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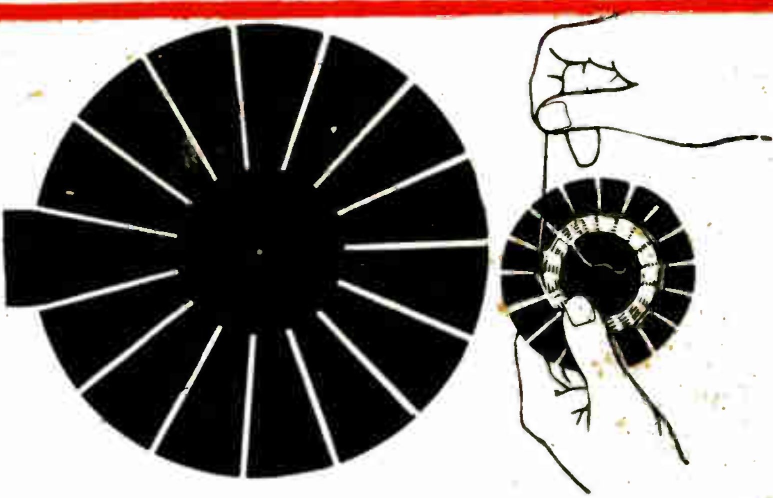

COMPLETE DETAILED INSTRUCTIONS FOR SPIDER WEB COIL RECEIVING SET IN THIS ISSUE.

By Henry M. Neely

E-Z COMPANY, Inc.

608 Chestnut St. Philadelphia

What Fire Underwriters Require on Radio Set

Following is a brief summary of the important radio regulations of the National Fire Protection Association:—

Aerial must not pass under or over other electric wires.

Splices and joints must be either clamped or soldered.

Lead-in wires: copper, not less than No. 14. Along wall, must be on insulated posts and at least 4 inches from other wires. Most cities require that the posts hold the wire five inches from wall. Must enter building through fire-proof, moisture-proof insulating bushing or tube.

Lead-in MUST HAVE LIGHTNING PROTECTOR GAP. Lightning switch is desirable BUT DOES NOT REMOVE NECESSITY FOR LIGHTNING ARRESTOR.

Lightning ground wire; copper, at least No. 10. Most cities require No. 4.

Grounding on gas pipes ABSOLUTELY FORBIDDEN.

Approved clamp must be used to connect ground wire to outside water pipe if such pipe is used. Galvanized pipe (or plates) driven into earth are approved.

Ground wire of set must be entirely separate from lightning ground.

Storage battery:—wiring must be at least No. 14 rubber covered.

Each wire must have fuse not greater than 10 ampere capacity, installed as near battery connection as possible.

Battery must have ventilated cover so constructed as to prevent accidental short-circuit across terminals.

E-Z RADIO

BY

HENRY M. NEELY

VOL. I. **JUNE, 1922** **NO. 2**

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CONTENTS

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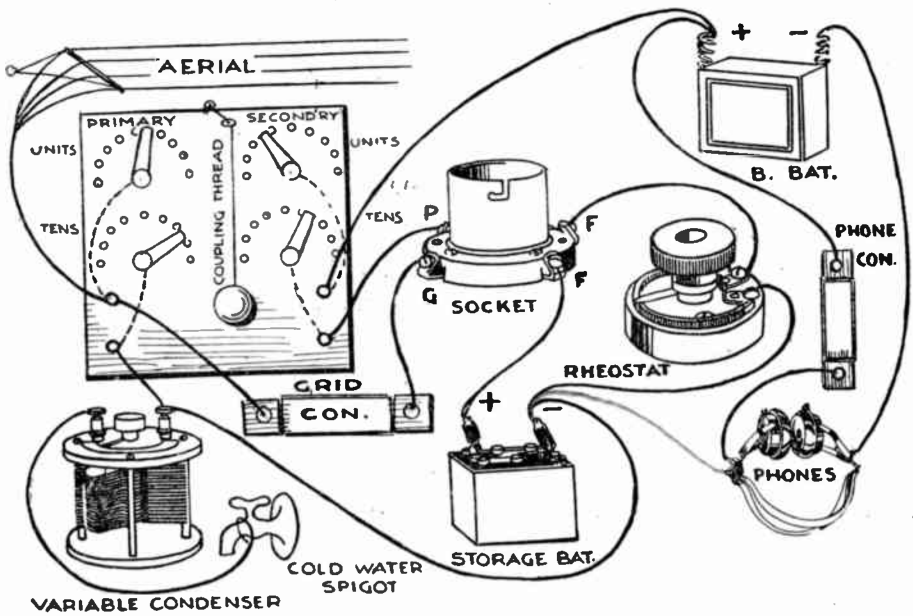
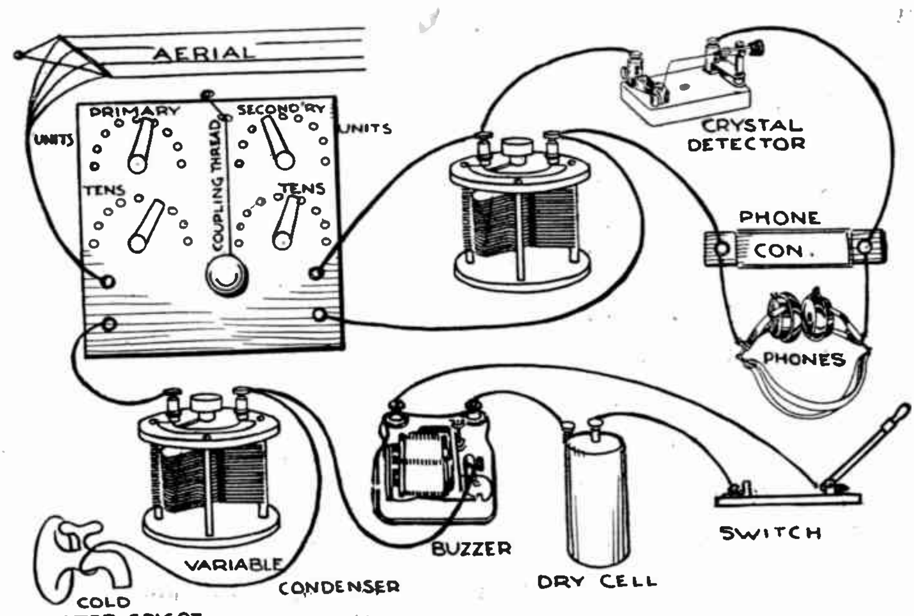




These are the simplest hook-ups for crystal and bulb detectors using the spider-web outfit described in this issue. But remember that, if you use variable condensers, you do not need the "units" taps on your spider webs.

BEWARE THE "BOOTLEGGER" IN RADIO APPARATUS.

This is the day of the "bootlegger" in radio.

Only about a week ago, a friend of mine—a novice who has become an enthusiast—came to me and handed me a package, gloatingly exclaiming, "I've found a detector bulb! Only $5.00!"

I opened the package and looked at the bulb. About the best you could say of it was to admit that it was a bulb. It had no maker's name on it. There wasn't a mark to indicate who was responsible for its manufacture. Whoever turned it out was ashamed—or afraid—to admit it.

I told my friend I was suspicious of it.

"But," he said, "the man tested it for me."

"Yes?" I answered. "How did he test it?"

"Why, he put it on a battery and it lighted all right."

"Certainly it did," I replied. "Anybody can make a bulb whose filament will light."

That night I took the bulb out to the E-Z experimental station at Delanco, N. J., and put it on half a dozen different sets. And each told the same story.

The grid in the bulb was absolutely a fake. It hadn't the slightest sign of life.

And when my friend went back to the store next day and angrily gave them my report, the manager showed every sign of guilt and quickly gave him his five dollars back.

Yet this store is supposedly a reputable store and it carries advertising regularly in various publications.

The manager has simply yielded to the temptation to cash in on the radio craze and the ignorance of the public on radio matters.

There are dozens of fly-by-night "firms" today putting out apparatus as fast as they can—apparatus that infringes lawful patents and is, at the same time, so inferior in workmanship that it will never give the service and satisfaction the buyer is entitled to.

This kind of thing, if it is not stopped, is going to kill the radio business and rob people of a very wholesome and instructive form of entertainment and study. It is going to disgust the public and the public will put the whole thing down as a fake.

The publishers of E-Z RADIO want to do all that they can to prevent this. They have asked me to devote more of my time to this publication, the extra time to be given entirely to ADVISING THE BEGINNER ON WHAT TO BUY AND WHAT NOT TO BUY.

You will notice that E-Z RADIO carries no advertising. We are not seeking any. And we give our readers our pledge, here and now, that we will not print one line of advertising unless I have personally tested the articles advertised and am willing to guarantee that they are what the advertisements state them to be.

E-Z RADIO is, fortunately, on a profit-making basis without advertising. We are satisfied with our business and our prospects. Naturally, we will take reputable advertising but only on the conditions here stated.

This position leaves me entirely independent in my advice to readers who want to know what to buy and where to buy it. I have no advertisers to lie for and no advertising prospects to fear.

Write to me freely and tell me your radio problems. Tell me what your local conditions are—how far you are from broadcasting and powerful commercial or government stations, what results you want to get, either in concerts or code or both, what your radio knowledge is and how much money you want to spend. Tell me also, if you can, what results are obtained by your neighbors who have sets.

Your local conditions, your skill or lack of skill and the size of your pocketbook will very largely govern the advice that I will give you.

If the requests do not swamp me, I will even do your shopping for you and get you your outfit at regular prices—and will personally stand in back of the material so bought. We have agents in various cities and can get immediate shipment on goods which your local dealer may not be able to buy.

There will be no charge whatever for this service. You will get your apparatus at exactly the same price you would pay if you went to the store and bought it yourself.

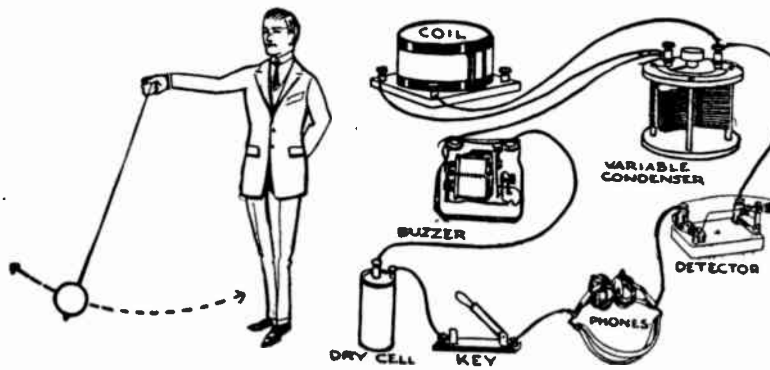
The publishers of E-Z RADIO have promised to furnish me all the help I need to carry it out and they want every reader of this publication to feel that, when he pays his twenty cents for E-Z RADIO, he buys with it the right to command my advice and my services up to the limit of my ability.

I want to do all that I can to prevent my readers from being hoodwinked by these "bootleggers" of radio and I can promise that the apparatus I advise will be standard, legal, suited to your conditions and the best that the particular size of your bank roll can buy. This offer holds good to all readers from the boy who wants to know the best crystal holder to the man who wants a $500.00 outfit. We realize that a reader disgusted with radio is a reader lost and it is an important part of our business to see that we do not lose readers. Therefore this offer.

Address me at our experimental station:—

HENRY M. NEELY,
Delanco,
New Jersey.

I. WHAT MAKES "WAVE LENGTH?"



A radio circuit vibrates or swings back and forth just as a pendulum does. The longer the pendulum, the longer arc it makes, and the greater length of time it takes to make a vibration. To the right is a collection of instruments that make vibrations and detect them in a radio circuit. We have means of varying them just as we vary the vibrations of the pendulum. The article explains it.

You never see an article about radio without reference to "wave length." We have already, in these little talks, explained that radio waves go through the ether in just the same way that waves from a thrown stone go over the surface of a pond. But I find a very general curiosity among novices as to just how these ether waves are produced for radio work and how it is possible to design a sending set that will transmit on any desired wave.

So, as we usually do when we want to explain radio, we'll talk about something else. Today it will be about a pendulum—just such a pendulum as you see in one of those stately old grandfather's clocks that stand in the hallways of our New England homes.

Did you ever watch grandfather regulate one of these clocks? In most of the old families, it's a regular Sunday morning duty, directly after the beans and brown bread have been disposed of.

He compares it to his big nickel watch which he set at the jeweler's window in town on Saturday night and, if the clock has lost during the week, he adjusts a little screw which moves the weight a little further up the pendulum or, if it has gained, he lowers the weight.

A pendulum of any definite length has a definite time period in which it completes one vibration—that is, in which it swings all the way over in one direction and all the way back. Scientists have what they call a "seconds pendulum"—that is they have figured out for different places the exact length a pendulum must be to take precisely one second to vibrate over and back.

In the Bureau of Standards at Washington is the official time measure of the United States. It is a half-second pendulum and it will always take just a half second to vibrate in Washington, though its period of vibration will vary in other parts of the world, always being the same for any one place. And the peculiar part of it is that, instead of being just half as long as the seconds pendulum, it is only one-fourth as long. In scientific language, the length of a pendulum varies not as the time does but as the "square" of the time. If, as in this case, the time of one is two times the time of the other, the length will differ not by two times but as twice two times, or four.

So you can see that, with the length of the seconds pendulum known, we can make a pendulum that will vibrate every quarter second or third of a second or in any division of time we want. It becomes a simple mathematical equation.

Radio waves vibrate up and down in the ether much as a pendulum vibrates back and forth in the air.

Hook up a coil and a condenser and you have a radio pendulum. It is ready to start vibrating any time you give it a push. Just as you start the pendulum by lifting the weight and letting it go, so you can start this pendulum by pushing an electric impulse in it. That impulse will swing through the circuit in one direction, turn and swing back, then forward again and so on until the resistance makes it die down just as the resistance of the air makes the pendulum stop.

The different layers of the coil have an effect upon each other and upon the whole circuit which we call "inductance." Roughly, we may consider this to correspond to the length of the pendulum.

The condenser has the ability to store up electrical energy and release it suddenly again when wanted. We can consider this to correspond to the force of gravity on the pendulum.

As I have already said, the standard pendulum will not vibrate in exactly half a second in some places other than Washington. This is because the force of gravity is different in places which are different distances from the center of the earth, which is the center of our gravity. The pendulum will change its period of vibration when you take it to the top of a high mountain because you have changed the influence which gravity has upon it.

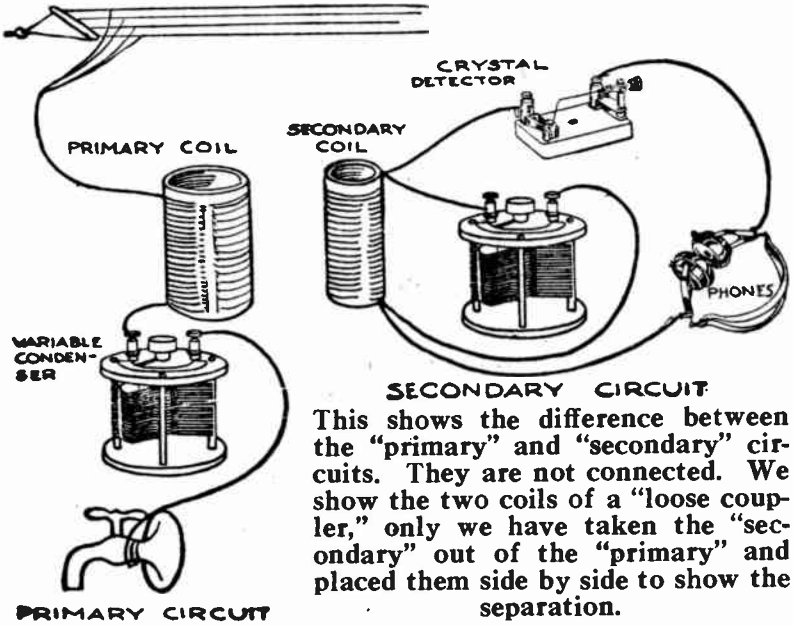
So you can change the period of vibration of our radio circuit by changing the amount of electric energy stored up in the condenser—what we call the "capacity." We have instruments which we call "variable condensers" which, by the turning of a knob, change this capacity to any extent we want.

We know we can change the period of vibration of the pendulum by lengthening the string. So we can change the time of vibration of our radio pendulum by lengthening the coil. We have means of changing this so as to include more or fewer turns of the wire in the circuit and thus alter the time it takes for the electric energy to make one swing once through the circuit and back.

When we have an electrical circuit like this, we call it an oscillating circuit — but oscillating simply means vibrating. In the illustration, you will see more instruments than the coil and the condenser, but these two are really the oscillating circuit. The switch and dry cell and buzzer are put in simply to cause the electrical push that starts our radio pendulum vibrating and the phones are included just to give us a means of hearing the result, because you can't see radio vibrations.

Hook up a circuit like this some day and listen while you vary the number of turns on the coil and the knob of the condenser.

II. THE "PRIMARY" AND "SECONDARY" CIRCUITS.



This shows the difference between the "primary" and "secondary" circuits. They are not connected. We show the two coils of a "loose coupler," only we have taken the "secondary" out of the "primary" and placed them side by side to show the separation.

You can make a radio set without knowing a great many technicalities, but you've simply got to know the difference between the primary and the secondary circuits. And it is a very easy thing to learn.

On any loose coupler or variocoupler or coil mount that you buy you will see two binding posts marked "primary" or else one will be marked "aerial" and the other "ground." There will be two other binding posts marked "secondary."

Now, as we have already learned, any coupler is a device consisting of two separate coils which have no actual metallic connection, but which are placed near each other in such a way that the electricity in the first coil "induces" or causes an electric current in the second. This coil in which the current is induced is called the "secondary." The coil which does the inducing is the "primary."

In the loose coupler the secondary coil of wire is wound around a smaller cylinder than the primary, and this smaller one slides into and out of the larger one.

In a vario-coupler the primary is wound around the cylinder and the secondary is wound around the ball, or "rotor," which turns around on a shaft inside it. Or, in the modern forms, such as the "basket ball," the primary is wound around the outer form and the secondary around the inner one.

With honeycomb coils or duolateral or spider webs, you use three coils on most hook-ups. The center one is then the secondary and the outer ones are the primary and the "tickler," the tickler usually being the smallest of the three.

Now let's look at the illustration to get a clear idea of the various instruments that compose the primary and secondary circuits. The term "circuit" may be taken to include all the wires and instruments which have actual metallic connection with each other.

In the illustration we have assumed that we have a loose coupler and that we have taken the secondary coil entirely out of the primary and placed them side by side. In this way you can see very clearly that they are not connected by any actual metallic contact.

This will enable you to see plainly just what instruments are included in the primary circuit, which is, of course, the circuit in which the primary coil is included.

First, there is the aerial and the leading-in wire. This is connected to the primary coil. The current runs through the coil and out usually directly to the ground, but in this case we have included a variable condenser just to show that there can be one in the primary circuit. When a variable condenser is included in this circuit it makes the natural wave length of the circuit much shorter, but it has the advantage of giving very sharp adjustments to the incoming signals. The condenser could have been placed between the aerial and the primary coil just as well. It wouldn't have made any difference.

This section of the apparatus, then, is the primary circuit. The radio impulses or signals are gathered by the aerial and sent into the ground through these instruments.

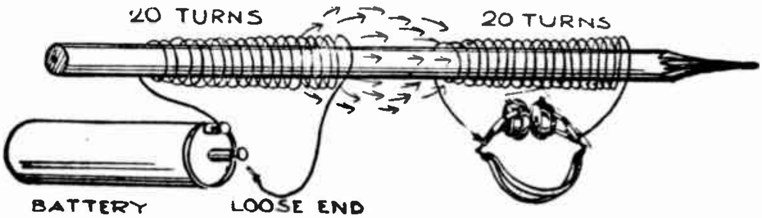
The secondary circuit includes all the instruments that have actual connection with the secondary coil. What these instruments are depends entirely on what kind of a set you are using—whether you have a crystal detector or an audion bulb.

If you will recall the audion bulb hook-up we gave some time ago, you will remember that we said it was what was known as a "single circuit" hook-up. Examine the diagram on page two and you will see why. You will find that the bulb and the rest of what would ordinarily be the secondary circuit have, as a matter of fact, two places where their circuits are actually connected to the aerial and ground circuits. Therefore, in that hook-up there is no secondary. The coil ordinarily used as a secondary becomes, in that case, a "tickler," and is used to gather the stronger currents taken from the dry cells of the "B" battery and "feed them back" to the primary coil and thus strengthen the signals that are coming in through the aerial.

III. YOU CAN PROVE "INDUCTION" YOURSELF.

Novices in radio often get weary of the constant repetition of such words as "induction coils" and "inductance" and "induced" currents. They probably wonder why radio fans have to use such terms so frequently. But the answer is simple. The whole art of radio depends on two things—inductance and capacity—and so naturally these two words are inseparable from any talk on radio apparatus.

We have already taken up the subject of condensers and compared them to tanks and bath tubs or anything that stores up water, just as condensers store up



Here we have a complete sending and receiving set in its very simplest form and also an excellent illustration of what an induction coil, a loose coupler and "coupling" mean. The article explains it.

electrical energy. And their "capacity" is about the same thing that the capacity of a tank is.

The subject of inductance, or induced currents, is perhaps even simpler than that of capacity.

With two pieces of wire, a pair of head phones and a dry cell, you can prove inductance for yourself and incidentally you can illustrate for some one else the basic principles on which radio works, for, with just these simple bits of material, you can make a sending and receiving station.

Wind one of the pieces of wire twenty or thirty times around a pencil, pulling the windings tight and pressing them together, so as to make them into a neat coil. It must be insulated wire, of course. Scrape the insulation off of one end and make it fast to one binding post of the dry cell. Scrape the insulation off of the other end and leave that end free.

Now wind a similar coil of the other piece of wire and make each end fast to the two wires of the head telephones.

Put the phones over the ears and listen to yourself "send." Take the loose end of wire in one hand and hold one of the coils in the other and with the loose end touch the free binding post of the dry cell lightly. Don't leave the wire in contact with it long. Simply touch the post and take the wire away immediately.

With the other hand move the two coils of wire gradually closer together along the pencil and soon you will hear a faint click in the phones as you touch the wire to the battery. This click will grow louder as the coils get closer together. And if you wind one coil actually over the top of the other the click will be very loud.

This little apparatus can be used to illustrate hosts of things in radio, but first we will use it to explain induction or inductance and induction coils with their important function of "coupling," which is so frequently spoken of in instructions for operating various kinds of sets.

By means of this and other experiments, it is possible to prove that when a current of electricity is made or broken in a wire it does a very remarkable thing. It sends out through the ether about it a wave of some kind of energy that we call magnetism.

You have seen the working of magnetism in the ordinary horseshoe magnet. In this little apparatus that we have made we can reproduce it. If, instead of the pencil, we had used an iron or wire nail and placed some iron filings or iron tacks at one end and then made and broken the current of electricity, we would have seen the tacks or the filings alternately attracted to and repelled from the end of the nail.

Try it for yourself and you will see more clearly the proof that a current of electricity through a coil does create magnetism.

Electricity can be insulated; that is, we have substances through which it will not pass. Magnetism cannot be insulated. It will pass through glass and air and rubber and bakelite and formica with perfect ease.

Now, while electricity and magnetism are different things, we always create magnetism when we send a current of electricity through a wire and, conversely, whenever we place another circuit or any part of a circuit within the influence of this rising and falling magnetic wave, we induce another current of electricity in the second wire, even though it has no connection with the first wire.

The strength and the personal peculiarities—what we call the "characteristics"—of this induced current will depend upon just which part of the field of magnetism we place it in. That is why, as you move these two coils closer together or draw them farther apart, you get sounds of different intensity in the telephones.

This moving of one coil in its relation to the first one is called coupling.

It is by means of this coupling—putting the second coil in such a position that it responds best to the "characteristics" of the current in the first coil—that we are able to "tune in" and "tune out" certain different kinds of signals in our radio receiving sets.

And it doesn't matter in what form you wind these coils. The spiderwebs described in this volume have the same effect upon each other as coils wound upon cylinders.

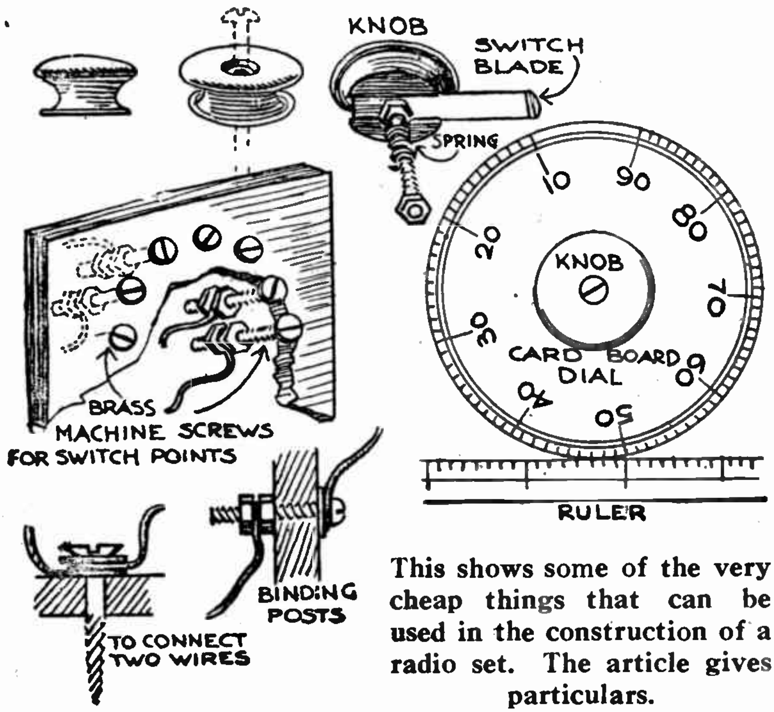
IV. YOUR PANELS NEED NOT COST A FORTUNE.

In building panels for mounting radio sets, of course there's nothing to compare with nice smooth shiny black formica or bakelite fronts with brilliant nickel-plated switch posts and blades and binding posts. Electrically, it's the very best combination you can get and it makes such a workmanlike job that it's a delight to the eye and something which the maker can be proud of when he displays it to his friends.

But formica and bakelite cost money and nobody is giving away nickel binding posts and switch points. And, if you do the sensible thing and adopt the "unit" system of construction advocated in these articles, the various panels, if built of the best, will total quite a tidy sum of money.

But it isn't really necessary to spend a fortune. It can be done with very little cost. The radio expert will frown with disapproval at the advice I am going to give in this article, and will warn you of "dialectric losses," but, if you've never met a dialectric loss personally and wouldn't recognize one if you saw it on the street, you can leave that fine-sounding term to the expert and go ahead and have all the fun you want with the stuff I am going to describe. I have myself used this a great deal and, while I might have established a criminal record with "dialectric losses" I heard the broadcast concerts and that was what I was after.

Instead of formica or bakelite, you can use any good hardwood for your panel. And, if you can't get hardwood, use just wood. And, if you can't get that, use compo board or heavy cardboard.



This shows some of the very cheap things that can be used in the construction of a radio set. The article gives particulars.

I made a lot of panels when I found an old desk being thrown away and saved those thin boards that form the partitions in the drawers and between the pigeon holes.

Just so long as these substances are thoroughly dry, you won't know that you are having "dialectric losses," but if you use a sappy wood or a damp piece of cardboard, I won't guarantee results.

For knobs for switches or coupling handles or condenser handles, I pay a cent apiece in a hardware store for those little wooden handles made for tin pot lids. And I buy a gross of half-inch-long brass machine screws and a half gross of two-inch-long brass machine screws and a half gross of brass washers.

It doesn't matter about the thickness of these machine screws or the kind of thread they have, so long as you can get nuts to fit them.

For switch contact points, I put the half-inch screws through holes, leaving the head of the screws on the front of the panel. On the back, put on your wire and screw the nut on tight and you have a good contact point. If you want to use them as binding posts, shove them through from the back with a washer on the back of the panel, put a nut on the end in front, twist your wire on the back and screw up hard on the nut. Then put on another nut on the front, so that you can screw down on a wire when you want to connect it there.

To make knobs, drill through the pot knob with a drill the size of the two-inch machine screws you bought. Then, with a larger bit, big enough to make a hole that the nuts will turn in, enlarge this hole front and back to a depth to take the nut, pass the machine screw through, put the nut on the other end and screw up hard and fast with a screwdriver, holding the nut with the end of your wire pliers until it is embedded firmly in the wooden knob.

The illustration will straighten out this puzzle for you.

For switch blades, use thin brass which has a good, stiff spring to it. If it is soft brass, it will soon cease to make good contacts. If you cannot possibly afford brass, open up an empty tin can and cut your blades out of that with your mother's sewing scissors—but don't let her catch you at it. She'll declare it will ruin her scissors. I've used my wife's for six months, and she doesn't know it yet. It's like those "dialectric losses" we've been talking about. Mostly theory.

For dials I cut a circle of cardboard any diameter I want. Then I roll it slowly edgewise over the edge of a ruler, marking it off in sixteenth inches until I have the whole circumference thus divided. Then I begin at any one mark and lengthen each tenth mark and then lengthen each five in between, only not so long as the tens mark. Then I number by tens from zero all the way around to the zero again.

The dials you buy are usually carefully divided into exactly 100 marks. This isn't necessary. You can use any number you want. The marks are only to let you make a record of the setting at which you heard the best signal or to let you know the position of your coupling or your condenser on the back of the panel.

You can think of a number of money-saving ideas like this as you build your set.

V. YOU "TAP" YOUR HOUSE PLUMBING SUPPLY.

Think we're dwelling a good deal on this subject of "tapping" wires in a coil? It's one subject you'll have to be patient with, for, unless you understand exactly what you're doing and why you're doing it, you'll never be able to build satisfactory radio apparatus.

Careful tapping is essential in most of the home-made apparatus you will see described in the radio magazines. If you have plenty of money and can afford two or three variable condensers, you won't have to tap quite so much, but in these early articles I'm assuming that the reader's pocketbook is much like my own—not quite so full of money as the evening is of spare time.

Tapping by tens and units, as recommended in previous articles, has only one object—the exact tuning of the set to a certain wave length. The switch which adds ten turns of wire at once in a circuit will get your tuning somewhere near the wave length you are hunting for, but you'll have to have the other switch, including one turn of wire at a time, for fine tuning and for making the signals loud and clear.

A variable condenser inserted between your aerial and your coil or between your coil and the cold water spigot will take the place of this unit tapping for the coil known as the primary, and, in fact, will be somewhat better. Another variable condenser, with one post wired to one of the posts marked "secondary" on your coupler and the other wired to the other secondary post, will take the place of the secondary unit tapping.

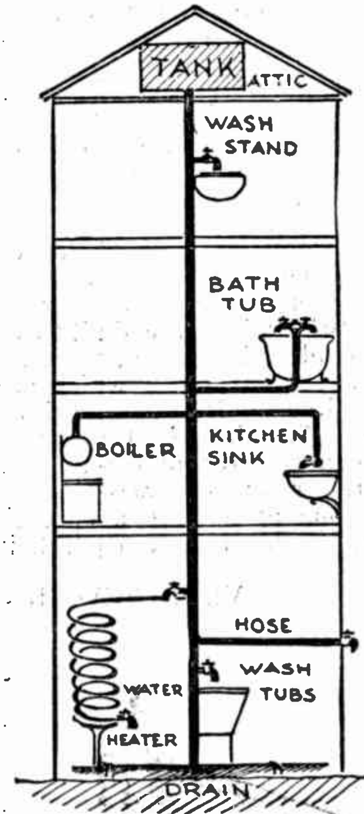
But the price of a good variable condenser has now settled around $5.00, and it may go higher, so that these two will mean the outlay of at least $10 just to save a bit of time and trouble. And, when your set is done and your friends are admiring it, you won't be able to show as much pride in it as you would if you had done this job of extra tapping.

I think it is advisable right here to go into a little explanation of tapping so that the man or boy who knows nothing whatever about electricity will understand why we do it. The very best way I know is to compare our set to the plumbing in the house, with its sinks and its spigots and its bathtubs. Then we will later take up this matter of condensers and explain just what they are and what they do and we'll again use the illustration of the house plumbing with especial reference to the bathtub.

You've all seen plumbers make pipe connections with what they call T's and Y's and L's and 45s. Tapping a coil of wire in a radio set is simply putting a T or a Y connection in one of the wires. In plumbing we have pipes and the water runs inside of them. In electricity the pipes are wires and the electricity runs mostly on the outside of them.

That's why we have to solder all of these joints. We must have an absolutely smooth metallic connection on the outside from one wire to another.

You might regard your aerial as the supply tank in the attic of your plumbing system. It collects the little electric current and our wires pipe it down to and through our set just as the pipes in a house bring the water down



Your house plumbing system will give you a clear idea of what we mean by "tapping" coils and what tapping does. Read the accompanying article and you will understand it.

from the supply tank.

In the house we perhaps put in a T connection for a washstand in the third floor. We insert it so that the main pipe will be continuous and the water will flow through the straight part of the T, and we take the washstand supply off the opening in the middle and lead it to a spigot over the stand. The pressure of water in a supply of this kind is exerted in all directions. So, when we open the spigot, the pressure forces the water out of the main pipe and through the small washstand pipe and we get it in the stand.

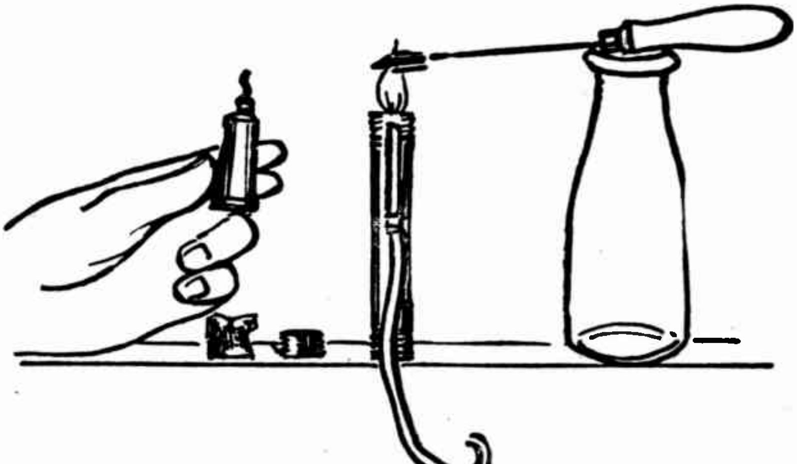
So we do with the wire of a coil. The electrical pressure is there all the time, ready to force the electricity in any direction as soon as a spigot is opened to give it a pathway.

Our spigots are the blades of our switches. We put in T joints (taps) every certain number of turns of the coil and lead all these taps, or electrical pipes, to little metallic switch points, which are much like bolts or machine screws. The blade of the switch can be turned so that it will pass over the heads of these switch points one at a time and, each time it touches a switch point, it forms a metallic connection on the outside and acts just like the opening of a spigot.

Thus, when we have all our taps connected to the contact points, we can revolve the switch blade over to any one we want, just as, in the house, we can open the spigot which lets water into the washstand, the bathtub, the boiler, the kitchen sink, the garden hose, the hot-water heater or any other place.

Pipes off the main supply line are the taps of house plumbing. Taps are the branch pipes of the radio set. And the spigots are the little contact points set in a semicircle so that the switch blade can touch and open any one we desire to use.

VI. A FEW HINTS ON SOLDERING.



Here is a soldering outfit. The hand is holding a tube of "dope" or "salts"; under it is a piece of solder, next the cap that screws on the alcohol torch, next the torch itself and then the soldering iron resting on a milk bottle.

Watch any three experienced amateurs building apparatus and you will see three different methods of soldering. Each one will choose the way that is easiest for his own flexibility of fingers and, if he's as double-jointed as the writer; and his fingers are all thumbs, he will sometimes nearly stand on his head to get the job done. But the results are the same.

It's remarkable how many beginners fight shy of this little job of soldering. They seem to think there's something very difficult about it. But there really isn't. It's fun.

When you buy your outfit get a very small soldering iron. The working end of mine is only five-sixteenths of an inch square. It looks like a toy and a plumber would sneer at it because it will not retain heat more than about a minute, but that's all you need for radio work and the small head permits you to solder joints in out-of-the-way places that you couldn't reach with a larger iron. I paid forty cents for this one.

Then there is the little alcohol blow-torch to heat the iron. This is merely a small cylinder with an asbestos wick in one end. The other end has a screw cap, which you remove in order to fill the tube with wood alcohol or denatured alcohol.

Fitted snugly around the cylinder is a little clamp carrying a metal tube with a small piece of rubber hose attached. For ordinary use this tube is not employed. I keep it slid down the cylinder out of the way.

Usually I rest the iron on a milk bottle or a pile of books or a box and stand the torch on the table beside it, arranging the heights so that the head of the iron is directly above the torch and about half an inch higher. This brings it well into the hottest part of the flame when the torch is lighted. When the iron becomes hot enough you will notice the flame taking a greenish tinge all around the head of the iron. The torch cost me seventy-five cents.

In addition to these two things you will need a tube or can of "dope" or "salts" as the radio fans call it. This is a greasy substance which takes the place of the old-fashioned acid that was such a nuisance to everybody. There are a number of good makes on the market and a tube or can will cost from twenty-five to forty cents and last for a couple of years of ordinary use.

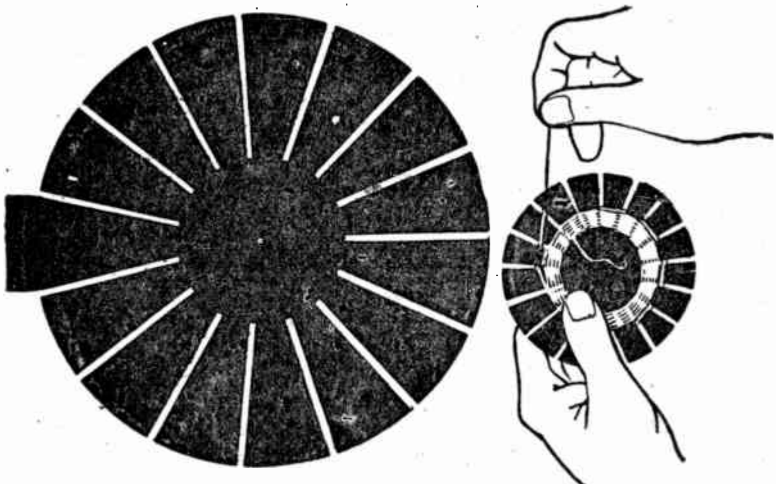
In making radio apparatus you will seldom need more than a drop of solder, so you go about the job differently from a plumber. My method, which just happens to suit my own queer fingers, is this:

To join two wires I scrape the ends clean and bright and twist them together tightly with wire pliers. Then with a matchstick I smear a little of the "dope" on them. All this time, of course, the iron has been heating.

When the green flame appears I take the iron, rub it into the piece of solder until I see some of the solder melt and attach to the iron and then I put the iron to the joint and rub it around until the solder comes off of the iron and forms itself around the wires. It takes about a second. Sometimes the solder won't adhere to the wires, but will drop off to the table in a little ball. This usually means there is dirt there and you'll have to disconnect your wires and clean them with your knife. If you have trouble making the joint the first time, heat the torch and try again, but always put more of the "dope" on. And always have a piece of paper on the table under the job, for the "dope" will melt as soon as heat is applied and run off the wires.

After very little practice you'll be able to drop a bit of solder right on the spot where it is needed and then it becomes really an amusement. If you don't want to learn to solder you'd better buy your radio apparatus, for it cannot possibly be made right without solder.

VII. THE HANDIEST COILS FOR THE NOVICE.



Here is a form that you can use for cutting out the cardboard to make spider-web coils. On the right, the picture shows the method of winding them.

I never could understand what fascination knitting had for a woman until I began to wind spider-web coils for a radio set. Then I knew. Nowadays, I sit and wind spiderwebs while I talk to friends at home, or do it to keep my hands busy while I'm thinking out some problems. That shows how easy and entertaining it is, once you get the hang of it.

Spider-web coils are also known as basket-woven coils. They are made just as willow baskets are made, with strands woven in and out around, and around a certain number of spokes. It is always an uneven number so that the successive layers of willow (wire, in the case of radio), will cross each other between the spokes.

The picture shows clearly what a spider-web, or basket-woven, coil is. It also gives a sample form which can be used to cut out the full-sized form from cardboard for actual work.

Don't use too thick cardboard. I standardize on that tough, red fiber stuff which is about one-thirtieth of an inch thick. Don't get discouraged, now, because you have no micrometer to measure one-thirtieth of an inch. There's a very easy way to do it.

Take your scissors and snip off fifteen or twenty small bits of the cardboard you thought of using. Pile these bits up and measure with a rule. Make a pile just one-half inch high. Then count how many bits there are in the pile. If there are fifteen, each is one-thirtieth of an inch thick. Simple, isn't it? So, when you see something calling for a piece of metal or cardboard .05 inch thick, don't get discouraged and think it needs a mathematician to figure it out. Figure this way: Five one-hundredths equal one-twentieth. Therefore, twenty in a pile will measure an inch high.

For these spiderweb coils use tough fiber sheets that will pile twenty or thirty to an inch. Ordinary cardboard will do, but is very likely to crack and bend. You want your finished coils (there must be at least two of them) to lie flat against each other. If they gradually assume a bowl-shape, as they almost certainly will, it's all right. Just set the rounded side of one into the hollow of the other and you have the requisite close contact.

I want you to make two of these coils even before you know what you are going to do with them. Then we'll take up the matter of hearing concerts with them. Just take my word for it that it can be done. A novice friend of mine made two the other night, hooked them up to aerial, phones and crystal detector according to the hook-up given on page two, and, even without the expense of the variable condensers, had five concerts on that evening and was able to tune one out and get the others at will. You can do the same thing.

Draw two circles on your cardboard, one two inches in diameter and the other five inches and a half or six inches. Use the same center for the two circles, so that they are around each other. Then trace out the spoke form in the picture, poke a pin through the center mark, transfer tracing and pin to the cardboard, stick the pin in the center of your two circles and you're ready to proceed.

Tie one end of a short piece of thread around the pin and, with this thread drawn tight, extend it out the white spaces between the spokes and mark on your outer circle where each one comes. That divides your six-inch circle into fifteen parts.

Take your tracing away and rule a line between these markings and the center, so that you have the spokes drawn on an extended scale. In other words, you are simply duplicating this black form making it six inches in outside diameter and the "hub" two inches in diameter.

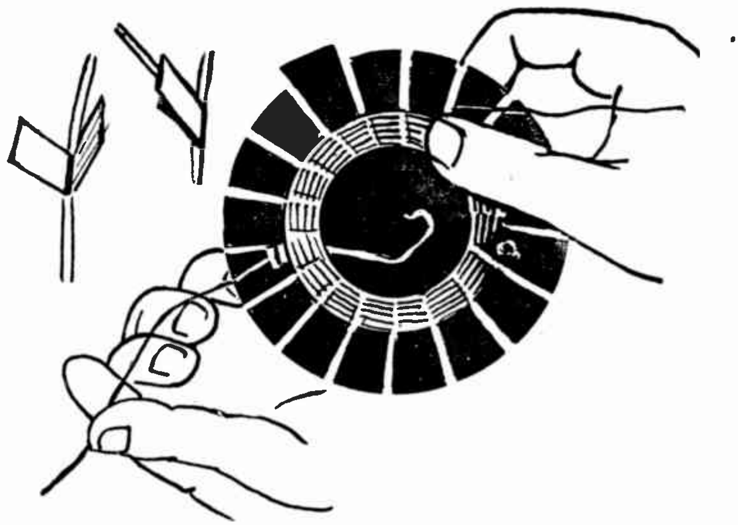
With a pin, punch a hole in the hub near one of the spokes. Use No. 26 or No. 28 cotton covered wire, either single or double, though double is better. Pass one end through the hole and pull through about a foot of wire. Then start winding.

Bring the wire up through any one of the spaces between two spokes and weave to the right, under one, over the next, under the next, over the next, and so on, keeping a fairly good strain on the wire, so that it will make a neat basket appearance. Keep on winding until you have put 100 or 110 turns on. That will make a coil good for about 800 meter wave lengths or any wave length under that for the average amateur aerial.

Make two of these coils. By the time you have them made tonight you'll want to go to bed, so we'll take up the rest of the process in our next lesson.

VIII. TAPPING THE SPIDERWEB COILS.

Have you wound those two spiderweb coils we spoke about in the last lesson? They don't look much as though they would produce music, do they? I can only say this about them; in my own station, I have every conceivable kind of receiving instrument and I'll back a couple of spiderwebs against any other apparatus an amateur can make for satisfactory work in receiving 360-meter broadcasts, either with crystal or audion bulb. And I have one big



This is how a spider-web coil is wound and "tapped." For tapping, little pieces of thin brass or copper are best, cut as explained in the article. The upper sketches show how the metal strips are used.

fellow that I made especially to get me the Arlington time tick on 2500 meters, that does the trick night after night on an audion without secondary, tickler, variometers, condenser or anything else.

But after you have wound your two six-inch coils you've simply got to face the job of "tapping" them.

A tap is an extra wire that is soldered to one of the wire turns of the coil. You must have taps arranged so that you can take the electricity from ten turns or three turns or fifty-five turns or any other number of turns you may require. And it really isn't difficult.

A tap is made in this way: you first scrape off the cotton insulation from one spot on the proper turn of wire. Then you cut from your spool about eight inches of wire, which we will call the "tap." Scrape off just a bit of the cotton from one end of this. As a matter of fact, it won't be necessary to scrape. You can simply push the cotton back from the end.

Now the bare metal of the end of the tap must be metallically joined to the bare spot you have scraped in the coil wire.

I have found the most convenient method to be as follows:

I get a sheet of very thin brass or copper, about the thickness of a piece of good writing paper. I cut twenty little strips — very small—only about a quarter of an inch long and an eighth of an inch wide.

At the spot on the coil where I am going to make the tap I slide one of these little pieces under the chosen wire and then with a sharp knife cut the cotton insulation and lay the wire bare right over this little metal strip. Then I insert the bare end of the tap wire under this bare coil wire, and with the pliers turn up the end and squeeze it together so that it is around the coil wire.

Then I solder coil wire, tap wire and metal strip all together with just a drop of solder. That done, I take the pliers and bend up the metal strip, squeezing its two flaps tightly together. That makes a good electrical joint.

You must thus tap each of the first ten turns on your coil. Also after that you must tap each tenth turn to the outside. This means that you have tapped turns Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9 and turns Nos. 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100.

In tapping be sure that you do not arrange the metal strips so that they can touch each other. This would give you a short circuit. You don't have to tap exactly in the same relative spot in each turn. Tap one on one spoke and the next on the spoke to the right and the next on the spoke to the left, and then where the wire comes in between the spokes, so as to keep the taps clear of each other.

But there's one wise precaution to take. Before tapping, note the direction in which the wire is wound around the coils. Lay them face to face so that both coils are wound in the same direction. Then make all your taps on the near side of one and the far side of the other so that when they are done you can have clear sides to place against each other and still have the wires wound in the same direction.

When you've got these two coils wound and tapped, you have a piece of apparatus that will take the place of a loose coupler, a vario-coupler or a pair of honeycomb coils in any hook-up you come across—and do it so efficiently that you will be astonished.

It only remains now to get these taps transferred to switches and then to mount them in a neat panel with the proper gadgets to operate them. So that's what we'll take up next. And I can't too strongly impress on you that this little outfit is worth all the space we are giving it and that you can use it on your crystal or afterward when you graduate to an audion bulb. I use one with two stages of amplification and it works like a wizard.

Just one thing: if you are going to use a variable condenser, you can avoid tapping turns Nos. 1, 2, 3, 4, 5, 6, 7, 8 and 9. If you use this condenser in the part of the instrument that includes aerial and ground — the "primary" circuit, as we call it—the primary coil need only be tapped by tens. If you use the variable in the "secondary," tens taps will do on that coil. We'll explain that when we come to mount the coils.

IX. SPIDERWEB COIL TAPS AND SWITCHES.

You see, we're still dwelling on those spiderweb coils. Have you wound yours yet? And tapped them, according to the instructions given in the last two lessons?

Now, before we build a neat little stand to hold and operate them, we must talk for a few minutes about the general method of handling taps from any coil.

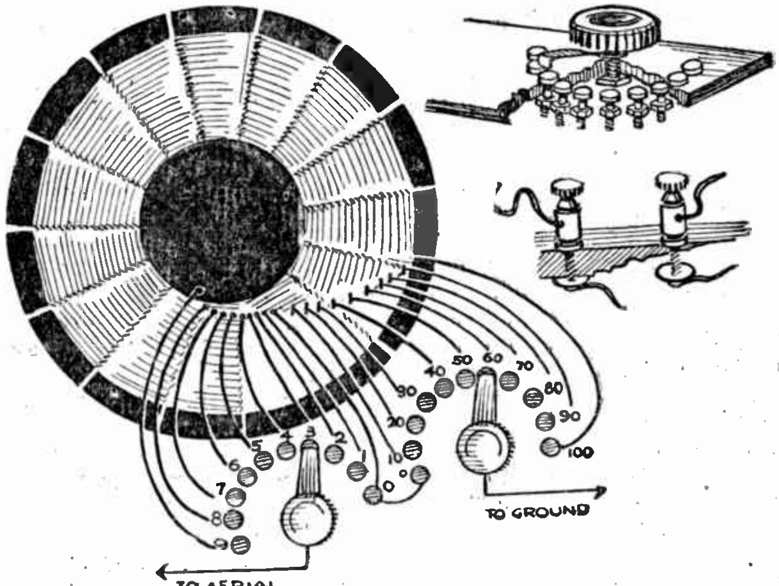
You'll want to get your material right now. So, for the complete spiderweb vario-coupler which we are building, here is what you'll need:

Forty-two nickel switch contact points.

Four nickel switch blades and knobs.

Four nickel binding posts.

Brass will do, but nickel plate



This shows how to "tap" spider-web coils. The wire you start with and each turn of wire for the first nine turns are tapped and the tap wires brought to the contact points of the "units" switch. The rest of the coil is tapped every ten turns and each tap wire is brought to a contact point on the "tens" switch. The two zero points are connected by a wire. Above, at the right, is a "ghost" view of one of these switch arrangements showing how the switch blade is mounted and how the contact points are put through holes in the panel. Below it is a view showing how binding posts are used.

makes a thousand per cent better looking job, especially if you build your stand of black, polished material such as formica or bakelite or ebony asbestos wood. The nickel-plated points and posts stand out against the black like a string of diamonds on a movie actress, and nothing could be brighter than that. You'll be proud of it—the panel, not the actress.

In the last talk we learned how to "tap" the spiderweb coil, taking taps first off turns numbers 1, 2, 3. 4. 5, 6, 7, 8, 9 and then of numbers 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100. The first bunch of taps we call the "units" taps and we have a switch and a set of switch contact points for them. The others we call the "tens" taps and they, too, have their switch and contact points.

A typical switch contact point is shown in the illustration. It has a threaded shaft that shoves through a hole in the panel. The end of the tap wire is bent around the rear end of this shaft and the little nut is screwed on tight, holding the tap wire firmly against the shaft and the whole switch point solidly in the panel. Naturally, you must scrape the insulation off the end of the tap wire so as to have a metal-to-metal connection.

These switch points must be inserted in the panel in a semi-circle with the knob and blade in its center, so that when you revolve the knob, the end of the blade will pass from one point to another smoothly. Consequently, the points must be so close together that the end of the blade does not have room to get in between them, yet far enough apart to prevent one point touching another or the wire on one point touching the wire or point next to it on the panel back.

When you are ready to lay out your panel, measure the exact length of the switch blade from the center of the shaft to the part of the blade that is to touch the points. With a compass or a pair of dividers or by any other method you choose, draw a semi-circle with this distance as the radius. Your contact points will go along this semi-circle and consequently the end of the blade will slide over each one.

Along this semi-circle, lay off points three-eighths of an inch apart—ten for the units switch and eleven for the tens switch. It is at these points that you must drill the holes to receive the shafts of the little contact points. The distance, three-eighths of an inch, is just about right for the standard-sized switch blades.

All wiring, of course, is done on the back of the panel. First connect with a short wire, the two zero points. Then wire up the taps as shown in the diagram. This means that the very first wire — the one you shoved through the pin hole before you began winding—goes to point No. 9. The tap on the first turn of the coil goes to point No. 8, the second to point No. 7 and so on. This means that the tenth turn goes to point zero on the unit switch and connects by short wire to the zero point on the tens switch, and this latter point has no other connection. The wiring of the tens points is plain sailing.

If you will follow the setting of the two switches shown in the diagram you will see that this arrangement makes it possible to include any number of turns of the coil we desire in our circuit.

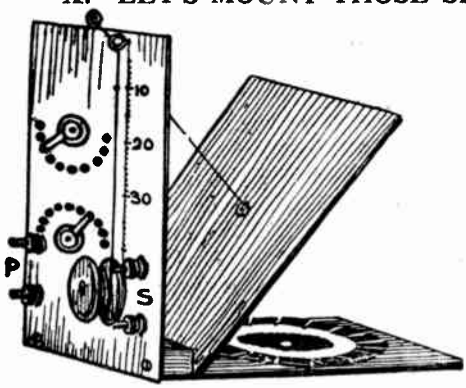
Imagine an electric current coming in from the aerial. It goes by wire to the shaft of the units switch blade, flows through the blade to the No. 3 point, through the wire, around the coil seeking a way out, but doesn't find an exit until it gets to the wire going to point No. 60 on the tens switch, from which it goes along the blade and by wire to the ground. We have thus included sixty-three turns of the coil in our circuit.

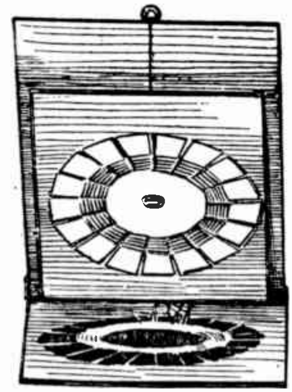
In this way we govern the wave-length which we are to receive. The more turns we use the longer the wave-length to which the set will respond.

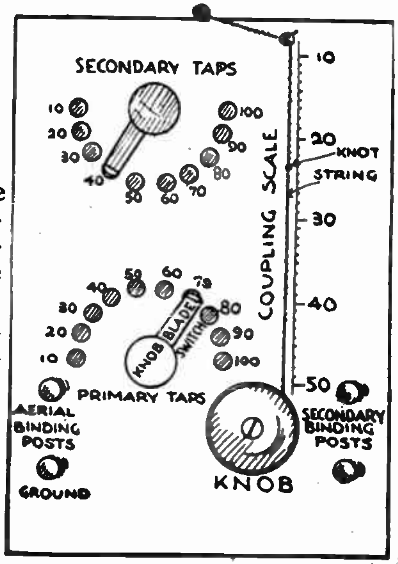
On my own aerial I find that I get the amateur, 200-meter stations, with the primary coil including about thirty-five turns and the secondary about sixty or thereabouts. The 360-meter broadcasting stations come in with about fifty or sixty turns in the primary and ninety to 100 in the secondary. This is without using any variable condensers.

If you use a variable condenser between the "ground" binding post and the cold water spigot, as shown in the hook-ups printed on page 2, you need not make the "units" taps on the primary coil. In that case, the "aerial" binding post is connected directly to the very center wire of the coil.

X. LET'S MOUNT THOSE SPIDERWEB COILS.







Here is a handily made little unit for mounting two spider-web coils to make a coupler. The upper pictures are actual views of such a unit. The lower one is a diagram of the panel arrangement. The article explains it.

Of course you've got those two spider-web or basket-woven coils made and tapped, both tens and units, by this time. That is to say, everybody has to tap them by tens and all must tap them by units unless they are the proud possessors of variable condensers. A variable condenser will accomplish the same result as tapping by single turns of the coil, but it won't work up to such big values as are included in the tens switch. An ordinary forty-three-plate condenser will give you about the same range of wave length variation as twenty turns of a coil made on an oatmeal box or one of these spider webs. That's approximate.

We have already printed the form for you to use in cutting out the pasteboard wheel around which you wound your spider web coils. You'll notice that one of the spokes was extended beyond the circle and was squared off at the end.

After you have wound and tapped your coils you place these two squared ends together and glue them with a hinge made of insulating tape or good tough dress braid, so that the two coils will open and close like the covers of a book.

The illustration shows a different method, if you prefer it. Each coil is mounted on a square of board or heavy cardboard by a screw through the center and the two boards are hinged at one edge. This method probably makes it more certain that the apparatus will keep its shape and the coils will continue to close center to center instead of working lop-sided. However, use either method you wish.

The unit illustrated takes the place of a loose-coupler or a vario-coupler or a pair of honeycomb or "duo-lateral" coils in any "hook up" you may see in one of the radio magazines.

It is simply one board screwed upright against the edge of a heavier board which is used for the base. The upright board is known as the panel.

One of your coils now becomes what we call the "primary" and the other the "secondary." It doesn't matter which you make which. I have made it a practice to use the bottom one as the primary always. That saves confusion when you make as many of these outfits as I do for experimental purposes.

The panel illustrated is the kind that would be made by a fellow who is the proud possessor of two variable condensers. It has no units switches on it. The primary coil is tapped in tens only and so is the secondary.

Then the tap wires come underneath the lower coil and fasten to the contact points of the "primary" switch. The blade of the switch is connected to the "ground" binding post and the inside wire of the coil is connected to the "aerial" binding post.

If you haven't the condensers you'll have to lay out your panel so as to include four switches and four semi-circles of contact points, two each for the primary and secondary, one semi-circle of each for unit taps and the other for tens taps.

If you have one variable condenser you can use it either in the primary or secondary coil circuits and thus eliminate the units taps for that coil. It is best to use a single condenser in the primary circuit. To do this instead of leading a wire from the post marked "ground" direct to the cold water spigot, you join that post and one post of the condenser by wire and then join the other post of the condenser to the wire leading to the spigot. That's what we call being "in series." It means that all of the electric forces which act through the coil must also act through the condenser before they reach the spigot and thus to the ground.

If you prefer to use the condenser with the secondary coil, you join it differently. You wire one post of the condenser to one post marked "secondary" on the panel, and the other post of the condenser to the other secondary post. That's what we call "parallel" or "shunt."

The series joining will shorten your wave length in your primary circuit. The parallel joining will lengthen the wave length of your secondary coil.

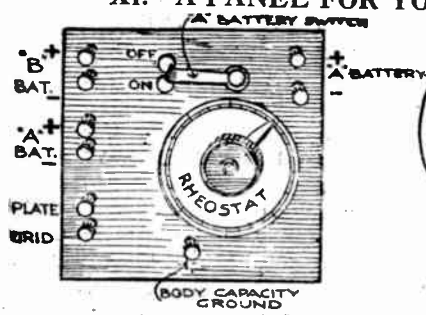
The only part of this panel that requires further explanation is the knob and thread and the scale marked alongside the thread.

Any kind of knob will do. I buy little wooden knobs intended for tin pot lids in a hardware store. They cost one cent each. Fasten the knob to the panel by a bolt and nut and glue one end of the thread to it. Pass the thread up through two small screw eyes as shown and down behind the panel to the upper coil and fasten either by tying around the screw or to the far edge of the coil or the board, if you have mounted the coils this way.

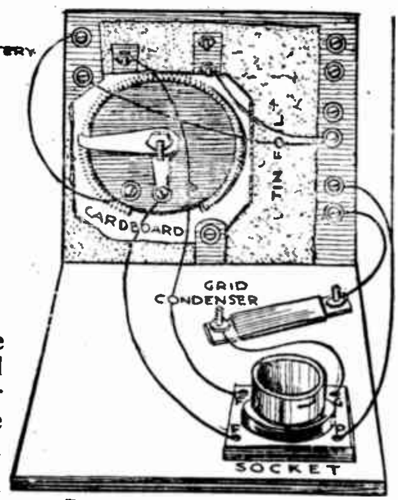
When you turn the knob you wind the thread up on it and this winding lifts the upper coil away from the lower as far as you want to lift it. This separating of the coils or letting them fall together is what we call "varying the coupling." The coupling is their nearness to each other.

There is a knot in the thread and when I use this outfit I vary the coupling until I hear a signal at its best and make a note of the "coupling" as indicated on the scale. Any kind of scale will do. It is merely to record the coupling so that if you listen for the same station the next night or the next week you know where you found him before and you are likely to find him somewhere around the same adjustment again.

XI. A PANEL FOR YOUR AUDION BULB.



PANEL - FRONT VIEW



PANEL - BACK VIEW

The audion bulb should be arranged in a control panel like this. If you mount your "B" batteries in a separate panel, by the method which we will explain later, you need not insert the two "B" battery binding posts shown, though it is better to do so.

The panel on which the controls of the audion bulb are mounted is one piece of radio apparatus that any novice can make and that requires no great trouble and has no complications. I made the one shown in the illustration in half an hour.

Let me say right here that I strongly advise all amateurs to adopt what is called the "unit" system of building apparatus if they intend to make their own and experiment with different kinds.

This "unit" system simply provides a little case for each separate piece of apparatus and each case is exactly the same size as the others.

I have found the most convenient size to be six inches all around. That is, the front board, or panel, is made six inches by six inches, the base, on which instruments are mounted, is a board the same size and I put another board the same size up in back. If I see a diagram of a new hook-up I take the units called for and stand them side by side or one on top of the other and simply connect the binding posts on the fronts of the panels by wires as the diagram calls for.

I have a variocoupler in such a case, a spider web coupler, a couple of variable condensers, my "B" batteries and amplifiers and everything else used around a radio set. Thus, when I try a new hook-up I merely build a house of blocks and it looks neat and is most convenient for wiring. So let's start right now, in these talks, to consider that we are going to build in units six inches by six inches.

Ordinary board will do for the base, but the front panel should be one of the insulating substances like formica or bakelite. The first thing to do with this audion bulb control unit is to glue tin-foil or copper foil over the entire back of it. The audion receiver has a very remarkable and very inconvenient disease known as "body capacity." Your own body is a condenser and when you turn the knobs to tune in a signal, that body capacity enters into the circuit. The consequence is that after getting the signal loud and clear, when you take away your hand and lean back in your chair the signal disappears. You have taken the capacity of your body out of the circuit.

This tin foil backing of the panel is in contact with the binding post shown in the middle of the lower part of the panel. When you are ready to hook this unit to your set you run a wire from this binding post directly to your ground wire and thus your body capacity is always "grounded" and is not so likely to interfere with your tuning. This tin or copper fail backing should be done to virtually all of your units.

Before mounting the panel bore holes for the six binding posts at the left, the two at the right, the one just spoken of, the shaft of the "rheostat," the switch blade and the two contact points. Then turn your panel over and cut the tin foil away from around all these holes except that which holds the binding post for the "body capacity ground." That post must make good contact with the foil. You should then take a larger bit and bore the "peep holes" which allow you to look at the bulb and see how it is burning. The foil need not be cut from around these holes, but must be cleared from the others to avoid the danger of a bare wire touching it and grounding the whole set.

On the back of the panel mount the rheostat as shown. It is wise to put a heavy piece of cardboard between it and the panel so that no metal on the rheostat can touch the foil. Then you are ready to wire up your bulb socket, and it is usually necessary to do this before screwing it to the base board.

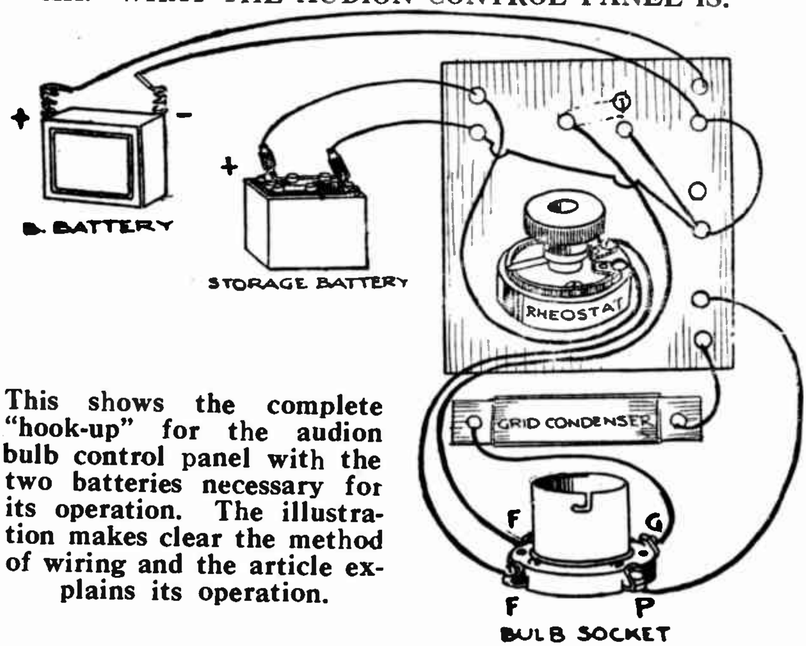
Mark your binding posts as shown in the front view of the panel. Use ordinary bell wire for the work in the back of the unit.

First a wire about six inches long goes from the binding post called "plus; 'A' battery input" to the nearest screw on the back of the rheostat. Next, a wire from the other rheostat screw to one connector marked "F" (meaning filament) on your bulb socket. Next a wire from the other "F" to the switch blade. Next a wire from the "on" switch contact point to the "minus 'A' battery output." Next a wire from that same "minus 'A' battery output" across the panel to the "minus 'A' battery input."

Then a wire from the "P" connector on your tube socket to the binding post marked "Plate." Then one from the "G" connector of the socket to one end of the grid condenser and one from the other end of the grid condenser to the binding post marked "Grid."

Thus your control panel is wired up. We'll talk about operating it later on.

XII. WHAT THE AUDION CONTROL PANEL IS.



This shows the complete "hook-up" for the audion bulb control panel with the two batteries necessary for its operation. The illustration makes clear the method of wiring and the article explains its operation.

There are a great many beginners in radio who do not want their receiving sets inclosed in a panel with every one of the instruments fastened permanently in its place. They want to have all the different apparatus separate so that they can have the fun of hooking it up in different ways to see what results they get.

I confess to being one of these enthusiasts myself. It is a fine thing to have one of those beautiful complete sets so that, when your friends come in for an evening you can turn on the "juice" and give them a radio concert. But there is an indescribable joy in fussing around with new hookups and trying every one that the latest radio magazine publishes or that your neighbor has copied from one of his friends.

That is why I recommend putting each separate piece of apparatus into its own little panel, six inches by six. This makes it much easier to hook up in a new way and the result looks almost as neat as a regularly designed complete set.

But whether you adopt this "unit" system or not, there is one part of the instrument that should by all means be mounted on a panel. This is the control system for your audion bulb. There are several instruments that go to make up this control and they are always connected in the same way, no matter what kind of hook-up you try, so having them permanently in this form saves the trouble of wiring them together each time you change the set and avoid the chance of making mistakes.

Let us examine the little panel which we described in the last article of this series.

Take the back view of the panel, as shown in the illustration. You will find it hooked up to two batteries. The storage battery, known as the "A," is the one which supplies the current of electricity to light the filament of the bulb. There are many makes of battery for this purpose and most of the ordinary batteries used in automobiles will do very well. All, however, will not. I have one very fine storage battery which will work beautifully on an automobile, but when I hook it up to my audion bulb it makes such a crashing and "frying" noise in the phones that I cannot hear signals. Before buying a battery be sure to investigate and ask some one who already has a set what kind of battery he uses for his "A."

The "B" battery is a series of little dry cells such as are used in flashlights. Each one of these cells has a strength of one and a half volts and ten or twelve of them in series gives ten or twelve times that voltage. Since the rage for radio has swept the country, manufacturers have put these dry cells into neat little blocks molded into an insulating substance. This is by all odds the best way to buy them.

These blocks of "B" batteries come in two sizes—22½ volts and 45. Some makes of bulbs will operate on 22½ volts; others require more. I make it a practice always to buy the 45-volt size and put it on a six by six panel-unit with a switch which enables me to take out 22½ volts and then, by steps of 1½ volts each, any strength up to 45. With that I can try any bulb I want in my set. And a little variation in this "B" battery strength will often give a great improvement in signals.

The rheostat is a continuous coil of special wire usually in a circle with a switch blade that revolves over its edge, touching any part of the circle desired. This wire offers a very high resistance to electric currents, so much so, in fact, that, if the entire circle is put in your "A" battery circuit, none of the current will reach the bulb.

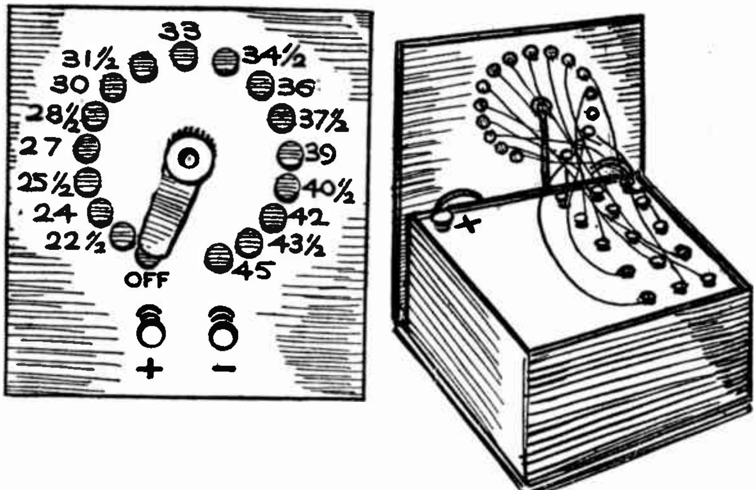
The switch revolves over this resistance wire, gradually including less or more, as you desire, and so regulating the brightness at which your bulb burns. This brightness is important and has much to do with the clearness of the signals received.

Always operate on the least brilliancy that will give you satisfactory signals.

It is a great mistake to force the filament of the bulb. Howling and whistling in the phones are usually a warning that you are putting too much current into your filament.

You will notice, in the diagram of the back of the panel, there is a wire from the minus binding post of the "B" battery to the minus of the "A." Almost all hook-ups call for this connection so you are safe in making it a permanent one on the back of the board. The rest of the illustration is self-explanatory.

XIII. THE BEST WAY TO HANDLE A "B" BATTERY.



The "B" battery, which is the one made up of a lot of flash-light dry cells, should be mounted on a panel and each step of voltage should be wired to a switch contact point on the panel as shown. This enables you to make rapid and easy experiments with the amount of voltage you use and this often results in much stronger and clearer signals.

Visit ten amateurs and "sit in" at their receiving sets and it is a safe bet that nine of them will have their "B" batteries chucked on the table any old place. They will have loose wires lying about them or will have one wire connected to the set and the other with a loose end with which they experimentally touch the various posts of the battery while they listen in and will then screw the wire to that post.

"It's good enough," they will tell you. And it undoubtedly does work all right, but it is a lot of trouble, compared to the way they might have it arranged, and it looks "sloppy" on a table.

It is well worth while to include your "B" battery in the "unit" system of construction we have been advocating in these articles. It saves a heap of trouble in operating and it gives that neat and workmanlike appearance to the set that brings added joy to its possessor.

It is as well at the very start of your career as a radio enthusiast to buy a 45-volt "B" battery. Then you are ready to face any kind of audion bulb that you buy or that your friends bring around for you to try on your set.

The handiest kind of battery of this strength has a wire permanently fixed to the "plus" side. Half the block is solid and the other half has binding posts coming up through the insulating substance, and these posts have milled-headed nuts on them to screw down over the wires and hold them tight.

There are fifteen of these binding posts on the minus side and another permanent wire imbedded in the insulating substance. These two permanent wires, the plus and the minus, give the full 45-volt strength of the battery. The fifteen binding posts give various strengths, in steps of 1½ volts each, from 22½ volts to 45.

For this panel, as for the rest of this unit system, you want a 6-by-6-inch board for the base and a 6-by-6-inch piece of formica or bakelite or a good piece of dry-wood for the panel.

Two binding posts are set about an inch apart low down in the center of the panel. These are the plus and minus posts and the strength of current that comes from them to your bulb will depend entirely upon where the switch blade above them is set.

There are seventeen contact points in the circle around which this switch blade revolves. The battery has fifteen minus binding posts and the last permanent wire on the minus side, which makes sixteen "taps" that you can take off your battery. But you want one more contact point in the circle to cut out the current entirely. This contact point, of course, is not connected to anything. It "opens" the circuit and stops the flow of electricity.

The "plus" wire or binding post on the battery block is connected directly to the plus binding post on the panel. The minus binding post on the panel is connected directly to the shaft of the switch blade.

Then each binding post on the battery block is wired to one of the switch contact points on the panel. The point against which the switch blade is resting in the illustration is the "out" point; the battery is "open circuited" and no current can be taken from it.

The next point connects at once to the 22½-volt post on the battery. It isn't necessary to have anyhing less than 22½ volts because all tubes need this much at least. Then, in turn, each succeeding post on the battery block is connected by wire to the next contact point on the circle and the final wire, embedded in the block on the minus side, goes to the last contact point.

With this connected up, you have a unit that is complete, readily adjustable, easily handled, and that looks neat and workmanlike. It is well worth the trouble to make because it saves a lot of trouble in operating the set.

XIV. WHAT IS A "CONDENSER"?

Your bathtub is a condenser. The kitchen sink is a condenser. The Shoshone Dam and the great dams on the River Nile are condensers. Your bank account is a condenser — a variable condenser —probably exceedingly variable. And the farmer's barn is a condenser.

Anything is a condenser that is used to store something up in until we need it. Your bathtub stores up water. In radio, a condenser stores up energy that we can turn into electric current when we want to use it.

But there's one very important difference to be borne in mind. While the condenser does store up this energy, it will not hold it indefinitely. It stores and discharges and stores and discharges with almost inconceivable rapidity, working up as fast as some three million times a second. But that's what we want in radio, so, for practical purposes, we can say that it stores the energy until we desire to use it.

If we could speak of this energy in terms of pints and quarts and gallons, it would sound a lot simpler, but if you can get into the habit of thinking that these electrical names are simply words to express much the same idea, they will not confuse you so much.

Suppose we have a supply tank at the top of the house. The man who installs your plumbing system will figure out how much water you will need and will instal, let's say, a 500-gallon tank. At the top, there will be a drain pipe so that, when the water reaches this level, it will overflow. That tank will hold just 500 gallons and no more, because, as soon as that limit is reached, the excess water runs out through this drain pipe.

So we, in building radio instruments, have mathematical formulas which tell us just how big a condenser we need in each place in the circuit and we know how to build a condenser that will give us just 500 gallons of the energy we want and will overflow as soon as that limit is reached. Only, in radio, it is this overflow that we use to do the work. And, unfortunately, we don't say "gallons"; we say "MICROFARADS."

And another very important thing to remember is that a condenser in radio doesn't simply let the excess energy flow out. As soon as the limit is reached, the whole thing empties at once, sending quite a powerful electrical current rushing through the wires.

If you can imagine your house tank rigged up in such a way that, when the first drop of water flowed through the drain pipe, it loosened a trigger which let the whole bottom of the tank drop out, you would have a better illustration of an electrical condenser.

Now, suppose you had some sort of system which operated by the force of this sudden discharge of water. Your supply pipe would keep on running, and every time the supply reached 500 gallons, the bottom would drop, the water would exhaust and the bottom close up again ready to fill once more. This would operate only on a 500 gallon supply. There would be no variation in it.

Then it would be what we call a "fixed condenser." Your phone condenser is fixed. Your grid condenser with an audion bulb is fixed. Sometimes with certain hook-ups you have fixed condensers in other parts of the circuits. They operate when the energy stored in them reaches a certain pre-determined amount.

But we also have "variable condensers," which are of great importance in "tuning" to get a signal sharp and clear and loud. Let us see what they do.

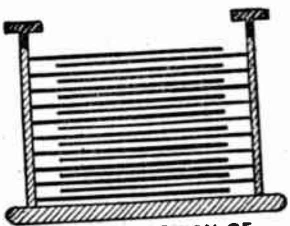
Go back to the illustration of the tank. Suppose we had various kinds of machinery to operate on various amounts of water. Then we would put in a number of drain pipes, each operated by a spigot so that we could open any one we wanted to. We might want them in "steps" of 100 gallons each. If we opened the top one, it would operate the trigger when the supply reached the original 500 gallons. If we opened the next lower one, the bottom would drop out of the tank when we had 400 gallons in it. The next would give us a 300-gallon operation and the next a 200 and so on. That would be a "step variable" condenser—one operating on various set amounts but not operating on any amounts in between.

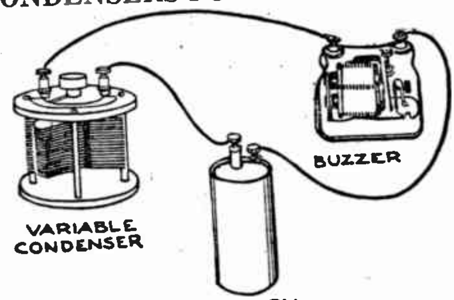
The condensers which you buy —the twenty-three-plate and the forty-three-plate operated by a knob — are "continuously variable." Suppose, instead of having the spigot arrangement on your tank, the release or drain pipe came right up through the bottom and that we could raise it or lower it any amount we wanted to. The tank would empty as soon as the level of the water reached the top of the drain pipe.

But we can raise or lower the drain pipe with a continuous motion by this arrangement and so we can run the machinery on 500 gallons, or 435 gallons, or twenty-three gallons, three quarts, one pint and a gill and a half or any other amount we choose.

That, then, is a continuously variable condenser such as you all want. And the wise amateur who is experimenting with his own set will make a special sacrifice and buy two of them, for they are mighty handy things to have and save a lot of coil "tapping" when he wants to try a new hook-up that some one tells him about.

XVI. TEST YOUR CONDENSERS FOR "SHORTS."





How to test a condenser. The left-hand diagram shows how the plates are arranged. There is no electrical connection between the two sets of plates. To the right is the hook-up for testing as explained in the article.

If you had a one-wire aerial with a natural wave-length of exactly 100 meters, you would suppose that, if you cut the wire precisely in the middle (assuming there was some way of keeping the aerial from falling), the wave length of each separate half would be exactly fifty meters. For practical purposes, it would be. But theoretically it wouldn't, and it would be possible with extremely delicate measuring instruments to prove that each half had a wave length of something more than half the wave length of the original aerial.

This is because the two ends of the cut wire, assuming again that the aerial didn't fall and that the ends were only slightly separated, would form a tiny condenser. A condenser, as we have already learned, has the ability to store up and release electrical energy, and these two ends would be able, by this storage of energy, to add a mite to the wave length of each half of the wire.

Suppose now that we attached to each of these two ends a metal plate and placed these plates very close together with their surfaces almost touching. We would at once increase the capacity of this condenser and add still more to the wave length of each half of the aerial.

The greater the surface of the two metal plates we thus place near together — but not touching —the more we add to the capacity of the condenser, and therefore to the wave length of the aerials.

But the moment any tiny parts of these two metal plates touch each other they cease to be a condenser and become simply a conductor; instead of storing up and releasing electrical energy, they merely pass electric current and, for radio purposes, the outfit becomes again only a 100-meter single-wire aerial.

When the two plates of a condenser touch, it becomes "short circuited" or, in radio parlance, "shorted," and is no longer a condenser, no matter how many plates it has or what you paid for it. A condenser does not pass electric current through it; its function is to store up the energy caused by the difference in voltage between the currents impinging on the adjacent plates.

Condensers quite often get out of order. Fixed condensers will meet with accidents that will permit two adjacent layers of tinfoil or copper foil to touch each other, and they are then "shorted" and cease to be condensers. If a condenser is subjected to a voltage difference too strong for the thin substance that separates the plates, this substance will be punctured by an electric spark and thus the two metal surfaces may come in contact.

Variable condensers, as all novices know by this time, are formed of many plates. Some of them are fixed stationary on one part of the case. The others are attached to a shaft in the middle and, when this shaft is turned, they interleave between the stationary plates much as the cards do when you shuffle a deck scientifically, and, as they are moved farther and farther inside. the total surface of all the plates is increased, which increases the capacity of the condenser.

Now it sometimes happens that a variable condenser will have one point on just one plate bent or chipped so that, at one point in this turning, it will touch the plate above or below it. That "shorts" the whole condenser and destroys its usefulness.

Test your condensers. Hook them up to a buzzer and dry cell as in the illustration. Then slowly turn the knob.

If, at any point, the buzzer buzzes, you know you must have let the electric current through, and that means that two plates are touching at that particular setting of the condenser. If you can turn the knob all the way around the scale without the buzzer buzzing your condenser is all right. But most variable condensers are built to "short" automatically at either their zero or 100 setting.

Test your phone and grid condensers by the same method. Hook this buzzer circuit to one side of the condenser and, with the bare end of the other wire, touch the other side of the condenser. If the buzzer does not buzz you are all O. K.

Most standard makes of condenser are carefully tested and inspected before they leave the factory, but that does not guarantee that they are in first-class shape when they reach you. Shipping and unpacking and handling in the store by clerks and shoppers all subject them to the likelihood of damage.

Before you pay from five to six dollars and a half for a variable condenser, make the clerk test it this way with a buzzer and dry cell.

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