed, with clips or a sliding contact to allow for variation. This number of turns is for a coil of eight inches average diameter. Only when tuned, will the resonator give effects from a violet haze to a crashing spark fifteen inches long.

The inner turn of the primary and the lower turn of the secondary, may be grounded or not as desired.

Rewinding Telephone Magnetos

WE experimenters often get tired, we might say, of using the same kind of current, especially those who experiment with the high voltage telephone magneto. Changing it from the high voltage to any desired lower voltage is quite simple, and is both instructive and interesting.

First remove all the fine wire from the shuttle armature, being careful to preserve the insulating material on the armature. Then rewind with 300 turns of No. 22 magnet wire, soldering each end of the wire to the same points to which fine wire was attached. This will give a voltage suitable for running 3-volt lights, telegraph sets, and many other electrical instruments.

By winding it with a heavier wire and less turns the voltage will be less and vice versa, each turn by the law of inductance contributing its potential.

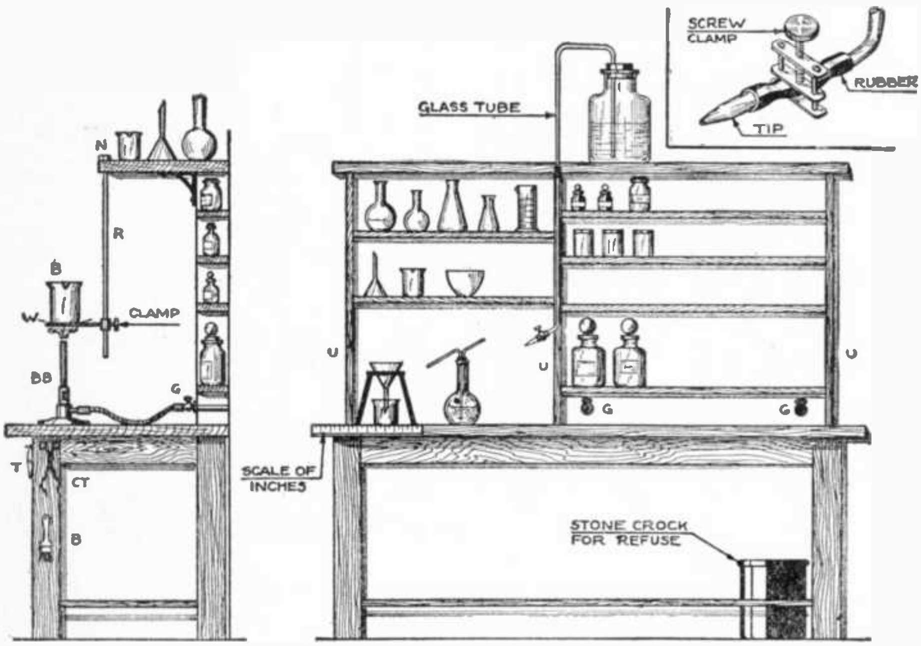
Contributed by Oliver G. Holt.

Influence of Magnetism on Life

EXPERIMENTS have been carried out by Messrs. F. W. and F. C. Lee at the Johns Hopkins University, to determine whether a rotating magnetic field had any effect upon the growth of a living organism. Trout were hatched from eggs immersed in the rotating field, but after 45 days, when all the eggs had hatched, no difference was observed between the fish thus produced and those hatched under control conditions, nor was the hatching time altered. Other organisms were tested, including bacilli, but always with negative results. Describing their work in *Science*, the authors conclude that in the case of growth matter is composed of atoms of which the electrons are in a state of static equilibrium.

Starting a Chemical Laboratory

By Raymond B. Wailes



A simple and well-organized chemical bench for the experimenter. Gas is to be had from hose cocks (GG). The gas line is hidden by a back-board.

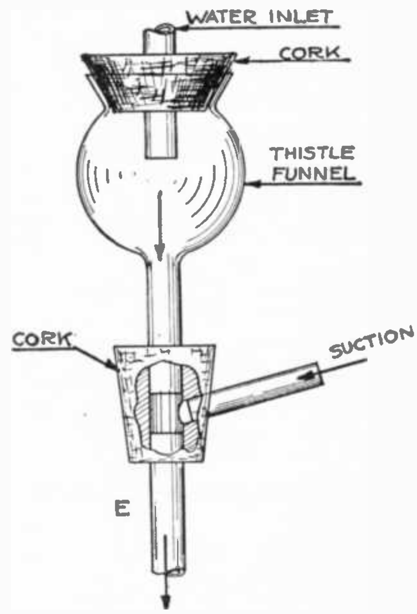


Fig. 2. A simple method for obtaining a vacuum. The parts here can be permanently installed or taken apart at an instant's notice, if they have to be used for other purposes.

A CHEMICAL laboratory is what one makes it. An unpretentious dark corner of a cellar, a squatty spot in the attic, a spare stall in the stable, a greasy bench in the garage; all can be the chosen hunting grounds of the sportsman in quest of a knowledge of chemistry.

But no matter where the undergraduate or experimenter, be he amateur or professional (and there are both of them), selects his working place, a little laboratory, simple as it may be, should have certain qualities which make for cleanliness and speed of work and at the same time incorporates a semi-professional aspect at least. The few ideas in this article have been found very useful by the author in his work, and it is believed that they will be of advantage to many experimenters who contemplate starting a chemical laboratory.

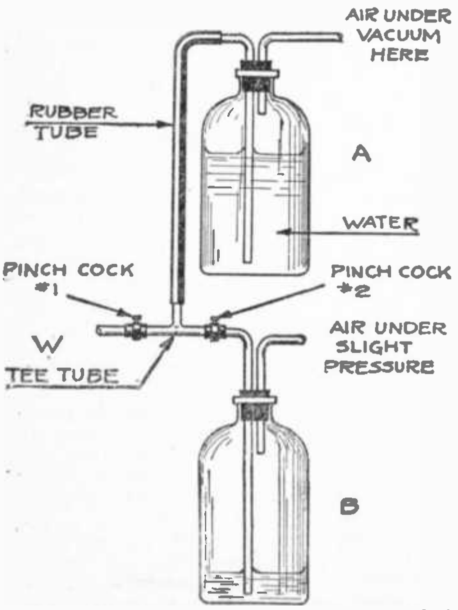


Fig. 1. Here's how to get water supply and air under slight pressure, even if running water is not available. Control is had by pinch-cocks (1) and (2).

The bench of the chemist can be likened to the artist's brush. It is indispensable. A typical chemical bench is shown. White pine can be used in its construction, which should present no difficulties to the average handy fellow. A bench made by the writer some years ago and having the characteristics of the one shown was found highly serviceable.

The bench should have a height of 38 to 40 inches, the top being two feet deep and as long as space is available. The construction is no different from that of the average workbench, excepting that shelves for the reagent and chemical bottles are needed.

The shelves are supported by three uprights (UUU) cut from 3 or 4-inch width dressed lumber, seven-eighths of an inch thick. The spacing between the shelves is left to the experimenter, depending on the height of the reagent bottles. The lower or first shelf can be fitted up as a shelf for the larger reagent bottles. Here the common and constantly used acids and liquid reagents should be kept, within easy reach. If a set of regular glass-stoppered reagent bottles are to be had and all are of the same size the first shelf must be capable of carrying them by making it an inch higher than any of the bottles. If desired guard rails can be fastened to the shelves as tne illustrations show. This keeps the bottles in place. A guard rail at the back is essential—most chemists would not use the front rail.

Apparatus can be stored on a similar sized shelf arrangement shown on the left of the sketch. Free working space is to be had to the extreme left of the chemical bench or laboratory table. No shelves are present here and distillations, filtrations and the usual chemical experimentation can be performed with freedom.

Running water is desirable in any experimenter's chemical laboratory, although not indispensable. If no running water is to be had, the bottle reservoir on a shelf topping the bench will be found valuable. Distilled or plain water can be

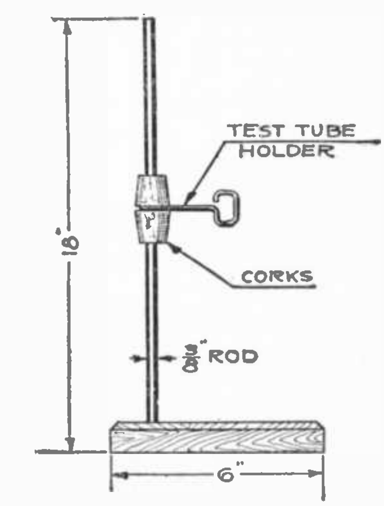
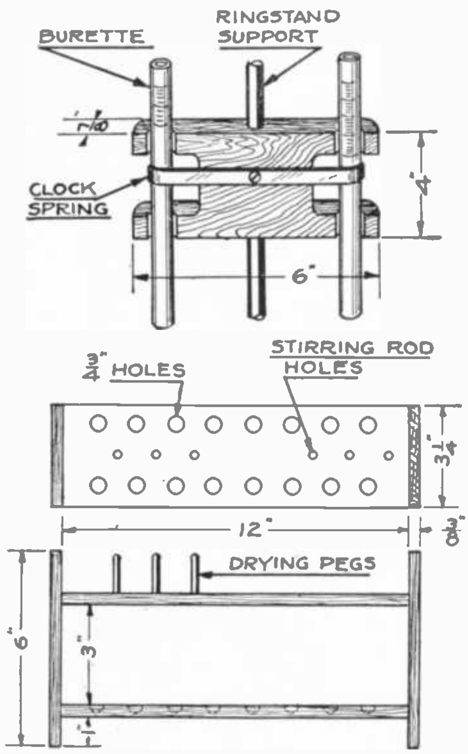


Fig. 3. The ringstand, made of a wood base carrying an iron rod. An ordinary test tube holder is shown here ready to receive a burette for a titration.

led to the stopcock or pinch clamp placed within easy reach at the middle of the bench.

The scheme shown in Fig. 1 can be used also. The bottle (A), full of water, is placed on the top shelf. By opening the pinchcock or pinch clamp No. 1 water will be delivered at (W). to a test tube, or other vessel. Opening pinch clamp No. 2 will allow water to pass into the bottle (B), which should be located beneath the table. The water flowing in this bottle (B) will force air out through the short glass tube bent in the form of an L, at (Y). This air under slight pressure can be led into water in which a chemical is dissolving, thereby tending to stir the whole. The air can also be used to operate a small blast burner to be described later.



Figs. 4 and 5. A clock spring and a wooden block can also be shaped into a burette holder as shown, and below it the dimensions are given for a professional-like test tube rack which can be made from quarter or three-eighths inch wood.

A method for obtaining air under slight vacuum is shown in Fig. 2. Here water with city pressure is led through a glass tube inserted into a stopper, which is in turn inserted into the bulb of a thistle tube. The water passes into the stem and through the stopper into and out of the lower tube (E). At the same time this passing water draws in air from the little side glass tube as shown. This side tube has a slight slant from the horizontal to prevent water from backing up into it. A fair degree of suction can be had by this simple method. The holes should be bored through the cork with a regular cork borer, or a hot nail considerably smaller than the glass tubes which pass through the cork, and filed smooth to exact dimensions with a round file.

Supports

Supports, or ringstands, as they are sometimes called, are used for many purposes, generally for heating, sometimes for filtering, and other purposes. A simple support can be fitted to any overhanging bench as shown in the laboratory table sketch. The rod (R) is thrust through a hole in the shelf and held in place by a nut (N). The clamp below carries a four-inch square piece of wire gauze (W), upon which rests a beaker (B), which is to be heated by a Bunsen burner (BB). This wire gauze will prevent many a flask or beaker from cracking. A sheet of iron five inches square and one-eighth of an inch thick can also be used over a Bunsen burner, and a vessel and its contents which are to be heated placed upon this. This forms a simple "hot plate" and is to be preferred to the wire gauze.

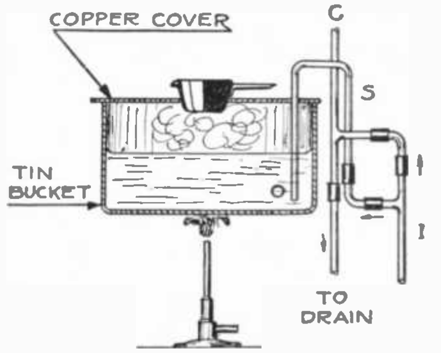


Fig. 6. A steam bath which will not burn out. A strip of paper placed in the bottom of the container will char and attract the experimenter's attention, however, if the water does evaporate completely.

Further additions to the chemical bench can be made by incorporating a foot rule on the edge as shown, and also hooks carrying forceps (T) crucible tongs (CT), which are used to handle hot crucibles, and a small brush (B) which can be used to sweep spilled liquids or solids from the bench.

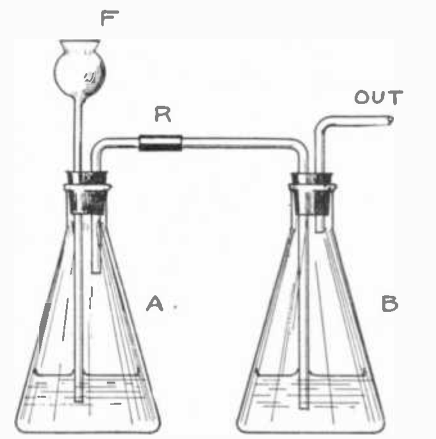


Fig. 7. The simplest gas-generating apparatus is made from two flasks (A) and (B) carrying two-holed stoppers through which passes the thistle tube and glass tubes as shown.

A widely used support is shown in Fig. 3. It consists of a wood or iron base 6 by 4 inches and seven-eighths thick carrying an iron rod three-eighths of an inch in diameter and 18 inches long. Many items, such as burette clamps, rings, universal clamps, etc., can be purchased from dealers in laboratory equipment to be used with this stand or support. A simple method by which a burette can be held is also shown in Fig. 3. An ordinary Stoddard's test tube clamp is slipped over the rod and held in position by two large corks which have a single hole bored in them and through which the rod passes somewhat tightly. The base of the support can be given a coating of black stovepipe enamel.

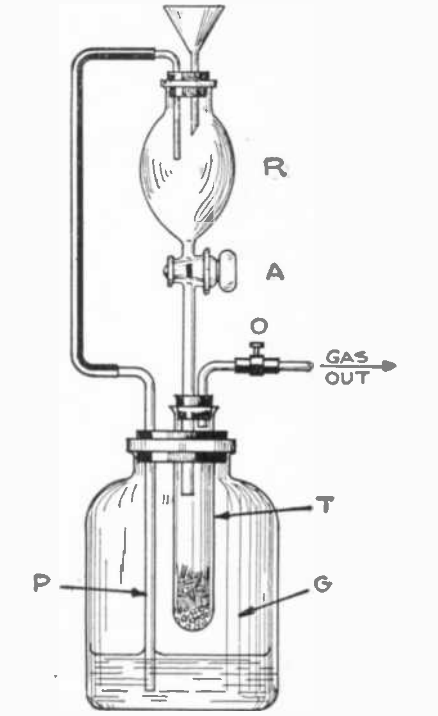
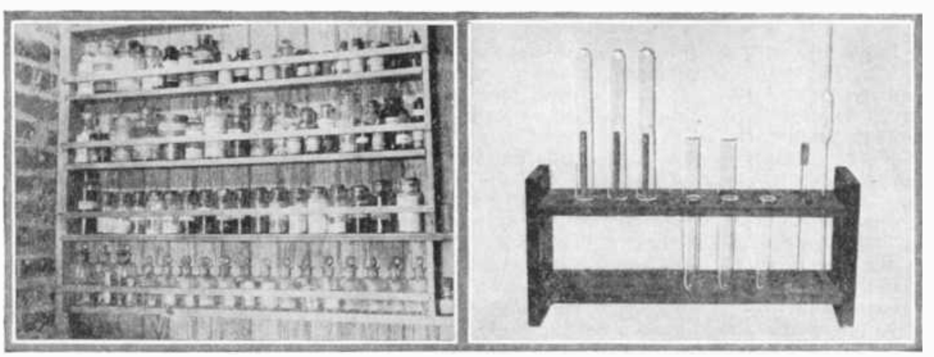


Fig. 8. This gas generator automatically circulates the acid over the solid in the test tube (T), thus assuring complete consumption of the acid.

A simple burette clamp is shown in Fig. 4. A block of wood six by four by seven-eighths inches is fitted to the support rod just described. A clock spring or strip of phosphor bronze is mounted so that it will engage tightly a burette placed as shown.

A rack for test tube is shown in Fig. 5. Glass or wooden drying pegs can be mounted on the top shelf; on these wet test tubes are to be inverted to dry. Several ¼-inch holes can also be made in the top shelf to carry pipettes, or even stirring rods, or policemen, as they are called. These can be made by closing both ends of a 6-inch or 8-inch length of glass tubing in the blue flame of a Bunsen burner and slipping a 1-inch length of rubber tubing over one end. This rubber tip is used to scrape sediments or precipitates from beakers, flasks, etc.


Left. A typical experimenter's chemical shelf. The guide-rails are wooden strips. The entire lower shelf is occupied by glass-stoppered reagent bottles.
Right. A test tube rack can be easily made by the experimenter. Small holes in the top shelf support pipettes, stirring rods, etc. Use dowel rods for the pins.

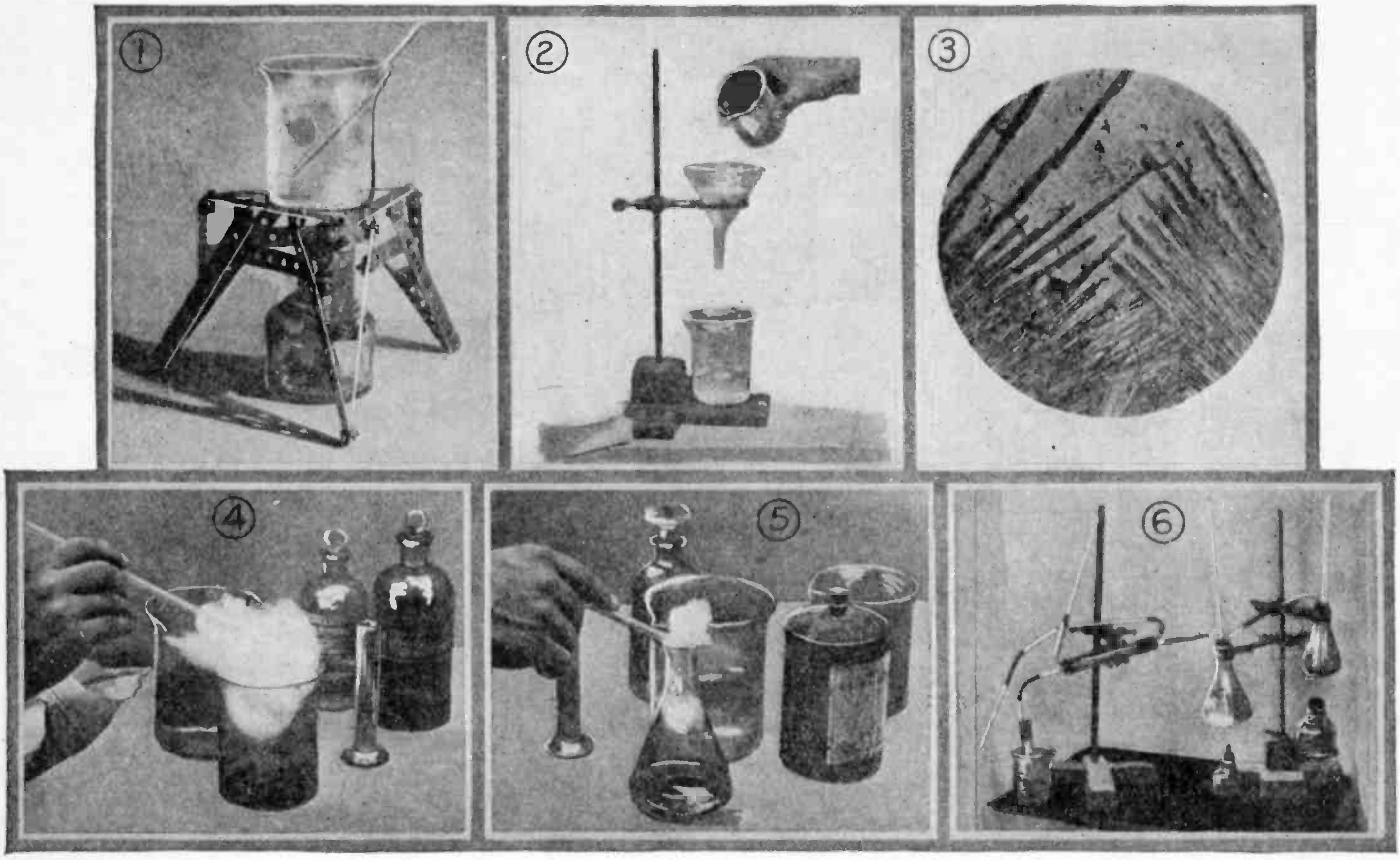
A Steam Bath

A chemical experimenter will have use for a steam or water bath, which is used to heat flasks, beakers, casseroles, etc., at a gentle temperature such as that of boiling water. A water or steam bath is shown in Fig. 6. The vessel is a tin pail fitted with a copper cover which carries a hole through which the

(Continued on page 69)

Chemicals in the Medicine Chest

By Dr. E. Bade



Various operations for experimenting with the chemicals found in the household medicine chest, including solution, filtration, crystallization and distilling, are here shown, making up a very interesting set of experiments to be tried with comparatively little apparatus.

CHEMISTRY is not an occult science, for its fundamentals are all around us and its rudiments are in daily use in the home. Even such a simple compound as sodium bicarbonate, one of the main constituents in baking soda powders, illustrates this as it makes the dough light and porous. It is a substance which readily gives off part of itself as a gas when heated or neutralized.

But this is not its only use. It is often employed as a medicine. One grain of this substance mixed with a grain of sodium chloride (common table salt) is used to relieve both headaches and dizziness caused by fumes of ether and alcohol when inhaled in excessive quantities. Sodium bicarbonate itself can be used by external application to relieve pain from small burns, and above all, it will help to cure infections derived from poison ivy.

Of far greater value in the medicine chest is iodine, a steel-blue solid element yielding a violet-colored vapor on heating. It is chiefly used in alcoholic solution (tincture of iodine), to which a small quantity of potassium iodide is often added. Applied to the skin, it prevents the spread of eruptions and reduces swellings. Starch, placed in contact with a solution of iodine, turns blue, while the reddish-violet solution of iodine in chloroform turns brown in the presence of the least quantity of alcohol.

Iodoform is an organic antiseptic compound containing iodine. This medicinal preparation can be made by dissolving 15 grams of potassium carbonate in 100 cc. of distilled water. Filter the solution, if cloudy, and add 20 cc. of 95 per cent ethyl alcohol. Warm the mixture to 70° C. and gradually add 20 grams of powdered iodine. Filter off the iodoform, wash with water, and dry in the air. Recrystallize the iodoform from alcohol to purify it, then filter and dry again. This substance crystallizes in lemon yellow hexagonal plates or star-shaped crystals which have a characteristic appearance under the microscope. It is used in medicine and surgery as a strong antiseptic and disinfectant, although it does not kill the bacteria directly, its action on the micro-organism being due to a decomposition resulting, under the influence of the heat of the body, from fermentation induced by the matter exuded from the wound. But on account of its peculiar penetrating odor, odorless iodole is often used as a substitute.

The best oxidizing substance to have at home is hydrogen peroxide, "peroxide" for short, having no injurious after effects. It is an antiseptic, mild in form and powerful in action, and is often employed to clean wounds, teeth, etc. The form in which it is most commonly met is its 3 per cent solution, although it can be isolated, it then being a sirupy colorless and odorless liquid which solidifies in colorless prisms at 2° C. (28⅗° F)

Peroxide is the active principle in the bleaching of clothes spread on the grass and not ozone as was formerly believed. It is a strong bleacher for organic substances, such as hairs, hats, feathers, etc., its 30 per cent solution being chiefly employed for this purpose. For the detection of peroxide a dilute solution of potassium dichromate with a little sulphuric acid is poured into a test tube containing a little ether (2 cc.). A little of the liquid to be tested is added and the whole is shaken, whereupon a beautiful blue color will be imparted to the ether.

Magnesia, or magnesium oxide, is not only used in medicine for dyspepsia, but also in toilet preparations. The magnesium hydroxide, which is practically insoluble in water, as well as magnesium oxide, are often employed as an antidote for poisoning by mineral acids. Magnesium sulphate, or Epsom salts, which was first found in England, is much used as a cathartic. A complex compound of magnesium carbonate and hydroxide known as magnesia alba is the chief constituent of many face powders. Magnesium carbonate dissolved in water containing carbon dioxide is used in medicine.

The coal tar derivative, acetanilid, although an effective and important drug in the hands of a physician for allaying fever, as its other name, antifebrin, indicates, is still dangerous and should not be used indiscriminately, as it has a depressing effect upon the heart. Internally it is also employed for sleeplessness, alcoholism, etc., while externally it is an antiseptic. It is quite commonly employed to preserve hydrogen peroxide. This substance is also quite frequently found in headache powders. For the detection of this primary aromatic amine the isonitrile reaction may be employed. A piece of caustic potash the size of a bean is heated with 5 cc. of alcohol. The warm solution is poured into another test tube containing 4 or 5 drops of chloroform and a little of the powder to be tested. If a reaction does not take place immediately, warm gently, whereupon a most highly characteristic and disagreeable odor is given off. This becomes still more pronounced when the liquid is poured off and water added to the tube. *This reaction should not be carried out in a closed room.*

Collodion, employed to stop the bleeding of cuts, etc., by covering the wound with an impermeable membrane, consists of a solution of nitrocellulose in a mixture of alcohol and ether. A small quantity of it may be prepared by *strictly* following the following directions: Two cc. of concentrated nitric acid are mixed with 4 cc. of concentrated sulphuric acid. When the mixture is cold some absorbent cotton is completely immersed in the mixture for a few seconds. Then cold water is poured carefully upon the whole to stop the reaction. Filter and wash the fibres thoroughly. Remove them and dry in the air. (Keep away from flames, as it burns with explosive violence.) Pour a few cubic centimeters of alcohol and ether into a clean test tube, add the dry collodion and shake. Filter after an hour. The filtrate contains the nitrated cellulose in solution, which is proven by the fact that a thin film, when the solvent has evaporated, will remain after a drop has been placed upon a piece of glass. Enough of the nitrated cellulose should be dissolved to give a thick gelatinous solution.

An important substance to have in the medicine chest is citronella, otherwise known as mosquito oil. This unpleasantly fragrant oil is much used to keep mosquitoes away. A drop or so rubbed on hands and face does the trick, although a rag dipped into this odoriferous oil kept near at hand will also serve. Citronella is of great commercial importance in the manufacture of essential oils such as geraniol, etc.

Glycerin, a household drug, is usually obtained by fat-splitting or as a by-product in soap manufacture. The fat is split into its two main constituents—glycerin and fatty acid—the latter being used for soap making. Quite recently glycerin, equal in quality to the best, has been obtained by the fermentation of sugar in alkaline solution, sodium sulphite being used. Glycerin has the most diverse uses. It is a wonderful ointment, is brushed on burns to relieve pain, is a vehicle for many medicines, is used as a cosmetic, and is also employed as a preservative. Then, too, it is a lubricator, but its greatest household use seems to lie in its ability to heal chapped hands.

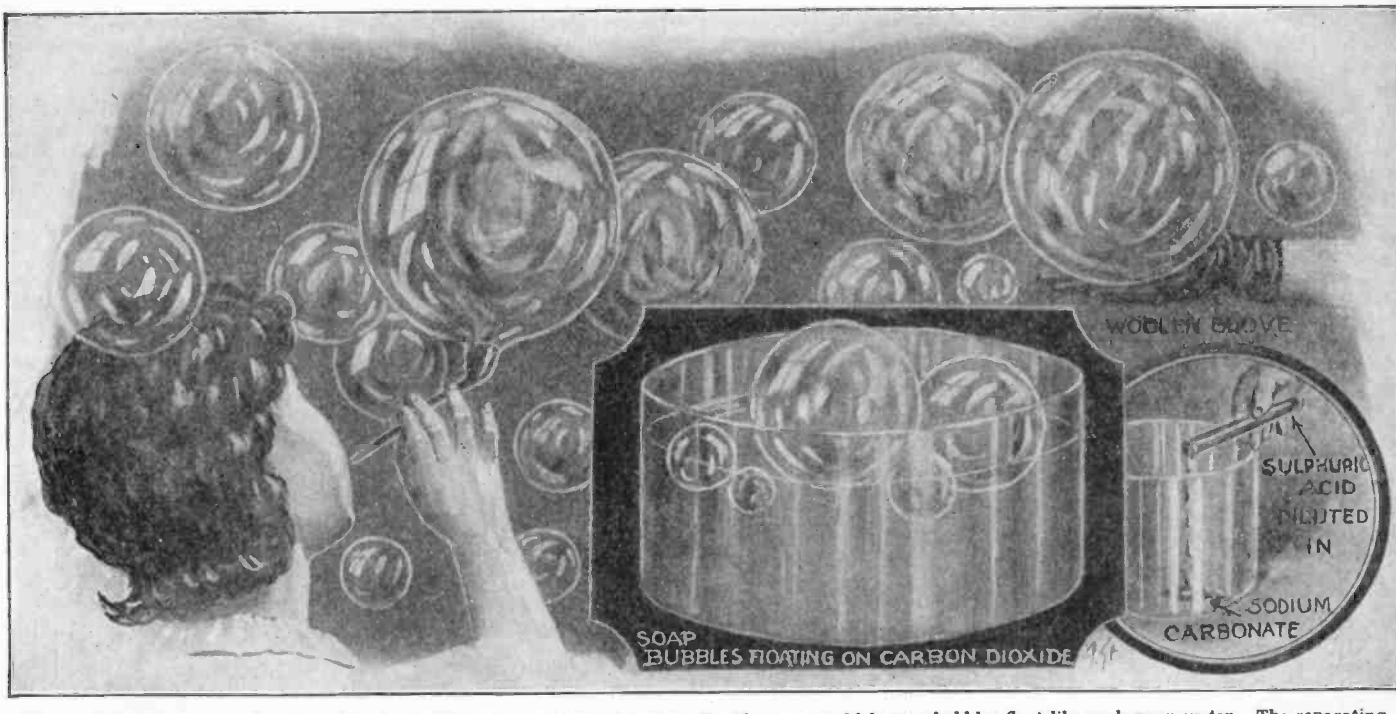
Anesthetics should never be handled at home, and are only to be administered by a physician. They are far too dangerous. Yet there is one local anesthetic which may, under certain conditions, be used advantageously to remove splinters, etc., without inconvenience to the patient. Due to the rapid evaporation of ethyl chloride, tissues surrounding the point of application are frozen, which permits cutting without pain. As ethyl chloride has a low boiling point (12.5° C.) it is quite difficult to keep. For this reason it should be placed either in special tubes with spraying nozzle attached, or in sealed glass-stoppered bottles. This liquid is applied in a fine spray to the affected part, but if too much is used or if the operation is repeated too often a very bad sore, like that caused by frost-bite, is produced.

A very small quantity can readily be prepared by carefully mixing equal quantities of cold hydrochloric acid and ethyl alcohol, at the same time preventing a rise in temperature. A two-hole rubber stopper is fitted into the flask, one hole holds a short curved gooseneck, the other a long straight glass tube, one of its open ends being placed just below the level of the liquid in the flask. This is a safety tube. The gooseneck is connected to a wash bottle containing water kept at a temperature of approximately 50° C. This flask is provided with a thermometer, a tube leading below the level of the water connected to the gooseneck of the first flask, and a gooseneck connected to a short condenser. This carries a flask at its end into which a glass tube leads from the condenser. The flask is packed either in ice and salt or, better still, in a freezing mixture. The ethyl chloride, which is produced by heating the first flask, is purified in the wash bottle. It then passes into the condenser, where it is slightly chilled as a gas, and finally condenses in the ice-packed flask as a very volatile and inflammable liquid.

Another very important product found in the medicine cabinet is alcohol. Grain alcohol, or ethyl alcohol, produced by fermentation of sugar in one form or another, is of great medicinal value taken both internally and externally. Wood alcohol, a product of the destructive distillation of wood, is an internal poison and has injurious effects when applied externally. The presence of the latter can readily be detected, not only alone, but in a mixture of both by the formaldehyde test. The liquid to be tested is diluted with water until the mixture consists of 10 per cent alcohol. Then a spiral of copper wire, wound from a piece about a foot in length, is heated to redness at the top of a Bunsen burner flame and plunged into the liquid. This is repeated four or five times, the tube being cooled in a beaker of water. In this way the wood alcohol is oxidized to formaldehyde. Boil the liquid a moment, filter if necessary, cool, and add two or three drops of a 0.5 per cent solution of resorcinol, and shake. Slowly and carefully pour a few cc. of concentrated sulphuric acid into the test tube in such a way that the acid does not mix with the liquid, but falls to the bottom. Now let the tube stand for a few minutes (five or more if necessary), and if wood alcohol is present to as small an extent as one-tenth of one percent a rose-red contact ring will be formed where the two liquids meet. If the tube is now gently shaken red flecks or specks will be produced. The production of a ring appears in other reactions.

Fun with Soap Bubbles

By Arthur A. Blumenfeld



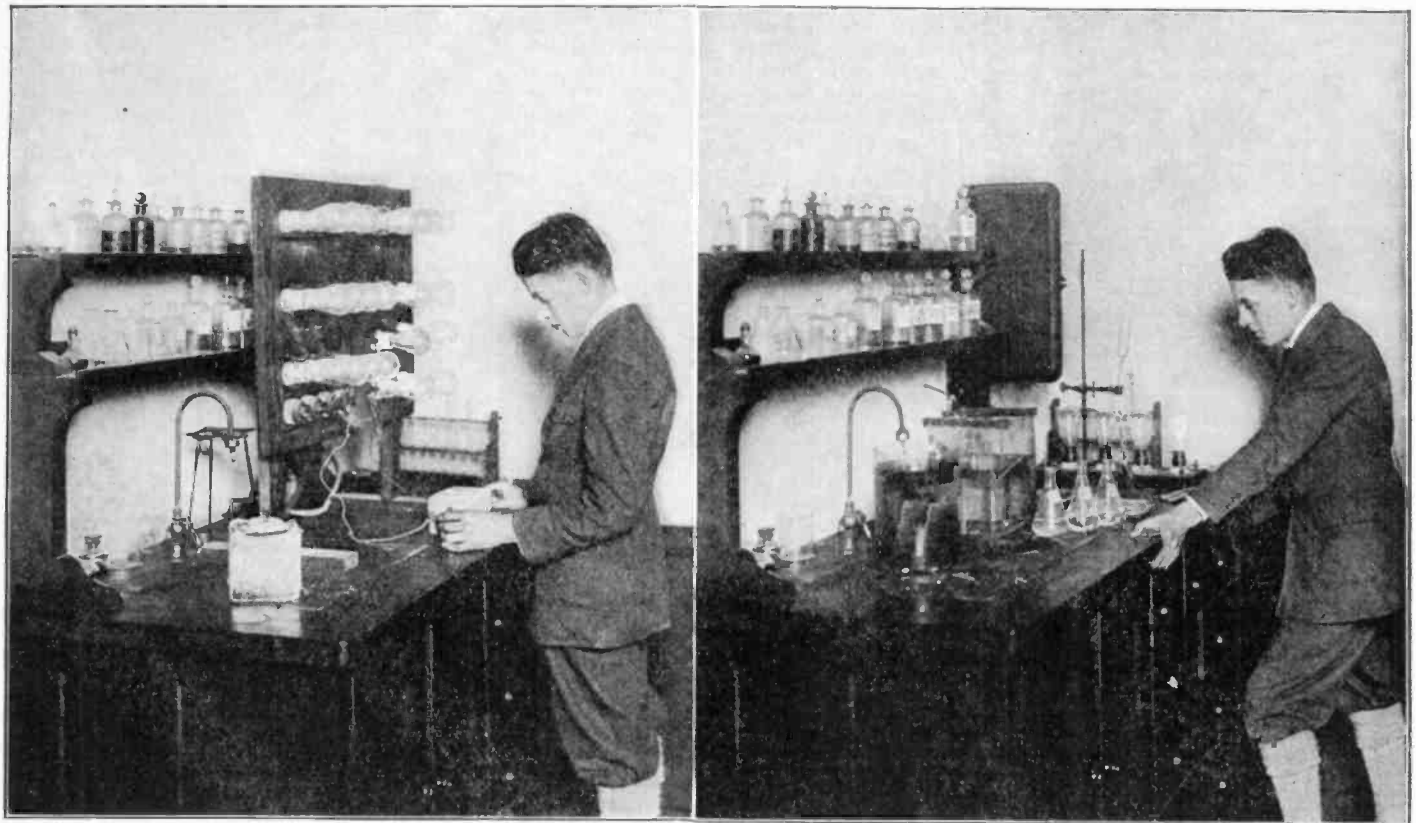
The chemist provides by a simple experiment a surface of carbon dioxide gas on which soap bubbles float like cork upon water. The separating surface between carbon dioxide and the air is invisible.

By acting on sodium bicarbonate with acid, even vinegar may answer the purpose, carbon dioxide gas is set free. If this is done in a vessel such as shown in the illustration, it will eventually become more or less charged with the heavy gas, which tends to be more concentrated at the bottom than the top and which will stay in considerable proportion for some time before it diffuses away. Nothing can be seen, the gas being quite invisible.

Now make some soap bubbles. These can be caught on a woolen glove and held in the palm of the hand and dropped into the vessel. Instead of going right down to the bottom, as soon as they strike the gas they will be arrested and will not descend. Some dexterity is required in handling the bubbles but the floating or buoying effect of the gas can readily be demonstrated, even if the bubble is only dropped from the end of the pipe into the vessel.

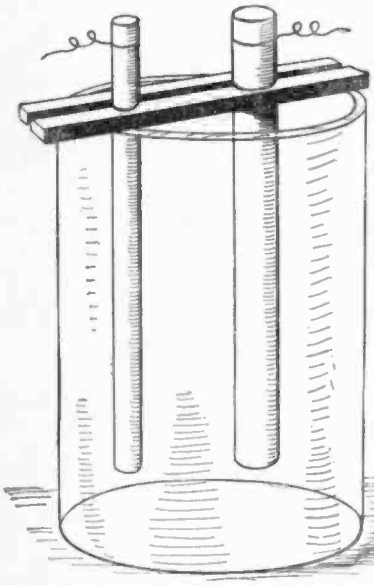
Electro Chemistry

By Floyd L. Darrow



The junior experimenter in his laboratory. He is working on the electrolytic separation of metals.
—From the author's *Boy's Book of Chemistry.*

THE other day my dentist placed a new silver filling in a tooth which happened to lie just under a tooth having a gold filling. When I brought the two fillings together, I felt the tingle of an electric current through the nerves of the teeth. Here we have the experiment of Galvani and the frog's legs over again. The gold and silver acted upon unequally by the saliva of my mouth constituted a miniature electric couple which completed its circuit through the nerves of my teeth and the bones of my jaw.



An extemporized bichromate battery. Be sure to amalgamate the zinc. One globule of mercury is enough.

I have in my laboratory a spot-light galvanometer, so sensitive that, when I connect to it a copper wire and an iron wire and place them in a tumbler of distilled water, the current generated causes the spot-light to dance all over the scale. When the wires are placed in the mouth, the resulting current seems prodigious.

From the time Sir Humphry Davy, seizing upon the simple experiments of Galvani and Volta, first turned the electric current to account in the electrolysis of water and the isolation of the alkali metals, the applications of electricity have been of tremendous importance in scientific research and the development of industry.

In this article I wish to describe experiments having to do with the chemistry of the electric current. For nearly a century after the first knowledge of electricity, all currents were generated by chemical action, and even today electric cells are still of great importance. And, as you probably know, the electric current may be made to produce chemical action as it may also be generated by it.

The Source of Current

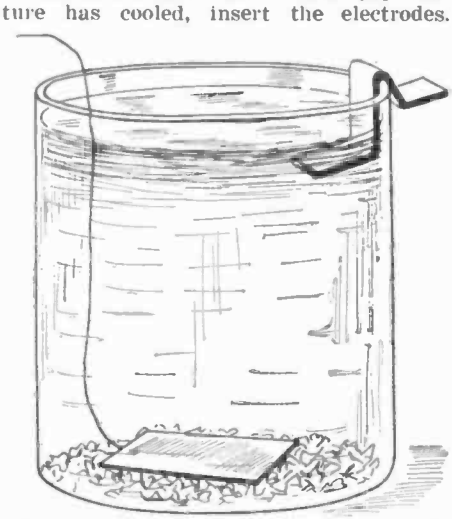
The first consideration for practical work is the source of the current. You may be fortunate enough to have direct current in your laboratory. If so, your problem will be easily solved. Since, however, 110 volts can be used directly in but few chemical experiments, you will need some sort of rheostat. The lampboard rheostat is the simplest to make. Mount a number of lamps in parallel on a base board fitted with binding posts and connect this board in series with your apparatus. Start with all of the lamps turned off but one. This gives the minimum amount of current. Each additional lamp turned on gives about 4/10 of an ampere more. With such a board you can easily adjust the current to your requirements.

If you have an old radio battery or one from your car, that will be ideal for many purposes, as it will be a storage battery.

If you lack either of these sources of current, you will depend on primary batteries. Since dry cells polarize so rapidly, they will be unsuited for any experiments except those requiring current for only short periods.

The bichromate cell is the best for the home laboratory worker to make. A half dozen of these cells joined in series will give about 12 volts, as much as will be needed for most experiments.

In making this cell place in a quart fruit jar or in a battery jar of about that capacity, 80 grams of chromic acid. Pour upon it 710 cubic centimeters of water and stir thoroughly until the acid has dissolved. Now add slowly and with constant stirring 45 cubic centimeters of concentrated sulfuric acid. When the mixture has cooled, insert the electrodes.



A copper sulphate cell of the gravity type; constant, but if left on open circuit the zinc becomes coated with copper.

These will consist of a rod or bar of zinc to which you have soldered a copper wire and the carbon rod from an old dry cell.

(*Continued on page 71*)

Laboratory Manipulation

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

THE correct performance of experiments in chemistry depends largely upon manipulation. In the chemical laboratory bad handling of apparatus, so often witnessed, is distressing to the practical chemist, and the failure to understand the significance of some every-day chemical terms leads to faulty work in carrying out analyses.

The incorrect folding of filter papers may cause delay—may bring about the breaking of a filter paper so that the filtration must be repeated; the putting down of a bottle stopper upon a laboratory table may mix up reagents and lead to trouble. If certain salts are in a solution they will

How to hold a bottle stopper when pouring out a chemical. The stopper must not touch the laboratory table, lest it should pick up impurities there.

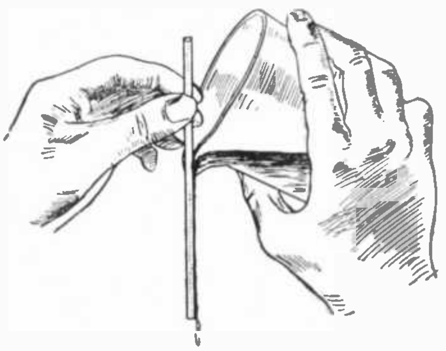
sometimes have a tendency to creep over the edge of a container, especially on heating, and this is notably the case with ammonium chloride. Over and over again beginners in chemistry are almost turned loose into a laboratory with insufficient instructions in the details of their work, and the books on chemistry are very apt to omit this phase of its operation.

Reagents in the laboratory are kept in bottles with ground glass stoppers, with the exception of sodium or potassium hydroxide. If these are kept in glass-stoppered bottles, the stopper will inevitably be stuck so fast by the action of the alkali upon the glass, and presumable formation of sodium or potassium silicate,

How to loosen a stopper when stuck; this plan is simpler than any other and works in the majority of cases. A wooden stick must be used, not a piece of metal, as the metal will break the glass.

that it will eventually be impossible to remove the stopper without the resort to rather extreme measures; and these may even not succeed. The correct stopper for such a bottle is an India rubber one; what is often called an India rubber cork, although it is not a cork at all. A good bark cork may also be used.

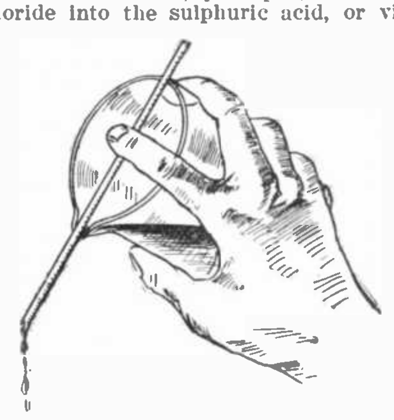
When glass stoppers become stuck in bottles various means may be tried for loosening and getting them out. A somewhat radical method is to heat the neck of the bottle in the Bunsen burner flame. This is often very effectual, as it expands the neck of the bottle without affecting the stopper, but it is liable to crack the



How to pour from a beaker; the liquid follows a glass rod. The rod must not be removed from the beaker until the latter is tipped back, and the pouring stops.

glass. By another method a heavy cord is attached to a doorknob or some fixed object, wound several times around the neck of the bottle, and the bottle moved rapidly up and down the string while it is pulled quite hard. This will often loosen the cork and will not break the bottle, although it operates by heating and expanding the neck. It is even suggested to wind a wire around the neck and pass a current of electricity through it. The simplest of all methods, one the writer uses practically always, is to press against one side of the stopper with the thumb while holding the bottle with the left hand, and with a rather heavy stick of wood, in the right hand, give a succession of quick sharp taps on the other side of the stopper. This will generally loosen it in a minute or less.

If a chemical acid is to be poured out of a bottle the stopper has to be taken care of. This is best done by holding the stopper in the right hand between the fingers, with the top pointing toward the inside of the hand, and then taking the bottle in the same hand for pouring. Nothing is so clumsy as to put a stopper down on a dirty desk so that it will pick up other chemicals, perhaps get barium chloride into the sulphuric acid, or vice

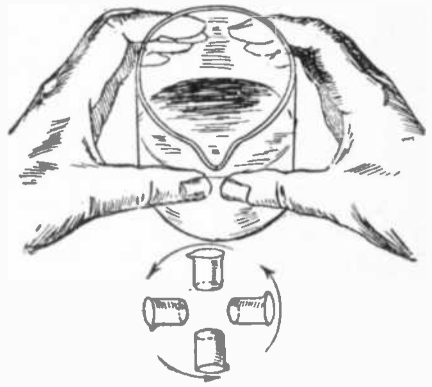


How pouring can be done with one hand. This is especially useful for small-sized beakers. For 500 cc. beakers and upward the first method is the best, and really the only one.

versa. This detail, simple as it seems, is of absolute importance.

When all the chemical that is to be used has been poured out of the bottle a drop will adhere to its lip, and this must be removed in every case by touching it to a glass rod, by touching it to the inside wall of the vessel into which it has been poured, or by touching it with the bottom of the stopper. No chemical should ever be allowed to run down the side of the bottle.

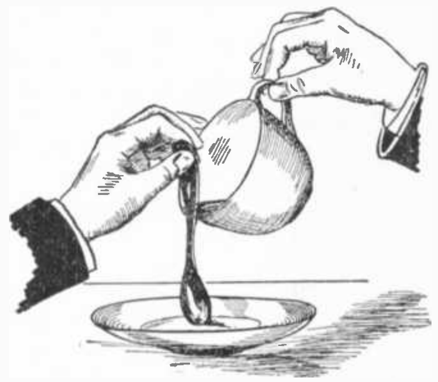
Solutions have constantly to be poured from beakers. It is here that the glass rod just mentioned comes into perpetual play. The rod should be about eight inches long and half or two-thirds as thick as a lead pencil. The ends must be rounded in the gas flame. If it is lead glass care should be taken to do this in the oxidizing flame; that is to say, pretty



An odd way of pouring only to be used when the entire contents of a beaker are to be poured out. The beaker is turned completely around as shown in the diagram below.

well outside the visible flame, in order to avoid darkening the glass. This darkening does no particular harm, but looks unattractive. It is well to slip an inch long India rubber tube over the lower end.

To pour from a beaker using a glass rod, the rod is to be placed against the lip of the beaker and held there while the beaker is tipped over; the fluid will run down the glass rod into the other vessel. As long as the rod is kept in contact with the beaker none will run down the side thereof. This is generally a two-handed operation, but can be done by one hand by holding the rod against the beaker with the forefinger.



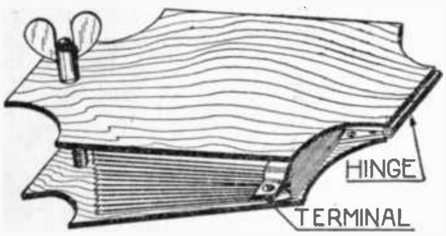
If you see anybody doing this at table you may make up your mind that he is a chemist. The teacup represents the beaker and the spoon the glass rod.

There is an odd way of pouring without using the glass rod. The beaker is held with the lip facing the manipulator and tipped over toward him so that the pouring starts. The pouring must be made continuous, as if it ceases for one instant the solution will run down the outside. The beaker is tipped further and further until completely empty, when it will be neatly and quickly turned completely over. The beaker is thus brought back to the vertical so that it has gone through a complete revolution.

Variable Condenser

AS the adjustment of this condenser is smooth and continuous, it will be found ideal for any purpose requiring a variable capacity with paper dielectric.

The condenser is assembled in the usual manner by interleaving sheets of metal foil with waxed paper. But instead of



A unique condenser whose capacity is varied by altering the pressure on the plates, and thereby modifying the dielectrics action.

binding the whole into one compact unit, the loose pile is placed within a compression device, the construction of which is made clear by the diagram.

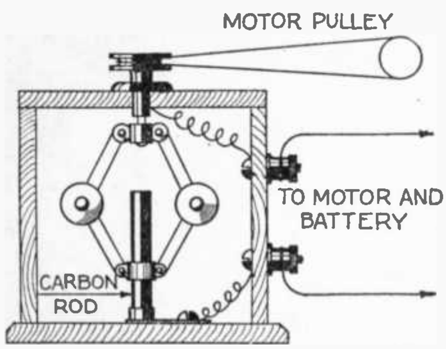
It is evident that increasing the pressure on the condenser also increases its capacity, because the plates are then forced into closer proximity. Releasing the pressure restores the capacity to its former low value.

Contributed by CHARLES D. SAVAGE.

Motor Regulator

THIS instrument may be used successfully to maintain the speed of a small series motor within constant limits. It operates by centrifugal action, and the exact way in which this force is applied may be seen from the diagram.

The brass tube and carbon rod over which it slides constitute a variable resistance like a rheostat, whose value is determined by the speed of the motor. Should the latter rise to an excessive



A centrifugal governor, varying the length of a carbon resistance connected in series with the electric motor. The motor turns the governor; practically constant speed is attained.

degree the brass tube slides up the carbon rod and introduces more resistance into the circuit, thus reducing the speed of the motor. The maximum speed permitted by the regulator can be varied as desired by using different weights in the centrifugal part of the apparatus.

A discarded flashlight cell provides the carbon rod. This may be fastened to the base of the instrument by soldering the brass cap on one end to a metal strip and screwing the latter to the base.

Contributed by CHARLES D. SAVAGE.

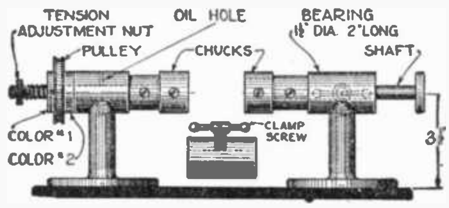
Coil Winding Machine

WITH an ordinary winding machine, when the wire happens to catch on the spool from which it is being taken it will usually be broken before the machine can be stopped, especially if the wire is small.

The machine illustrated here was built to overcome this fault and also to be able to wind the wire as tight as possible without the danger of breaking it.

This particular machine was built to wind several kinds of solenoids with No. 22 asbestos covered wire, but was found excellent for winding other types of coils.

The main feature is that it has an adjustable clutch by which it can be adjusted to slip when the pull on the wire comes too near the breaking point of the wire being wound, thereby allowing the



Machine for winding coils for solenoid magnets, for rheostats and the like. A very complete apparatus which will not break the wire.

wire to be wound as tight as possible. The diagram gives the dimensions which were used but need not be followed, in fact, they should be changed to suit the approximate size coils of wire for which it will be used. A description of the material is as follows:

The supports are of brass with four holes around the base for mounting-screws. A hole is drilled through the column and the bottom end is countersunk to clear a machine screw and head. The top of the column is cut out round to fit the bearing, which in turn is held in place by this screw. The bearings may be of either brass or bronze, or steel. The running shaft is preferably of steel and has one end threaded to take the adjustable nut as shown, and has a small hole drilled in it where collar No. 1 is, which allows this collar to slip back and forth but stops it from turning and loosening the adjustment screw, which it otherwise will do.

Collar No. 2 has three set screws equally spaced to hold it well in place on the shaft and is about three-eighth inch wide. No. 1 is one-quarter inch wide. The pulley must have straight sides as large as the collars because this surface acts as the clutch. It may be of any convenient size, according to the speed desired, and may be driven by a motor proportional to the size of machine. We used one-quarter horsepower.

The dead end shaft slides back and forth to fit the piece being wound and has a knob on the rear end. The chucks were made to hold different kinds of stocks which fit the coils and if tubing is to be wound, two cone chucks work well, the dead end only acting as a bearing.

The clutch spring should be quite heavy and an old spring off a wringer, one of the spiral kind, will be just about right.

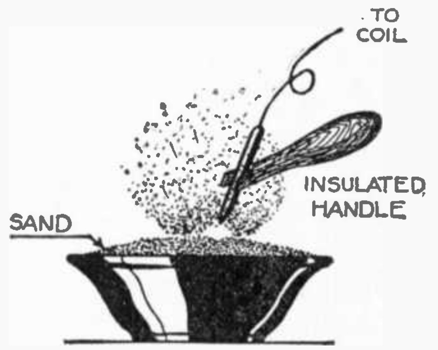
This machine has been in use continually for over ten months and more than paid for itself many times.

Contributed by HENRY RISSI, JR.

Electric Sandstorm

PROCURE a dish of fine dry beach sand and place it on a table or bench.

Now bring a pointed needle (or other contact) connected to a Tesla coil, near



Try this spectacular eruption caused by a spark from a Tesla coil; the discharge causes sand to fly about as by a miniature lightning stroke.

the sand. When the spark jumps into the sand, the latter flies up in the air. This can be done also with a spark coil on a smaller scale; it makes electricity appear like matter with a body.

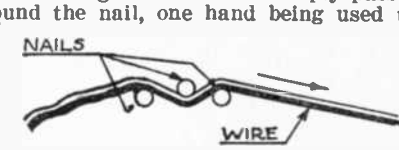
Contributed by LESLIE CARPENTER.

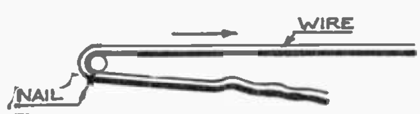
Wire Straightening

SMALL magnet wire often requires straightening before it can be used—especially if it has been used before. It is the purpose of this article to show a simple way to straighten wire quickly and easily.

A good method is shown in the illustration Fig. 1. Three nails are driven into a board out of alignment with each other, the wire passing around them as shown. All that is necessary is to keep the wire between the nails and pull it through.

Another good way to straighten wire is to use a single nail, which is usually handy when using the wire. This is shown in Fig. 2. The wire simply passes around the nail, one hand being used to





This method of straightening wires is as effective as it is simple; the three nails operate well and even the single nail will do much to improve a crooked wire.

keep the wire from slipping off the nail and give it the proper tension, and the other hand to pull the wire.

When no nails are at hand I have found that a good method is to let the wire pass under the sole of the shoe, which is quite effective. As a warning when straightening wire:

Do not pull so hard as to break the wire—be especially careful with the smaller gauges.

Be careful that the insulation does not slip and break.

Enamel wire cannot be straightened without breaking some of the enamel.

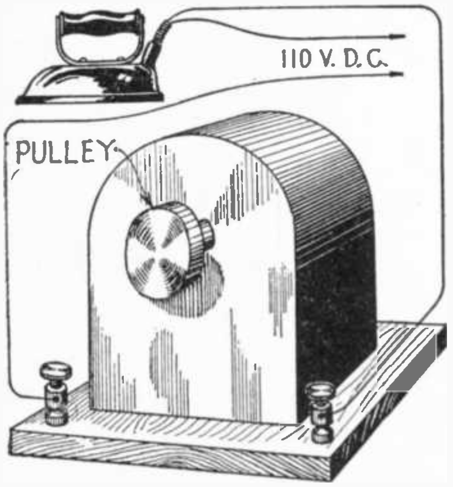
Also be very careful of kinks in the wire as they may break it.

Contributed by EVERMONT FISET.

High-Speed Motor

GENERATORS taken from old automobiles may easily be converted into high-speed motors by connecting the field magnet in series with the armature.

If the motor (generator) is now connected to the D. C. 110-volt mains, using an electric flat-iron as a resistance, high speed is obtained and the motor will not heat up as would be expected.



A handy high-speed motor for the laboratory constructed from a discarded automobile generator. A flat-iron acts as a resistance.

The motor experimented with by the writer developed from one-quarter to one-half horsepower at from 3,000 to 3,500 revolutions per minute.

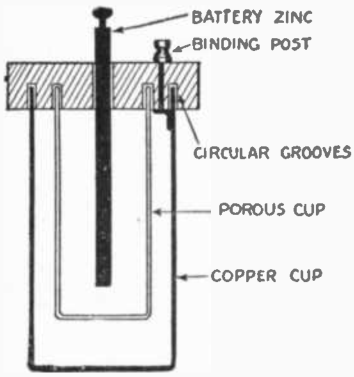
Such a motor as this is often very useful to the amateur.

Contributed by ROSCOE BETTS.

Portable Daniel Cell

By EARLE R. CALEY, B.Sc.

ONE of the most satisfactory types of wet cell to use for experimental work in electricity, especially for electrical measurements, is the ordinary copper sulphate or Daniel cell. Unfortunately, however, the gravity cell which has become the usual form of this battery, does not lend itself readily to transportation.



A slight departure from the conventional type makes an efficient portable Daniel cell for experimental uses.

In laboratory work it is sometimes highly desirable to move or to change the location of batteries. To overcome this difficulty the author has devised a readily portable form of the copper sulphate battery which can be handled in much the same way as an ordinary dry cell and used in almost any position. This cell is shown in the illustration.

The container takes the form of a copper cup which also serves as the positive electrode. To this copper cup is fitted a wooden cap. On the under side of this wooden cap is fitted a porous cup. An ordinary battery zinc passes through the wooden cover and is held inside the porous cup. Holes, which when the battery is in use are closed by rubber stoppers, are bored through the wooden top and lead to the copper cup and to the porous jar. A binding post mounted on the cap makes contact with the copper electrode. The complete details for the construction of a cell of this kind are given below.

The outer container, the cup of sheet copper, is six inches in height and three inches in diameter. A cup of this kind can be easily constructed by any one possessing some knowledge of sheet metal work, or can be made by a tinsmith at a trifling cost. Pure sheet copper of a good thickness should be used for the purpose. The wooden cap for the top of the cell is turned from hard wood, preferably maple. The wood used should be one inch in thickness and is turned to a disk four inches in diameter.

On one side of this disk circular grooves must be cut for receiving the top edges of the two cups. These are made to fit the exact sizes of the copper cup and the porous cup. The outside dimensions of the latter should not exceed two inches in diameter and five inches in length. These grooves should be cut about half way through the wood. In the exact center of the cap a three-eighth hole is drilled for the reception of the zinc electrode. Half-inch holes for filling and emptying the cell are drilled in the positions shown. An eighth-inch hole is also drilled near the outer groove for the reception of a binding post which makes contact with the copper cup by means of a piece of stiff copper strip. The cell is now ready to be assembled.

The wooden cap should be given several coats of good spar varnish to render it moisture proof. The zinc electrode is then set in place and the joint rendered tight by means of sealing wax. The porous cup is then set in place over the zinc after placing a quantity of molten wax in the groove. The copper cup is fastened in its groove in the same manner. The cell is now complete and has only to be filled to be ready for operation. The copper jar is filled nearly full of a saturated solution of copper sulphate in distilled water. The inner cup is filled with distilled water containing a few drops of sulphuric acid. The solutions have to be introduced after measuring, the amount being previously determined. After the filling, the holes are plugged with rubber stoppers or even with ordinary corks and the completed cell is then ready for any service that may be required of it.

Earthquakes by Radio

There has recently been invented a radio seismograph which is far more sensitive than the present mechanical instrument used.

You can read all about it in the November issue of RADIO NEWS.

Articles to Appear in November Issue of Radio News

Longitude by Radio.
By C. H. Swick.

The Life and Work of Lee De-Forest.
By W. B. Arvin.

The Radio Seismograph.
By J. E. Anderson, M.A.

A Microphone Without a Diaphragm.
By Nicholas Langer.

How to Build a Crystodyne Receiver.

Multi-tube Radio Frequency Amplifiers.
By John Scott-Taggart.

Vacuum Tube Curves and What They Mean.

The Resonant Circuit.
By J. M. Grigg, B.S.

Loud Speaking Telephone

By HYMEN BUSHLOWITZ

LOUD talking apparatus is one of the most interesting appliances in experimental electricity. The apparatus can be used to talk through show windows (loud speaker outside in street and salesman talking into microphone transmitter); as a detectaphone; for transmitting phonograph music from one room to another; as a radio amplifier; as a telephone extension (by placing the regular telephone receiver against that of the telephone transmitter), and for many other uses which will suggest themselves to the experimenter.

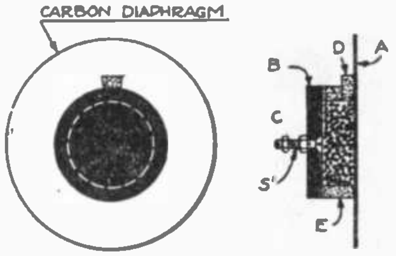


FIG 1

The diaphragm of this sensitive microphone is of carbon, while the side wall of the carbon case is made of felt. It is designed for construction in the laboratory.

The transmitter is highly sensitive. The shell of a watchcase receiver makes an excellent outer case as shown at (P), Fig. 3. For the interior mechanism we need a thin carbon diaphragm (A), Figs. 1, 2, 3, preferably standard size, 2⅛ inches wide and 1/64 inch thick. A felt washer (E) 1¼ inches in diameter with walls 3/16 inch square should be made with an opening (X) 3/16 inch wide. Glue the washer to the center of the carbon diaphragm.

A second carbon diaphragm (B) 1¼ inches wide and about ⅛ inch or 3/16 inch thick is made; the thinner it is the more sensitive the apparatus will be. A hole large enough for a ¼-inch screw is bored through the center of this diaphragm. Countersink the hole a little on one side so that when a ¼-inch bolt, ½ inch long, and a nut are bolted on this button, the head of the bolt will not touch the first carbon diaphragm (A), Fig. 2. The smaller carbon diaphragm can be easily made with a hacksaw and the hole bored with an iron bit.

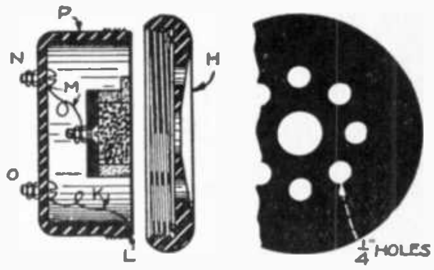


FIG 2

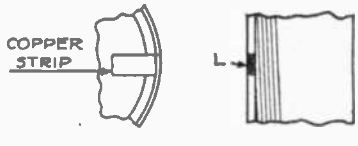


FIG 3

A sectional view of the dissembled microphone, showing the means for connecting up carbon diaphragm and carbon cell. Detail of the copper strip completing the connection for the current.

It is better to insulate the head of the bolts by dipping it in shellac. The carbon button must now be glued to the felt washer with the head of the bolt and the beveled side of the carbon inside, see Fig. 2. After the glue is dry, the chamber between the two carbons is loosely filled with polished carbon grains or balls. They must never be packed tightly but should fill the space entirely. Do not touch the carbon grains with the hands, as the natural oil from the hands destroys their sensitiveness. It is better for the experimenter to buy these carbon grains from some electrical supply house than to attempt to make them.

A piece of paper bent to a scoop will simplify the filling of the chamber. The openings between the ends of the washer must be plugged with a piece of felt (D), Figs. 1 and 2. This can be done with a pin or sharp pointed knife.

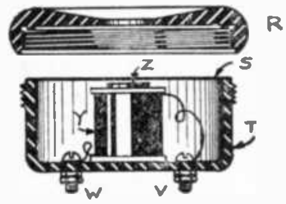


FIG 4

An unusually effective loud speaking receiving telephone, readily constructed by the amateur on the lines shown here to go with the microphone.

The binding posts (N) and (O), Fig. 2, are fastened on the bottom of the transmitter case. The connection from one of the binding posts to the carbon diaphragm should be made with very thin copper or brass strips, ⅜ inch wide and about 1½ inches long as shown at (K), Fig. 3. The copper strip is bent over the edge of the shell and cut off flush at the edge of the rim (L), Fig. 3.

Do not place the carbon diaphragm with its edge over the strip, as the strip, being higher than the rim of the shell, will crack the diaphragm when the cap is screwed down. For that reason, by means of a small file or knife, make a notch in the rim of the shell at (L). This slot must be exactly the thickness of the copper strip, so that when the strip is put in the slot, the top lies flush with the rim of the receiver shell.

The other terminal (N) should be connected by three No. 28 insulated copper wires to the terminal (C) of the carbon button. The three small wires have more flexibility than one large one. The carbon diaphragm should now be put in place, and a receiver cap screwed on the transmitter as shown in Fig. 3. The transmitter will be more sensitive if a number of ¼-inch holes are bored in the cap as shown in Fig. 4.

Any watchcase receiver can be used. The double pole type is more efficient, but it is easier to make the receiver from a single pole type. First remove the permanent magnets from the receiver, then take out the spools of wire and its soft iron core. Another coil of heavy wire (Y) must be wound over the core (Z),

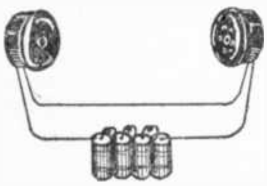


FIG 5

The battery, microphone and telephone connected. This gives a detectaphone circuit, if the experimenter has done his work well.

Fig. 5, in place of the fine wire. One hundred and fifty feet of No. 24 enameled or cotton insulated wire is about right as this will give five ohms of resistance. Give this coil a coat of shellac to hold the wires in place; then bolt the electromagnet back in its original position. The connections should be made from the magnet to the binding posts on the back of the receiver.

The instruments are now complete and are to be connected as in Fig. 6, using at least four dry cells. Talk in a moderate tone into the transmitter and the receiver will talk very loudly and distinctly, the voice being heard clearly a long way off. It is important that all connections be made as tight as possible.

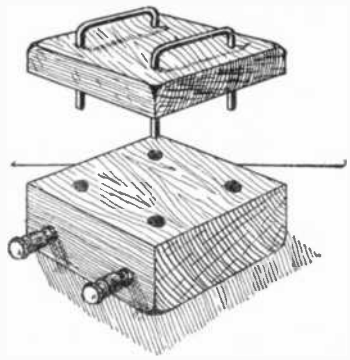
The apparatus can be used as a marvelously sensitive detectaphone. Put the transmitter in back of a picture, and run the wire to an adjoining room and you can become a detective.

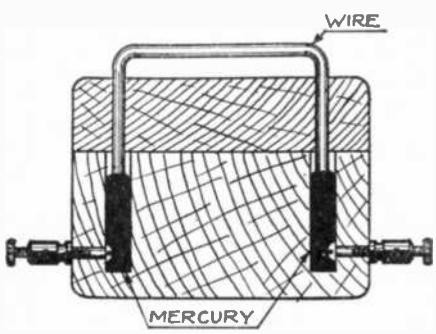
Current Reverser

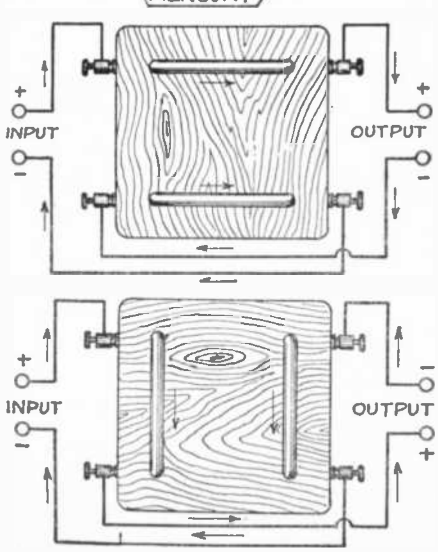
A SIMPLE current reverser may be made of two square blocks of wood, one 4 inches by 4 inches by 1 inch, and the other 4 inches by 4 inches by 2 inches.

Half way through the 2-inch block drill four holes, fill them with mercury and connect binding posts to each. Through the 1-inch block drill four smaller holes and bend two wires through them so as to have projecting ends, as shown. Connect the input and output as shown and the reverser is complete. To reverse, give a one-quarter turn.

Contributed by Arthur A. Blumenfeld.







A simple reversing switch, which will prove a welcome addition to every experimenter's outfit. A sectional view of the switch, showing mercury contact wells is given; and below is shown the reversing switch hook-up.

Home-Made Tipping Cell

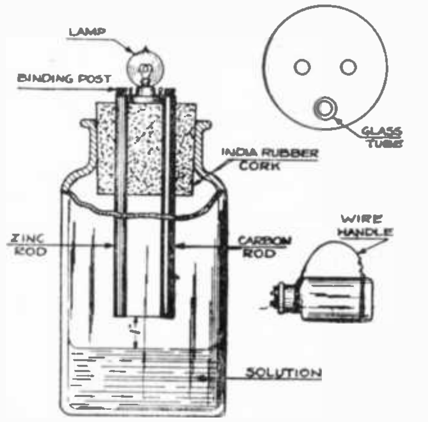
ONE of the most novel of the many electric torches which have been recently brought before the public, consists merely of a wide mouthed bottle for the electrolyte, having rods of zinc and carbon inserted through a rubber cork. These rods project down into the bottle for about one-third its depth. On the top of the cork a small electric lamp is mounted, similar to those used in ordinary electric torches. Connections are made between the lamp and the zinc and carbon rods.

A mixture of water, bichromate of potash, and some sulphuric acid is put into the bottle, and stands at a level of one inch below the ends of the zinc and carbon rods when the bottle is upright. When the bottle is turned on its side, it becomes what is known as a bichromate cell, a well-known type of cell for producing small quantities of electricity for electric bells and similar devices.

The electric current produced when the solution surrounds the zinc and carbon rods is strong enough to light up the lamp, and the apparatus becomes an electric torch. The cork of the bottle must be perfectly water-tight.

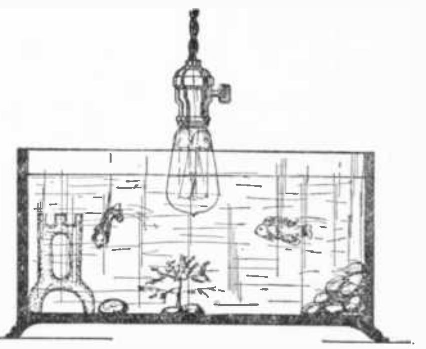
Square bottles with large round mouths, such as are used for pickles and similar products, are very suitable for these torches, as they can be laid down on their sides when a light is required. Put on a wire handle so that the proper side will always be down. A glass tube is passed through the part of the cork, which is uppermost when the bottle is on its side. This is for the escape of gas.

Contributed by H. Bushlowitz.



A novel electric torch with wet cell attached; the lamp is carried on the jar; the contact is closed by placing the jar on its side.

Aquarium Heater



A modern heating installation for the goldfish; the heat radiated from a lamp filament is quite sufficient for a large aquarium.

TO keep the goldfish warm in a cool room, or for heating aquariums to a proper temperature, an ordinary light bulb will work well.

Suspend it by a cord in the water, or mount it on the side; it can easily be turned on when heat is desired.

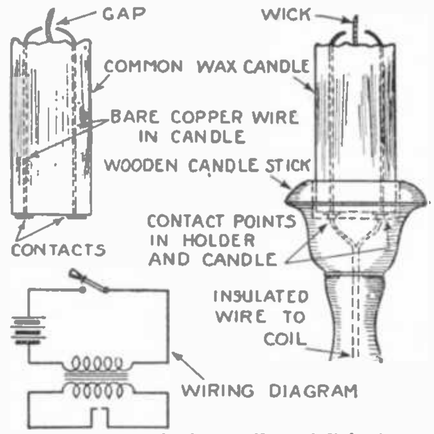
Contributed by Leslie Carpenter.

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

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

Magic Candles

FIRST a pair of wooden candlesticks were procured and wired as shown in Fig. 1, the wires ending in contact points spaced as far apart as possible in the socket of the candlestick. Next a pair of candles. Each had two wires run up their length and bent to form a small gap at the base of the wick. The wires were introduced by being heated, so as to melt their way through. These wires were bare and so placed as to make a contact



Wires go through the candle and light it mysteriously.

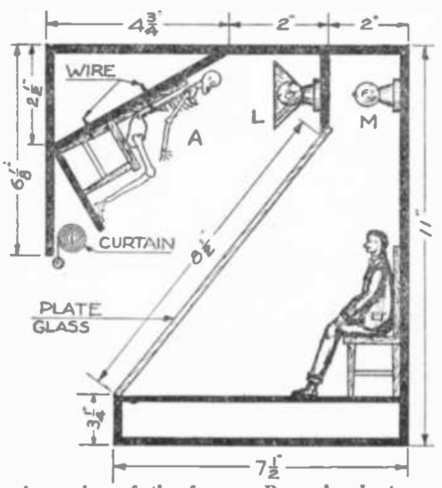
with the wires in the holder when the candle was firmly inserted therein.

The whole device was then connected up with a spark coil and battery which were placed out of sight. A secret switch controlled the coil and was placed conveniently for the performer, but also out of sight. After piling a little flashlight powder beneath the spark gap on the candle top all is in readiness for the surprise.

At the proper moment a touch on the switch excites the coil, a spark travels to the gap and ignites the flash powder, which in turn lights the candle in a most mysterious manner, much to the spectators' astonishment unless familiar with the method employed.

A Ghostly Skeleton

By John North



A version of the famous Pepper's ghost on a miniature scale.

WHILE at an amusement park I entered a show building where the man at the door announced that tons of electrical apparatus were required to produce this effect.

The effect was this. A person from the audience was asked to mount the stage; he would sit in a chair and then would slowly fade away until he became a skeleton.

It can be done with electric light on the small scale quite effectively.

Behind the real figure there is a black screen. Between the audience and the figure in the chair is a sheet of perfectly clean transparent plate glass, inclined at an angle so as to reflect objects located in front of and above it, but so clear as to be invisible to the audience and to the man sitting in the chair. At the beginning the stage is lighted only from behind the glass; then the person sitting on the chair is seen in full visibility as usual.

The lights in front of the glass (behind the scenes) are now raised very gradually as those behind the glass are turned down, until it is dark there. The perfectly black surface behind the glass now acts like the silver backing for a mirror, and the object upon which the light is now turned (in this case a skeleton) is reflected from the glass, appearing to the audience as if really occupying the seat on the stage.

The model which I will illustrate is a box 11 by 7 by 7½ inches inside dimensions. The box can be made of almost any kind of wood as the entire interior with the exception of the glass, figures and lights is to be colored a dull black. This can be done by painting with a mixture of lampblack and turpentine with a little linseed oil. If everything is not black, especially the joints and background, the effect will be spoiled.

The glass should be the clearest possible and must be thoroughly cleaned. Its edges should nowhere be visible, and it should be free from scratches. The figure (A) should be a skeleton about four inches in height, which can be purchased at any Japanese store, and the other figure is a doll, about the same height, dressed in bright colored clothes.

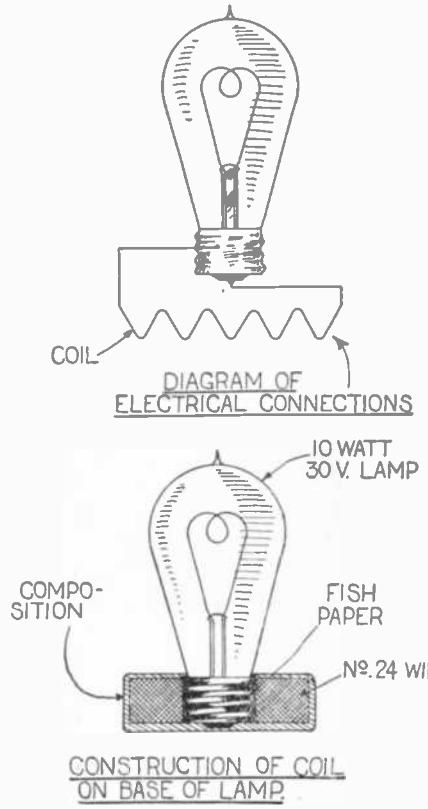
The lights (L) and (M) are miniature electric lamps, which can be run by four dry cells or a 6-volt storage battery. They should give a fairly strong light, especially (L), which should have a small tin reflector to increase its brilliancy and prevent its being reflected in the glass.

Since the stage should be some distance away from the audience to aid the effect, the angle of the glass and the inclination of the skeleton (A) has been so designed that if the stage is placed on a mantel or other high shelf the skeleton of (A) will appear to be sitting upright to an observer sitting in a chair some distance away, within the limits of an ordinary room.

If it is desired to place the box lower down other angles for the skeleton and glass may be found necessary, but the right angle can be found easily with a little experimenting.

Mystery Light

PROCURE a powerful electromagnet wound for 110 volts. Mount this magnet under a table as shown. A large glass jar about two-thirds full of water is then placed upon the table directly above the



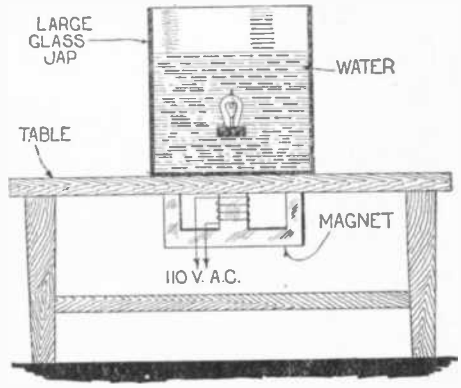
A lamp lighted by induction connections required.

magnet. Then a coil of No. 24 wire is wound upon the base of a ten watt thirty volt lamp. The construction of this coil is shown clearly in Fig. 2. The composition into which the finished coil should be dipped is taken from old dry cells.

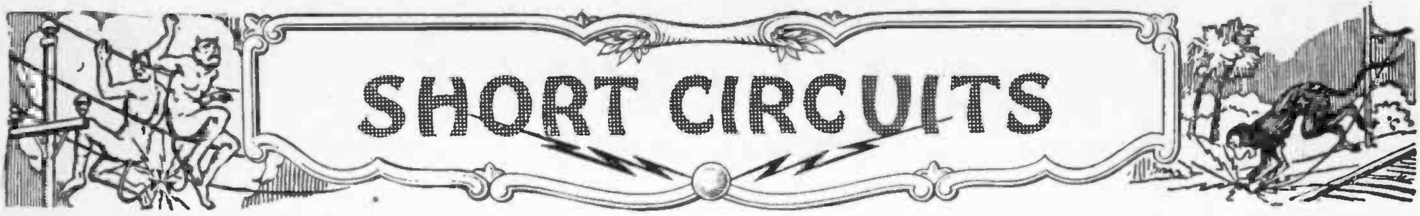
The lamp with coil attached should just sink into the water. The correct weight of the coil will have to be ascertained by experiment. An alternating current is passed through the coil when the lamp is to be lighted.

This makes a very attractive window display, especially if the magnet is connected to a sign flasher.

Contributed by C. J. Carmody.



How the lamp floats and is attracted by the magnet.



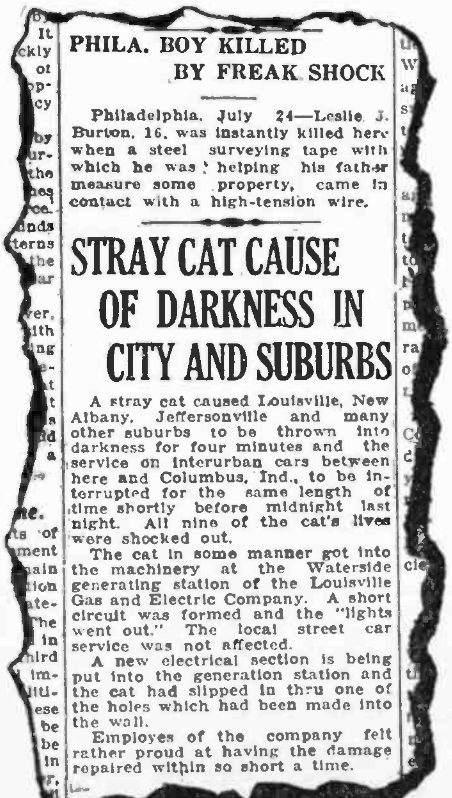
THE idea of this department is to present to the layman the dangers of the electrical current in a manner that can be understood by everyone, and that will be instructive, too. We have given monthly prizes of $3.00 for the best idea on "short-circuits." Look at the illustrations and send us your own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

Lies buried here
Old farmer Patrick Dorm.
He repaired a fence
In an electric storm.
—B. TRIMPE.

Within this cold grave
Lies Daniel P. McBiron.
He soldered a pipe
With an electric iron.
—H. M. FALOON.

'Neath this green sod
Lies Miss Mary Fishes,
Who turned on the light
While washing the dishes.
—LUTHER CRAMER.

Cold 'neath this sod
Lies Joseph Van Ramp.
His developer pan
Grounded his lamp.
—LOUIS L. HALL.



PHILA. BOY KILLED BY FREAK SHOCK

Philadelphia, July 24—Leslie J. Burton, 16, was instantly killed here when a steel surveying tape with which he was helping his father measure some property, came in contact with a high-tension wire.

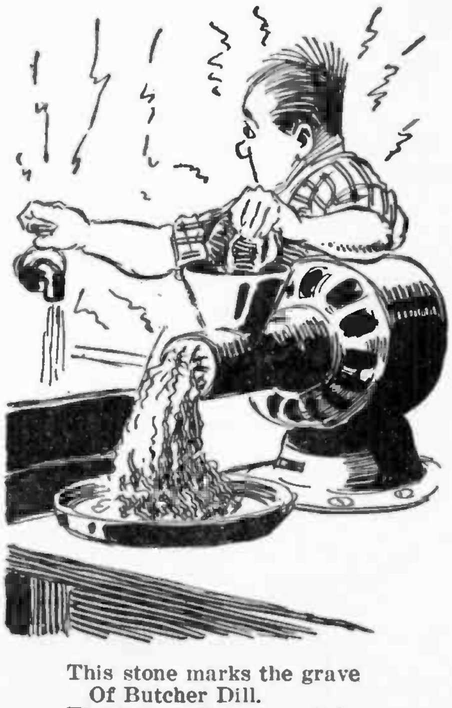
STRAY CAT CAUSE OF DARKNESS IN CITY AND SUBURBS

A stray cat caused Louisville, New Albany, Jeffersonville and many other suburbs to be thrown into darkness for four minutes and the service on interurban cars between here and Columbus, Ind., to be interrupted for the same length of time shortly before midnight last night. All nine of the cat's lives were shocked out.

The cat in some manner got into the machinery at the Waterside generating station of the Louisville Gas and Electric Company. A short circuit was formed and the "lights went out." The local street car service was not affected.

A new electrical section is being put into the generation station and the cat had slipped in thru one of the holes which had been made into the wall.

Employes of the company felt rather proud at having the damage repaired within so short a time.



This stone marks the grave
Of Butcher Dill.
The water pipe grounded
His sausage mill.
—E. V. ELLIS.

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

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

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

Osophone

(482)—Harry Smith, Oakland, Calif., writes:

Q. 1.—Please inform me if the so-called deaf-phones, of which there are many on the market, enable a deaf person to hear distinctly and if they are any better than the Osophone.

A. 1.—The difference between them may be understood from a brief explanation of the action of the human ear. When sound waves impinge on the outer ear they set up vibrations which are communicated by a link-work (middle ear) to the inner ear, where the mechanical energy is transformed into nervous energy. If the inner ear is in good condition and the reception and transmission mechanism are only slightly impaired, a simple microphone and receiver, with amplification of about 30, will be effectual in enabling ordinary sounds to be heard. A double set with two microphones about eight inches apart and two receivers makes location of a given sound easier.

When the transmission mechanism is so far impaired that such an instrument is ineffectual, the attempt to enforce hearing by producing louder sounds only tends to increase deafness and set up irritation. The inner ear must be stimulated through some other channel. This is accomplished by transmitting the sound vibrations through the bones of the head or through the teeth. The sound is transmitted through the teeth when using the Osophone. With a powerful amplifier it enables very deaf persons to hear, but the average deaf person will find the microphone and receiver more convenient. Deafness due to defects of the inner ear cannot be overcome by any known electrical method.

Induction

(483)—Chas. J. Baker, Springdale, Pa., writes:

Q. 1.—I am about to install four lines of 1½-inch galvanized conduit running side by side for a distance of 80 feet. In this conduit will be placed a No. 6 three-conductor varnished cambric lead-covered cable, voltage 2,200. By running these cables side by side in conduit, will there be enough induction effect to cause any serious trouble? If so, how can I overcome it; I must run these four lines separately.

A. 1.—There will be practically no induction between the cables as they are placed inside of the iron conduit that acts as a magnetic shield. The magnetic field around the cables will be absorbed by the iron conduit, and hence the fields of the separate cables cannot interfere with each other.

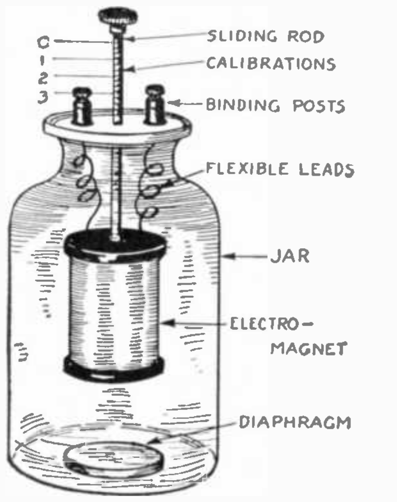
There is another effect which you should carefully look into before installing the cables. A single conductor carrying alternating current should not be placed inside of an iron conduit. The iron conduit absorbs the magnetic lines of force, causing hysteresis losses, and increases the self-induction of the cable. The effect will be similar to that obtained when connecting a reactance coil or choke coil, so-called, in the circuit. This effect can only be overcome by placing the two wires in the same conduit so that the magnetic field of one neutralizes the field of the other, leaving none to be absorbed by the iron pipe.

The two wires of a single-phase line or the three wires of a two or three phase line should be placed together in the same circuit. If you intend to carry one side of an alternating current line in a conduit this should not be done. It is perfectly correct to run one side of a direct current line in a single conduit, or to run one side of an alternating current line in a fiber conduit, but in this case induction will take place between the separate lines, as there is no magnetic shield between.

Simple Ammeter

(404)—George Hastings, Kansas City, Mo., asks:

Q. 1.—Please give the construction of a simple ammeter that will measure currents up to 10 amperes.



A most ingenious and easily constructed ammeter, strictly home-made.

A. 1.—The illustration shows such an ammeter. All that is required is a jelly jar, a five-ohm electromagnet, and a telephone receiver diaphragm. The magnet from a five-ohm telephone receiver may be used or one can easily be wound with a few feet of No. 20 magnet wire. It is not necessary that the coil have a resistance of five ohms. This magnet is attached to a sliding rod as shown. The instrument is calibrated by connecting it in series with a standard ammeter, a battery and rheostat. The rheostat is adjusted until the current is one ampere and the magnet is lowered until it just attracts the diaphragm. A notch is cut in the rod, which indicates one ampere. This is repeated for 2, 3, 4, amperes, etc.

You will find it a most interesting apparatus to experiment with in your laboratory.

Generator Query

(485)—Tom Mollay, Joplin, Mo., writes:

Q. 1.—While studying the action which takes place when an electrical generator is in operation a question has arisen which is not quite clear to me.

Using a simple bi-polar machine, is it the magnetic attraction of the pole pieces which affects the magnetic field surrounding the armature windings and tends to keep the armature from being rotated, or is it the presence of the iron in the core which does it? The question refers to a cylindrical core armature.

A. 1.—Both have a slight effect in retarding the armature. The magnetic effect in the iron core is known as hysteresis, causing losses due to the rapidly changing of the polarity of the armature core. This generates heat in the iron, but its effect in retarding the armature is practically negligible. Eddy currents are also induced in the iron core which cause slight losses.

Q. 2.—If an armature were constructed with a wooden core would it take any more mechanical power to turn it when a current was flowing through the windings than if the coils were all disconnected and no current flowing?

A. 2.—Yes. It requires power to move a closed conductor through a magnetic field regardless of whether any iron is present or not. A current is induced in the closed conductor which sets up a magnetic field at all times opposing the magnetic field producing it. For example, it requires more power to rotate a metal disc between the poles of a magnet than it requires to rotate the disc if the magnet were not present. This is due to current generated in the disc which sets up a magnetic field of such a polarity that it is opposed by the magnetic field in which it is rotated and a dragging action is noticed when turning the disc. This principle is made use of in electric meters, in which an aluminum disc is placed between the poles of a permanent magnet for damping purposes.

Radius vs. Circumference

(486)—Adolph White, Cambridgeport, Mass., writes:

Q. 1.—Will you please explain through the EXPERIMENTER magazine or through the mail the following subject: I understand that 3.1416 is the ratio of the circle's circumference to its diameter, but what principle is involved when 2×3.1416 (2π) is used in computing electric current or potential and why 2×3.1416 and not just 3.1416?

A. 1.—All scientific calculations involving the circle and its functions are based on the radius. The diameter is not a true function but is $2r$ or twice the radius. The circumference of a circle is therefore $2\pi r$, or $2 \times 3.1416 \times r$. The ratio of circumference to radius is used, not that of circumference to diameter. The radius is always used in these calculations.

The Arc of the Covenant

By Victor MacClure

(Continued from page 21)

my father had wakened me I was landing with him at the seaplane jetty west of the park.

The Landing

There was quite a fleet of planes round the landing-stage, mostly the bronze-painted machines of the water division of the Air Police; speedy, sinister things they were, but trim enough to make my old boat look more like her nickname than ever. I had never seen so many police machines together at the Battery landing stage before, but I imagined they were there merely upon their lawful occasions.

The pierman, an old friend of mine called O'Grady, gave me my mooring ticket and would have held me inconveniently in gossip, but I shook him off and legged it up Battery Place in pursuit of my father, whose impatience forbade him to wait for me. It was lucky I overtook him, because a cordon of police had been drawn around the Wall Street area, east and west from Trinity Place to Pearl Street, and, I presently discovered, north and south from Beaver Street to Liberty Street. The police saluted the old man and would have stopped me, but he snapped one word at them, whereupon they stepped back and let me pass. The presence of so many policemen at such a distance from the bank made me begin to think that the robbery was something of an affair.

II

We went right up Broadway, my father and I. As I walked behind him, I realized again his great bulk and, tall as I am, I felt for all the world like some faithful but skinny pup tagging at his heels. All about me were clusters of foot police round the doors of various buildings. I wanted to stop and find out what they were doing on guard so far away—as I thought—from the scene of the robbery, the National Metallurgical being up Broadway at the corner of Liberty Street, but I hung close to my father in case I were challenged. We arrived at the door of the bank.

The Bank and the Robberies

The squad of policemen who were strung across the doorway made an opening for the president and myself, and I followed him right into his room. We were immediately joined by Jaxon, officer in charge of the armed guard which was mounted every night in the bank. Poor Jaxon looked like a man who had just come out of a bout of fever. He was in a daze.

"Well?" the old man snapped.

Jaxon simply lifted his arms and let them drop in a gesture pitiful in its expression of helplessness—especially pitiful since the man normally was alert as a terrier and sharp as a needle.

"I don't know what to say, Mr. Boon," he gulped. "I just can't understand it."

A quick look at the man made my father suddenly grow kind.

"Sit down, Jaxon," he said. "Let's get to the bottom of this. When and how did you first realize that the bank had been robbed?"

"About five o'clock, Mr. Boon. I—I—woke up—"

"You woke up! Do you mean to tell me you had been asleep?"

"I wish I could say—I musta been doped—me and all the other five guards—"

"What! All six of you doped?"

"All of us, Mr. Boon," Jaxon said, sullenly. "And what's more—it looks like everybody in the district has been doped—"

"Rubbish!" the old man barked. "Talk sense, if you can, Jaxon. Who could dope a whole district?"

"I wish I knew—and I am talking sense, Mr. Boon. As far as I can make out, everybody between here and Battery Park was asleep between three and five this morning. Yes—and what's more—this is not the only bank that's been robbed. The State Sub-Treasury, the Guaranty Trust, the Trade Bank, and the Dyers' National—they've all been entered. All the lot of them—"

Jaxon slumped forward in his chair. The old man shot a look at me and signalled to know if I thought the guard was mad. I shook my head. Way back there on the Argonne I had seen infantrymen get into the same sort of daze after a punishing fight. Jaxon had all the symptoms. He was sane enough, but a beaten and bewildered man.

Just then a detective came in, a headquarters man, and with him was the bank's own investigator. They both confirmed what Jaxon had said about the other banks, and both the detectives were as bewildered as poor Jaxon. They could make neither head nor tail of the affair, and when they had both finished, the man from headquarters could only sit and shake his head, letting out staccato laughs and curses.

I was beginning to imagine I was still in bed and dreaming it all, and I could see that the old man, for all his poker face, was getting the same feeling. He got up quickly from his chair and started off to look round the building.

It was plain that entrance had been made into the bank through one of the windows next to the main door. A section big enough to pass a full-size man had been lifted clean out of it, and the steel astragals round the panes had been cut through as if they had been strips of cheese. I did not need the detectives to tell me that the cutting had been done by powerful oxyacetylene. I could see that plainly enough when I examined the edges of the removed section, which had been neatly set against the wall on the sidewalk.

Oxyacetylene's Work

Jaxon led the way to the door of the great vault. When the president saw what had been done to this elaborate piece of mechanism he grunted as if somebody had hit him.

There was a neat aperture cut in the central panel of the door, sufficient to let anyone step into the vault without trouble. The flame had sheared right through the machinery of the complicated locks, and there had been no attempt to find the easiest line. The hand that had done the work had simply cut out a chunk from the door, four square, and had not turned aside even for the gun-metal wheel handle. This had a segment shorn clean from it, and the severed fragment was lying on the floor. It was mighty good work even for oxyacetylene.

Without a word of comment, my father stepped into the vault by the opening, and I followed him. The compartments inside had all been broken open, and the floor of the vault was littered with bonds and securities that seemed to me to be worth stacks of money. I saw a pained expression creep into the old man's face, and I permitted myself the first question that morning.

"Bad?" I whispered.

"Bad!" he repeated soberly. "Lord, son—there will be a lot to do before we get over the badness of it!"

I always had thought my father would make a game loser, but the way he took the disaster filled me with admiration for his self-control. I couldn't say much to him then, for he is not the man you can readily offer sympathy to in words. I just sort of put my hand under his arm and gave it a bit of a squeeze, and I remember how it flashed on me that his biceps would have been a credit to a good heavyweight. The old man had a chunky brown face that had the appearance of having been modelled by a vigorous thumb, and had it not been for his thatch of silky white hair he would have looked, at that moment in the vault, for all the world like a bronze statue in a business suit. His fighting chin went up, and he gave me a short nod.

"It will take me some time to estimate the damage, Jimmy," he said. "Just take a look round the district, will you, and bring back as accurate a report as you can of what has really happened. These fellows are too rattled to please me."

"Right," said I, and left him there.

III

The first thing I did when I stepped from the vault was to get Jaxon into a corner and ask him about the doping idea. I shot questions at him, but got little out of him beyond the fact that from three till five o'clock he had been oblivious of everything. He had waked about five to find himself sitting on the floor of the reception hall with his back to one of the partitions. He had no memory of falling asleep, nor of sitting down. It had been as if those two hours had been cut clean out of his life.

Investigation and Queries

The other guards told much the same story. The lack of detail in their accounts was maddening, and for a minute or two I began to consider the whole thing a frame-up. But, beside the consideration—if the report of the whole district being doped were true—that the frame-up was unparalleled in the history of crime, the guards were all too sincerely bewildered to be lying. I could see that they were not acting a part, and that poor Jaxon, in particular, thought himself disgraced forever. He was heartbroken.

Jaxon had been with the bank for a quarter of a century, and his reputation for honesty and loyalty was unimpeachable. More than once his faithfulness had saved the bank from loss, and indeed there had been one occasion when he had been wounded by safe-breakers before he shot two of them in defense of his charge. The bank had presented him with a fine big gold watch, of which he was tremendously proud. He believed it kept better time than any clock in the State Observatory.

Jaxon's Watch

I mention Jaxon's watch because through it I discovered a curious thing. I was setting out to do the round of the district, when I found that I had left my own watch behind me. I looked at the

(Continued on page 60)

clock in the main hall, and it seemed to me to be slow.

"Is that clock on time, Jaxon?" I asked.

"Ought to be," he replied. "I checked it with my own watch last night. Let's see—" And he took his famous time-piece from his pocket. He pulled off the chamois cover in which he always carried it.

"Well, I'm dodblasted!" he exclaimed, as he looked at the half-hunter face. "What in hell's happened to my watch?"

The gold case was tarnished to a dull brown-green. From the look of it, one would have judged the watch to be a brass one that had lain for days on a sea-beach. Jaxon was bewildered, but I'll admit that my astonishment—if I did not show it—was even greater. From some little training in chemistry I could think of no reagent, even in the most up-to-date laboratory, that had such an effect on gold. The incident set me thinking, and before I had got into the street I had discovered that the gold leaf, so plentifully used in the interior decoration of the bank premises, was tarnished much in the same way. I said nothing about this additional discovery to Jaxon. I kept the fact to myself, and left him looking round for polishing material.

As it chanced, the first person I met on Broadway was Dick Schuyler, who had been in the same flying squadron as myself during the European War. He was and is still a commander in the sea division of the Air Police, so I grabbed him to act as safe-conduct for me round Wall Street.

"What do you make of it, Jimmy?" he demanded straight off. "A scientific feller like you should have a theory."

"I don't know a thing about it yet," said I. "You cops should have more information than I have. Is it right that these other banks have been robbed?"

"The Sub-Treasury, the Trade, Dyers' National, and the Guaranty," he said, making most of the mouthful. "There's a report, too, that the Post Office has been visited as well." The extent of the affair was beginning to impress me. Dick Schuyler has a cheery, careless manner, but he is not given to speaking without the book, and this confirmation brought me to a realization of what the morning's outrage involved.

"But what were the police doing all the time?" I demanded.

"Sleeping, as far as I can make out," he said dryly.

Further Details

The details of the affair, as Disk told me them, were incredible. The first intimation that anything was wrong in the Wall Street district came when a policeman recovered consciousness to find himself lying on the sidewalk. He thought he had fainted or suddenly dropped into sleep, and in either case was afraid of losing his job, for they want neither sluggards nor heart cases on the force. He got to his feet, glad that he had not been discovered by his patrol, and he began to hurry along his beat. He had not gone far when he fell over the feet of somebody who was sprawled across the steps in a doorway, and he stooped over to investigate. He found it was his own inspector, and he had no sooner laid hands on him than the sleeper awoke. Dick did not go into details of what the cop said to the inspector, or vice versa, but it must have been mighty interesting. Anyhow, the pair joined forces and set off round the district.

They were half-dazed, the two of them, and to their badly working intelligences it seemed as if they had suddenly found themselves in a city of the dead. All along the sidewalks and in doorways, even in the middle of the streets, sleeping men were lying at intervals. Dick Schuyler wanted to bet me that there never had been as bewildered a pair of men in the history of the world as those two cops, but I would not take him.

It is difficult to bring things together in their right sequence. What I gather from the many accounts I got that morning is that suddenly the police headquarters became noisy with repeated telephone calls, as bank after bank reported it had been robbed. Squads of police were rushed into the area at once, but when they arrived the thing was over and the thieves had got clean away. I remember wondering what would have happened under the old system of direct alarms to police headquarters. But this system, of course, had been largely discarded after the scandal of 1926, when the police were proved to have been in collusion with the crooks who effected the big robbery of the Dyers' National. It would have been interesting to see what would have happened to the police if they had been rushed into the district during the unaccountable two hours.

The other four banks were in a like case to the National Metallurgical. For two hours in the morning the guards and watchmen had been asleep and could tell nothing. Something in the nature of oxyacetylene had been used to effect entrance to all the buildings concerned, and their strong-rooms had been cut open by the same means. The thieves had got away with an enormous haul while the district was fast asleep.

I got much of this information from Dick Schuyler as we were walking along, and I had the chance to confirm a lot of it first-hand. The neighborhood now was filling rapidly, and automobiles and motorcycles were beginning to be frequent in the street. Newspaper men were everywhere, eagerly searching for information, but, beyond the one central inexplicable fact of the mysterious two hours, found little data for their write-ups. One excited little reporter rushed up to Dick and myself, and danced around us, waving a notebook.

(To be continued in our next issue)

Radio and Life

By Hugo Gernsback,

(Continued from page 11)

The writer particularly calls attention to the very important fact that the entire discussion is based upon constant electrification, not for hours, or days, but for decades of years. It is the steady, uninterrupted "dosage" that will create all the benefits above mentioned. Even with a weak stimulus great changes can be wrought if it extends over a period of years. The time in all cases is the important factor.

Summing up, it is quite certain that life on this planet with the influence of radio super-stations will be greatly enhanced by radio during the next fifty years.

Horsepower in the Household

(Continued from page 8)

kilowatt hour each day, 42 watts per hour. A kilowatt has 1,000 watts and the day has 24 hours.

Seven hundred and forty-six watts make one horsepower. Our household machines therefore use 42 divided by 746, or about one-eighteenth of a horsepower. But if we calculate the work hours per day as being ten, this gives us in round numbers one-quarter of a horsepower, which is more than the power a man can continuously produce. Sometimes our household machines must deliver still more, as we show clearly in the pictures on page 8.

For instance, we light a lamp on our writing table, another on the wife's sewing table, one in the chandelier, one in the kitchen, one in the hall. This represents one-half horsepower altogether. The wife uses the electric iron, one-half horsepower. The electric range keeps our tea hot; this is one-quarter horsepower. The electric heater warms our room on the cold rainy evenings, one-half horsepower. So there we are using more than two horsepower on this evening in our house.

Radio Television Plane

(Continued from page 22)

where it is supposed to drop its bombs. Moreover the distant control operator can see *exactly* when his machine arrives over a given spot. A sighting arrangement can be attached to the plane in such a manner that when the object to be bombed comes over the cross wires, the bomb or bombs are dropped at the exact moment. Suppose that the enemy becomes too strong and that a great number of machines attack the radio controlled plane and that there is no escape from the enemy. In that case the control operator will simply press another key which will immediately set the radio television plane on fire, bringing it down in flames. Thus it would be useless to the enemy and no lives will have been risked or taken—it being cheaper to destroy a machine than the valuable life of an aviator.

In the future such radio controlled television planes may be used not only singly but in squadrons as well. They can be used for attacking the enemy if necessary. They can be used in pursuit of the enemy, for taking aerial photographs, and for any other military operation, just the same as a present-day plane conducted by an aviator. Suppose the enemy has the same kind of machines, which, of course, he will have. It then becomes a matter of "playing chess" the same as if the machines contained live aviators. The battle, of course, would not be bloody, but practically the same results will be achieved as far as the military result is concerned.

For peace purposes it goes without saying that the advantages of such a mechanical and almost human plane are unlimited. It will be possible in the future to send mail planes from one end of the country to the other without a human being on board and such planes will be just as safe letter-carriers as if they were manned by human beings. Every second of the flight would be watched by the Post Office Department operator and the plane would, of course, be able to defend itself against attack. It could readily be equipped with electrically operated guns if such should be necessary. Particularly for transporting mail and the like, the radio controlled television plane will be invaluable.

There are, of course, hundreds of other applications of the idea which readily suggest themselves to anyone. The writer is certain that such planes will be in existence during the next ten years.

Single-Tube Reflex Experiments

(Continued from page 30)

single tube reflex circuit will give an amplification of over 3,000 times.

Simplified Reflex

Circuit 11 is similar to circuit 9 except that the transformer is omitted and the currents are amplified directly from the crystal. This is a combination of circuit 2 and circuit 8. The fixed condensers shown are not marked; it is up to the experimenter to determine the correct values. The amplification will be less than that of circuit 10 as the transformer is omitted.

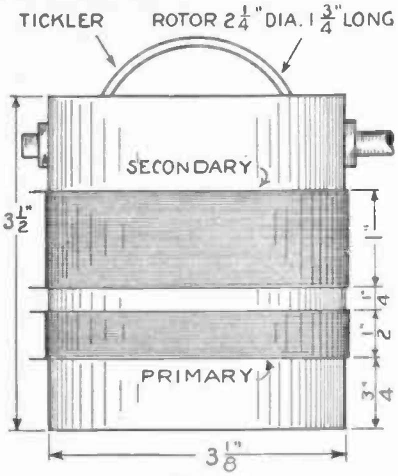


FIG. 13

The experimenter can easily construct a home-made tuning coil by following these dimensions. This coil, comprising primary, secondary and tickler windings, may be used in many circuits.

Improved Reflex

Slight improvements are embodied in the circuit shown in Fig. 12. In the first place the secondary of the amplifying transformer is connected to the center tap of the secondary of the tuning coil. One end of the coil connects to the grid and the other to a one-half megohm grid leak connected to the filament. This makes a bridge circuit and no radio frequency currents will pass through the audio trans-

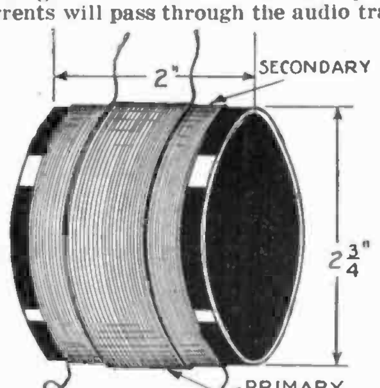


FIG. 15

This air core radio transformer works very well in a reflex circuit when used in conjunction with a crystal detector. By tuning the coil with a 23-plate variable condenser it covers the broadcasting range. It is used in many of the experimental circuits described.

former and a by-pass condenser is unnecessary. This circuit is more stable than the others. The plate circuit also differs. Instead of the usual transformer, a single coil with a slider is used. This not only tunes the circuit but regulates the amount of energy taken by the crystal. The coil may be a single layer winding of No. 26 wire on a 2½-inch diameter tube. About 80 turns should be used.

In the above circuits we have given the approximate amplification possible. This is given as voltage amplification and not energy amplification. If the voltage amplification is given as 1,600, the energy amplification is the square root of this, or 40, and the sound will appear about 40 times as loud, and not 1,600 times.

In our next issue we shall show a number of unusual and little known reflex circuits using a crystal detector and a single tube.

Single Control Receivers

(Continued from page 35)

trouble is obvious here. It is impossible to construct—ordinarily—a variometer which would increase its inductance in the proper relation to the wave length being received.

Such an idea was successfully carried out in the laboratory with the use of pulleys and belts. After a little experimentation the builder found the proper ratio and with the use of minor adjustments at other points in the set succeeded in operating a one-tube regenerator with comparative ease and efficiency from the one control. Such sets are not for the died-in-the-wool DX hound; they are, rather, for the man seeking something new, desiring to leave the trodden path.

There is no end to the number of commercial laboratories engaged in experimentation looking toward the unification of control in such sets as the neutrodyne. Systems of gears have been worked out but again the practical impossibility of obtaining condensers which increase capacity in the same ratio will be a great and constant hindrance. If the gear idea is applied, small vernier condensers for each stage of amplification may be added to make the final delicate adjustments.

The application of the single control to the super heterodyne type receiver is indeed new. In fact, to the best of the writer's knowledge, this is the first place in which it has been mentioned.

The system is shown in Fig. 7. Instead of using a tuning element between the aerial and the first tube, an ordinary radio frequency transformer of low ratio is inserted. In the present instance the tropadyne feature is shown in the hook-up. Small study on the experimenter's part will show immediately, the adoption of the idea to the regular super-heterodyne or the ultradyne.

The iron core transformer gives the broadest possible tuning, when used with any respectable outside aerial and easily covers the whole of the broadcast wave lengths or any equally wide range of frequencies with practically the same efficiency at all wave lengths. The only tuning done with such an arrangement is with the oscillator. When it comes to the proper frequency with the carrier of the station, the signals are heard. The only control moved is the oscillator.

In experiments with this circuit, it proved to work with excellence. Of course, there was a drop in efficiency from the standard set, but the results were much better than expected.

The ratio of the transformer used to couple the antenna and the set will be a great factor in the results obtained. Also, the construction and efficiency of the instrument will have no little bearing.

In conclusion a few notes might be added on experiments of this nature. In the usual case, up to the present, experimenters have only lightly attacked the question of relation between the tuning of the set and the increase or decrease of regeneration accordingly. Two controls are usually employed. An operator may use a set for years without taking the slightest trouble to investigate the connection between the two dials on his set representing tuning and regeneration.

In many of the sets illustrated in the first part of this article in which regeneration is controlled through the same means as the tuning they will be found to work well for most wave lengths. Exceptions will be noted, however. At certain points the apparatus will defy all the laws of regular usage at other frequencies and break into the most violent oscillation. In many cases this may be remedied by some slight change in the value of a piece of the apparatus. At other times a change in the arrangement of the set will help.

All the sets shown, with the possible exception of the super-heterodyne present real problems in construction.

The diagrams given here are only the beginning. There are multi-tube and reflex adaptations of the schemes shown

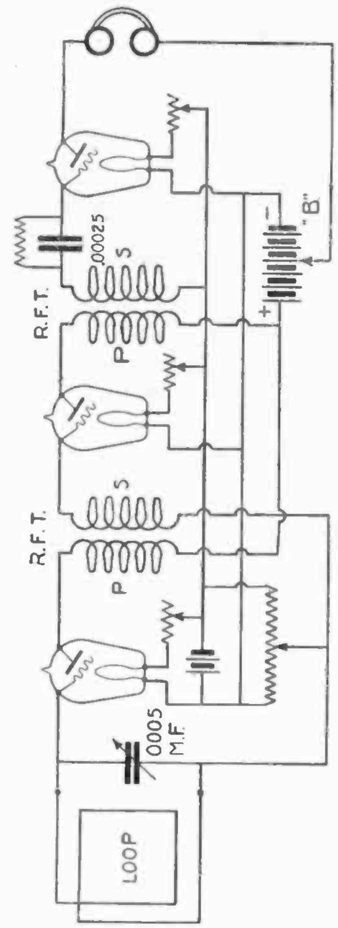


FIG. 6

In a standard radio frequency amplifier using iron core transformers only one tuning control is used. The potentiometer used to stabilize the circuit requires little adjustment.

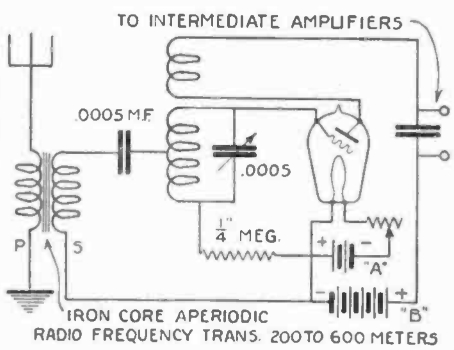


FIG. 7

The antenna circuit is connected to the oscillator circuit through an aperiodic R. F. transformer designed to cover the broadcast wave length range. Therefore it is only necessary to tune the oscillator circuit. The Tropadyne connection is shown, although it works effectively with other super-heterodynes.

for which more experimentation will be necessary than the ones shown.

The work may be long and tedious and the problems great, but most of the future of radio is tending toward the simplicity of control more and more and the experimenter who gets into the field early is the one who will catch the proverbial worm of publicity and payment.

Every amateur in radio who is worthy of the name longs for improvement in his favorite topic. Simplicity is one great thing to be striven for, but ahead of it perhaps comes selectivity. There is work for all in several paths.

Some Little Known Methods of Producing Oscillations

(Continued from page 31)

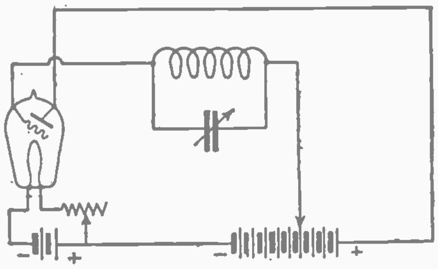


FIG. 6

An unusual way of producing oscillations with a vacuum tube.

The condenser then charges again and the same cycle of operation takes place.

The frequency of the discharge is controlled by the value of the resistance (R), the capacity of the condenser, voltage used, and the characteristics of the tube. By reducing the resistance and capacity, the frequency of the discharges increase. The frequency may also be raised by increasing the voltage across the tube. By properly adjusting the elements of the circuit the tube may produce frequencies ranging from one flash in several minutes to several thousands per second.

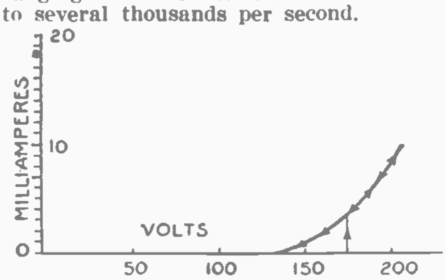


FIG 7

Typical curve of a neon tube.

Measurements

A neon oscillator may be used in several ways. It may be used to measure resistances, capacities, or even high voltages, since it may be calibrated with some tested instruments. For instance, if the capacity of an unknown condenser is to be measured it is connected across the tube and the voltage and resistance adjusted so that a small number of flashes, which are visible and may be counted, are produced each minute. By replacing the unknown condenser by a calibrated

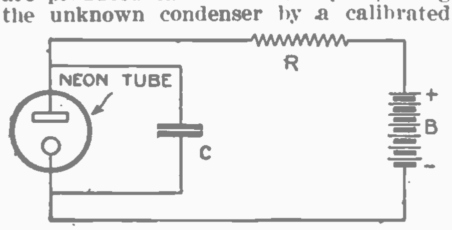


FIG. 8

Circuit of a neon tube oscillator. The frequency of the oscillations produced depends upon the values of (R), (C) and (B).

one the capacity may be found by adjusting the calibrated condenser until the same number of flashes are produced each minute. The capacity of the condenser is now the same as the unknown one.

An unknown voltage may also be measured in the same way; it is applied across the tube instead of the battery and the number of flashes per minute or second is counted. The battery is then connected and substituted for the source of unknown voltage, and the voltage is varied until the same number of flashes are produced. At this point the voltage of the battery is the same as the unknown source.

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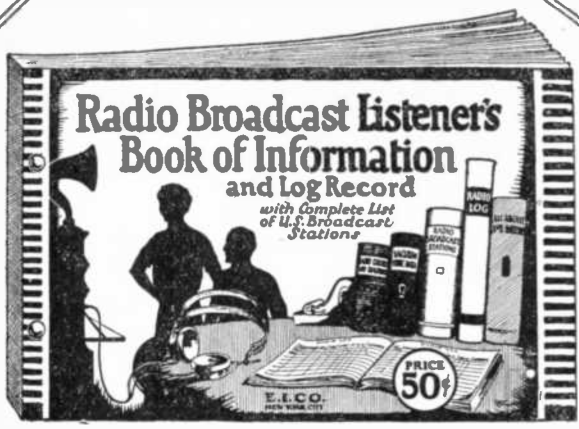

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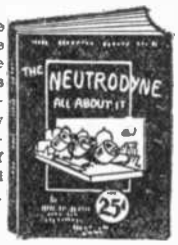

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Practical Hints and Data for Building Electromagnets

(Continued from page 41)

writer's own notebook, and these magnets were calculated and actually built, giving the pulls mentioned in the descriptions. It is a good general rule to observe, at least for small and medium sized electromagnets, to make the depth of the winding not over one and a half times the diameter of the core. In some cases the winding may be a little deeper, and in other cases a little shallower than this. In building solenoids it will be found best to place the cores in the lathe and either turn or file them quite smooth, and always smear a little oil or vaseline on them, so that they slide freely in the brass or copper tubes within the magnetizing coil.

Where slower action is desired in the case of the solenoid, a trick often used by inventors is to utilize the piston-like action of the core sliding within the brass tube, to produce a dash pot. To do this the core should fit the tube quite accurately, and the air compressed behind the core is allowed to escape through an adjustable valve in the rear stop core or yoke, this arrangement consisting merely of a hole drilled axially through the stop core, and the size of the hole being varied with a cone tipped screw. Fig. 7-C shows an oil dash pot attached to solenoid on a motor starter. The slow movement of the dash pot piston in the cylinder which is filled with a light grade engine oil, is regulated by a small valve in the piston or in some cases, simply by having a small hole drilled through the piston. In other cases where a very slow motion is desired, the solenoid draws the piston through the cylinder, the oil simply escaping by the piston as it is dragged forward. The descent of the solenoid core with its attached dash pot piston and rheostat contact brushes is accomplished by the weight of this part of the whole mechanism in the average case, or it may be augmented by springs or other arrangements.

(To be continued)

Starting a Chemical Laboratory

(Continued from page 47)

vessel to be heated by the steam from the water is placed. It is evident that if the water is heated the steam will heat the vessel (C). If no water is replaced, the pail will burn out. A constant level device is shown, and is made from ¼-inch glass ell tubes and tees. Water passes in at (I). By holding the finger over (C) and pinching the rubber tube (X), which leads to the drain, water will flow into the pail through (O) by way of (S). If the finger at (C) and constriction in (X) is released the water will siphon back out of (S) and fall through (X) if the water level in the pail is higher than the side arm of the tee-tube. As the water evaporates, more will flow in from (S).

Gas Generators

The simplest gas generator is shown in Fig. 7. Flask (A) carries the reacting substance and thistle funnel (F), through which acid is usually poured, which liberates gas from the substance placed in (A). This gas then bubbles through the desired liquid in (B), if desired.

A more elaborate gas generator is shown in Fig. 8. The test tube (T) carries the solid chemical, which is attacked by the acid from the separatory funnel (R).

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Tattooing

Electric Tattooing Supplies; facts on removing tattoos; illustrated catalogue free. Waters, 1050 E. Randolph, Detroit.

The test tube (T) is pricked with holes while softened in the Bunsen flame. When the stopcock (A) is turned, acid flows into (T), reacting with the substance there, the gas passing out through (O), assuming that the pinch clamp at this point is open. If gas through (O) is no longer desired, (O) is shut, and the gas forces the liquid which has exuded through the holes in (T), up through the tube (P) and back into the reservoir (R), to be used again. Of course, the stopcock (A) should also be closed with (O). This device uses every bit of activity of the acid by a continuous circulation.

The theoretical side of chemistry should also be studied by the chemical experimenter. Many tests are available which, with the aid of *The Experimenter*, will enable him to gain a very wide knowledge of man's most useful science, chemistry.

Electro-Chemistry

(Continued from page 50)

The zinc must be amalgamated by rubbing a globule of mercury over it after it has been dipped in acid. This if properly done will leave it silver-bright. A bit of scrap zinc or galvanized iron makes a good rubber.

For electroplating, in which a constant current is needed, a storage battery will be ideal. But, if you lack this, you may make two or three gravity cells. In the bottom of a battery jar place a good handful of crystals of copper sulfate. Fill the jar nearly full of water and add a few drops of sulfuric acid. Solder or fasten a copper wire to a square of sheet copper and place it in the jar, allowing the copper square to rest on the bottom. Bend a heavy piece of zinc so that it may hang over the edge of the jar and just dip into the solution. Fasten to the zinc a copper wire and the wires from the two poles, making a closed circuit. The gravity cell should always be kept on closed circuit. From time to time, more copper sulfate must be added, and the zinc will gradually be eaten away. It is this chemical action of the acid on the zinc which produces the current.

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These are only the important uses of the tool, but many other uses will readily suggest themselves to every radio experimenter. You will wonder how you have gotten along before without the 16 to 1 radio tool. Get one of these happiness tools. You will never again be without it. N-4800 RASCO 16 to 1 Radio Tool, each $0.35

35c

CRYSTODYNE DETECTOR

(PATENTS PENDING)

6900

$1.75

Here is a detector which has been especially developed by us for the new Crystodyne circuits. This detector while using the natural mineral zincite can be used with any other crystal as well. Several unique features are embodied in this detector. To begin with it is the only detector that has a sliding crystal cup with perfect contact arrangement and which cup not only slides but rotates with an eccentric motion. (Note slot A). By means of the small knob the cup slides easily so that any point of the crystal can be brought into contact. A new crystal can be inserted immediately by unscrewing the small knob. The contact plate which at the same time forms the catwhisker is made of spring steel. The combination of steel-zincite is the only one that was found practical for the Crystodyne oscillating crystal. Note the micrometric adjustment that can be made by means of the large knob bearing against the steel spring. This raises and lowers the steel point to the finest possible degree. The base is of bakelite, all parts nickel plated and polished.

N6900-Crystodyne Zincite Detector with Crystal............$1.75

N6900-Natural Zincite Mounted Crystal especially tested for Crystodyne work, fits any crystal cup $0.60

"RASCO" Snap Switch

At last a REAL radio switch constructed for radio purposes, not just a battery switch that may be adapted for radio. The RASCO switch is the only switch with a POSITIVE DOUBLE spring action. No more guess work if the circuit is open or closed. A push of the finger and the current is on. A slight pull and The Handle Snaps Back of its own accord. An internal coil spring pushes the handle back when a little pull is applied. This switch is intended as a battery switch to disconnect your "A" batteries.

Only one hole to drill. No tools required to mount only your finger and thumb. Also this switch takes up a minimum of room, much less than other switches, the base of the switch measuring only 1¼x½"

4850 **25c**

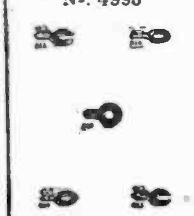
All metal parts nickel plated. A switch you will be proud to possess. N4850-RASCO Snap Switch, Each 25c

"RASCO" NAME PLATE ASSORTMENT No. 4994

This Name Plate Assortment Packet contains Nine Binding Post Name Plates as follows: one Aerial; one Ground; two Phones; one "A" Bat. —; one "B" Bat. +; one "A" Bat. + "B" Bat. —; one "C" Bat. +; one "C" Bat. —.

N4994 Nine Name Plate Assortment $0.20

"RASCO" LUG ASSORTMENT 50 LUGS 5 DIFFERENT STYLES No. 4995



This Lug Assortment Packet contains fifty of the most important lugs for the man who "Builds His Own" as follows: 10 lugs for 8/32; 10 for 6/32; 10 prong lugs (solderless) 6/32; 10 ditto 8/32; 10 flat type 6/32. All lugs are tinned.

N4995 Lug Assortment $0.22

"RASCO" RADIO NEEDS ASSORTMENT 108 PIECES No. 4996

This assortment contains 108 pieces as follows: 36 "T" Wire Bus-Bar Connectors; 4 Adapter Bushings (to fit ¼" dial to 3/16" shaft); 4 Separable Phone Tips; 4 Angle Brackets; 24 Lock Washers; 36 Assorted Lugs, already tinned for easy soldering.

N4996 "RADIO NEEDS" Assortment $0.48

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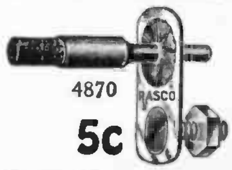
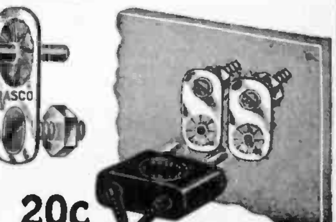
Again, Rasco leads with a small but important radio novelty. JIFFY JACKS are the simplest, and most efficient Cord Tip Jacks ever designed. Stamped from a single piece of metal they grip any style cord tip from any make phone or loud speaker. The JIFFY JACKS take but a minimum of room. All you need do is to drill two small holes in your panel and mount the JIFFY JACK with screw and nut furnished. No soldering necessary as the wire goes right on the screw. X-ray view shows how two of the jacks are used in conjunction with our Jiffy cord plug. The jacks go on in back of panel, only screws show in front. JIFFY JACKS take practically no room when mounted and are made of best spring brass that will not wear out. Hundreds of other uses for our JIFFY JACKS. We will pay $1.00 for every new use for JIFFY JACKS that is accepted by us.

JIFFY PLUGS are made of semi-hard rubber into which the tips of your phones or loud speaker are pushed. The cheapest and simplest plug ever designed. Its small size and neatness made it famous over-night. Size 1 in. long, ½ in. wide and ⅜ in. thick. No tools required. Just wet the metal cord tips and push through openings. Plug can be used with any standard cord tip jack, but best with RASCO JIFFY JACK.



4870 **5c**



20c N-4875

N4875-Two Jiffy Jacks with nuts and screws and one Jiffy Cord Plug..............$0.20

N4870-One Jiffy Jack complete with nut and screw 0.05

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7887

Here is something that every experimenter has been waiting for impatiently. This is a flexible silk-covered conductor to the ends of which are soldered strong brass spring clips.

Instead of using wires to make your connections—screwing and unscrewing binding posts—a clip lead hooks in a jiffy onto any wire, any binding post or other conductor in order to make a safe experimental connection.

"RASCO" CLIP LEADS come in two colors, green and red, to distinguish connections. Brass clips have powerful grip. Length of clip lead, one foot.

N7887 RASCO CLIP LEADS. Each..$0.12

Dozen lots 1.35

"RASCO" Brackets

Here is a line of small brackets evolved especially for the man who "Builds His Own." They can be used in a number of different ways—to hold tuning coil tubes; inductances; spider webs, etc.; to hold up panels; to attach various instruments to baseboards, etc. "Rasco" brass brackets are stamped from heavy metal and have been designed to do the work right. They are nickel-plated and carefully finished.

All illustrations are exactly half-size. Every builder needs at least a dozen of these. Order them now and save money and effort.

N1475 Brass Angle Piece, 5/16" wide x 7/16" high. Each..........$0.03
N1476 Brass Bracket, ¾" high x 2 lugs ½" long. Each............ .05
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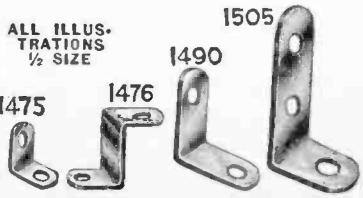
ALL ILLUSTRATIONS ½ SIZE



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