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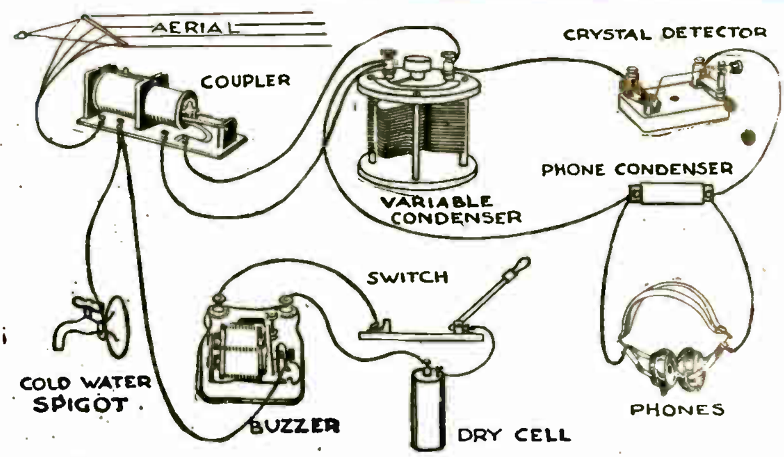
E-Z RADIO



All instructions are given with simple pictures like this. No confusing electrical diagrams.

By Henry M. Neely

E-Z Publishing Co.
614 Arch St. Philadelphia

E-Z RADIO

BY

HENRY M. NEELY

The Real
RADIO PRIMER
For Beginners

The E-Z PUBLISHING CO.
614 ARCH STREET PHILADELPHIA

HENRY M. NEELY

THIS BOOK AND ITS AUTHOR

"E-Z RADIO" is designed to be a monthly publication for the BEGINNER in Radio. It does not attempt to interest the experienced amateur. But, if he is not too experienced, even he will find much of value, taken from the actual operating knowledge of a man whose commercial first grade licenses prove his actual, first-hand intimacy with conditions as well as theories.

Each one of these monthly volumes will contain many articles of general interest, instructions for making and using simple apparatus and at least one crystal and one audion "hook-up."

There will be nothing very technical and the hook-ups (like the one on the front cover) will be given in pictures, on the assumption that few people know—and fewer want to know—the symbols used in electrical diagrams.

We have been planning this service for some time, but there was only one man capable of writing it in the simple, direct and almost childishly clear style which we wanted. That man is Henry M. Neely, well known as a writer both of fiction and on popular scientific subjects, and for years a leader in both amateur and commercial radio work in the East.

Mr. Neely's radio experience goes back to the very earliest days. In 1910 he founded the Wireless Association of Pennsylvania, and in recognition of his work, has been elected an Honorary Member of that influential body.

He has for a number of years been the holder of commercial first-grade licenses and to get material for stories, has spent several years at sea as a regular ship operator for the Marconi Company. His last trip, which ended less than two years ago was aboard a Norwegian whale-hunting ship and the eight months' voyage took him nearer the South Pole than any living American has been.

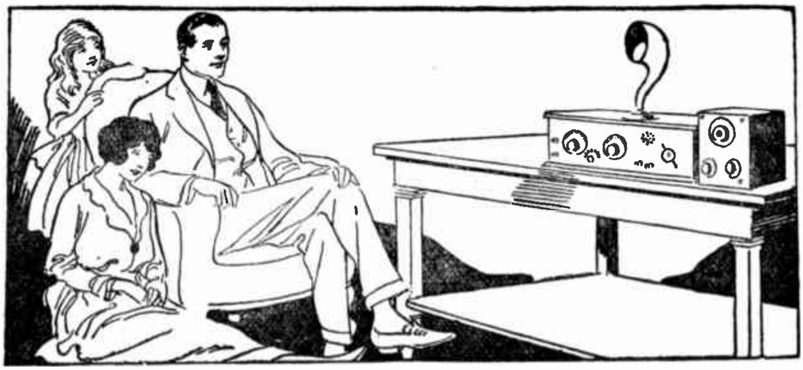
In the early days of the war, Mr. Neely acted as an instructor in radio until he was able to get an assignment overseas in another branch of service. He was offered a lieutenant commander's commission to stay on this side and help organize the radio service of the Fourth Naval District, but he preferred service on the other side.

These radio articles are so simple that the most unscientific man or woman cannot fail to understand them. They are not going into the complicated details of the whys and wherefores of radio. They are designed to ANSWER THE NATURAL QUESTIONS THAT EVERY LAYMAN ASKS WHEN RADIO IS MENTIONED TO HIM.

Back numbers can always be secured from

E-Z PUBLISHING CO., 614 Arch St., Philadelphia

I. WHAT'S ALL THIS CRAZE ABOUT?



Radio is an actual home entertainment today. Here we have a typical family seated listening to music from several hundred miles away. We have the long box which contains the first part of the receiving apparatus and then the small box which builds up the strength of the signals so that they can be transferred to the loud speaking horn. Everybody in the room can then hear them as plainly as they would hear a phonograph.

What is this radio craze all about?

What is there in the air to interest people who don't know anything about radio?

Don't you have to know a dot-and-dash code or something to get anything out of it?

Nine men out of ten who read every day about the wonders of radio broadcasting ask themselves and their friends these questions. And unless they can get satisfactory answers, they go on about their daily routine convinced that radio is beyond them — one of those deep and involved sciences that require a lot of special study and complicated apparatus that only an expert can keep in working order.

But they are wrong. You don't have to know anything about radio to get the enjoyment out of this broadcasting. You don't have to know any dot-and-dash code.

If you buy a standard set designed to receive a broadcasting station, you simply put on the head phones, turn a couple of knobs until they get the best results and then sit back and enjoy such an evening of instruction and entertainment as no other invention has yet offered to us.

There is, of course, a lot of broadcasting done in the dot-and-dash code. But there is nothing in this to interest the average layman. For him, when his phones are on and his set adjusted, there is the sound of the human voice telling what station it is sending. The voice comes in even more clearly and distinctly than it does over his house or office telephone.

Then comes, perhaps, a vocal solo—a soprano, we will say, singing a beloved air and the music is received in the phones almost as purely and distinctly as though the listener were in the same room with the singer.

There are orchestral concerts, lectures, speeches, market reports for the day, general and sporting news, all the results of the day's games or the night's fights; there are dance music programs which, with proper apparatus, can be put on a loud-speaking horn, or, with an ingenious and cheap little attachment, transferred directly to the tone arm of the phonograph and a roomful of people can dance to the music of an expensive orchestra perhaps three or four hundred miles away.

On Sundays there are special sermons in the afternoons and, in the mornings and evenings, actual services held in real churches and sent broadcast on the radio waves over the country by means of transmitters installed in the churches. So clearly do these services come in under favorable conditions that you can hear responsive readings of the congregations, the sermon and prayers, the organ and the choir and almost the coins dropping while the collection is being taken up.

This all sounds like a madman's ravings to one who has not actually done it, but if you know an amateur who has a set, get yourself invited to his house some evening and you will come away chortling about radio to yourself and your family and your friends just as irrepressibly as the rest of us chortle to you now.

There isn't a spot in the whole area of the United States or Canada which can't get at least one of these radio concerts. The mail of the big broadcasting stations, even in the extreme East, brings almost daily an account of some one in the wilds of the Far North woods or the mountains of Mexico who is finding life less dreary since the ether waves have started bringing home and art and news and civilization to his lumber camp or his ranch or his mine or oil well.

There is one thing about it, of course—the farther you are away from a broadcasting station, the more expensive a set you will have to have. But the result can be achieved by any one anywhere between the Atlantic and Pacific.

And it's all so well worth while that you will find the money for it somewhere once you have had a taste of what is in store for the owner of a set.

II. HOW MUCH RADIO DO I HAVE TO KNOW?

If there is one thing more than another that keeps the average layman from going into the fascinating game of radio, it is the belief that he has to know a good deal about electricity in order to manipulate a set and hear the concerts, news and lectures that are being broadcasted day and night all over the country.

Most non-scientific men do not want to be bothered with the necessity of studying the intricacies of electricity. They approach the subject of radio as they would approach the purchase of a motorcar. They know what result they want. They don't care about the technical details of how this result is obtained.

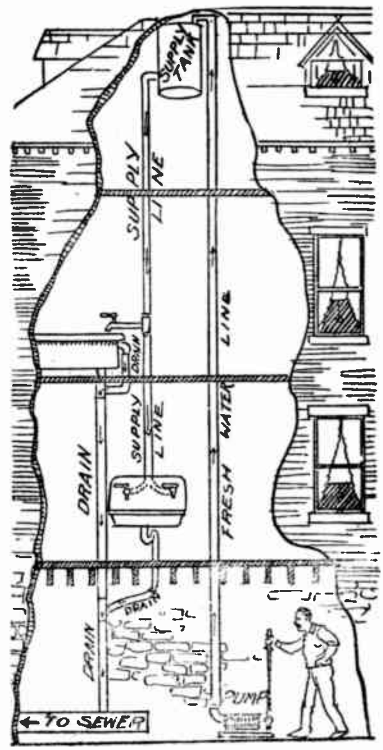
On a car, they want a self-starter and a wheel and a gear-shift mechanism—they'd prefer to get along without the last if they could—but they don't want to have to raise the hood and rearrange all those mysterious and technical-looking gewgaws inside.

Radio doesn't have to be any more technical than the running of the best fool-proof car. It is much more fun if you do know something about the science, just as the man who tinkers with the mechanism of his own car usually has more fun with it than the man who doesn't.

But the similarity goes further. Speaking of the average amateur, the man who doesn't tinker with his car usually gets more use out of it than the man who does. So the man who buys a standard radio set and doesn't even inquire what is inside it will probably hear more of the broadcasting than the man who takes it apart and tries every new hook-up that he sees in the latest fan magazine.

But, in ninety-nine cases out of a hundred in the radio game, it is safe to make the prediction that the man who hates the thought of studying electricity and using technical terms will, within six months of the installation of his first set, be talking glibly and arguing forcibly about variable condensers and series and shunt inductances and microfarads and milhenries and milliamps. Right now, he would bet his last cent that he won't. But the fascination of it gets hold of him and he finds himself, in spite of himself, quickly drifting into the real "nut" class. And it is one phase of life in which it truly is "great to be crazy."

Working a radiophone set in the home doesn't require any more knowledge of radio than working a phonograph requires of acoustics and mechanics. You get your phonograph furnished complete so that all you have to learn is how to insert the needle, how to put on the record, how to



A radio set might be likened to a house plumbing supply. The pump is the sending station. The tank is our aerial which receives the water. We guide it by means of pipes (wires) to the places where we can use it. We have various apparatus like tubs and spigots and stoppers where the water (current) is made useful. Then we let it go on down into the drain or sewer (the ground).

wind the machine and how to start and stop it.

So with any of the standard radio sets. You have a switch for turning on the electricity for lighting the little incandescent lamp through which the receiving is done; you have a knob to turn to let in more or less current according as the signals grow better or worse with the operation and you have from two to four other knobs the turning of which affects the clearness with which the signals come in.

You don't have to be a scientist to judge this. The result in your phones tells you when you are getting the best adjustment.

And, unlike your phonograph, you don't have to wind her up again and change the records and be careful to stop it when the record is through. You simply find your best signals, leave the apparatus set that way and sit back and enjoy it for the rest of the evening.

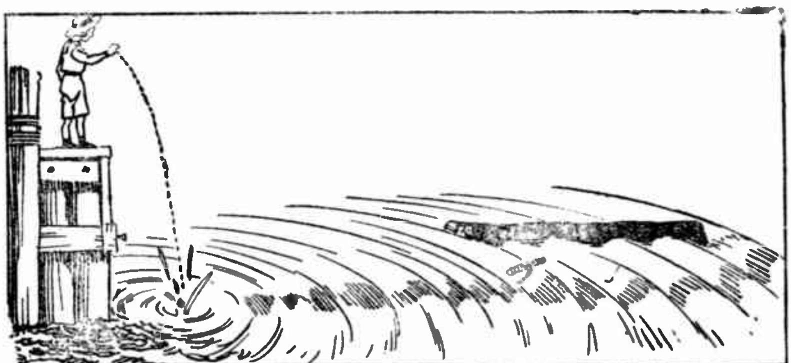
The fundamental electricity necessary for understanding the installation and working of a radio set is no more involved than the knowledge necessary to understand how your house plumbing system works.

We'll say you have a tank or an incoming supply of water up under the roof; it is piped down through the house, led into certain rooms, turned on or off with spigots, stored in tubs or other receptacles by means of stoppers and, when used, is allowed to escape through the drains into the sewer under the house.

Exactly the same thing happens in a wireless set, using electricity instead of water.

We are not going to become technical in these articles, but we are going to show now and then how extremely simple the basic principles of radio are and we will probably use that house-plumbing idea to teach it all the way through.

III. DON'T THE SIGNALS GET ALL MIXED UP?



The ether is like a still pond. The transmitting station is the boy throwing a stone into it. The waves go out in all directions. They will rock the small stick of wood but not the big log. But the log would rock if the waves were the size of the ocean waves. Here the stick is "tuned" to this wave length, but the log isn't. Same way with radio receiving sets.

Talk to almost any non-radio man about these broadcast concerts and entertainments, and among the first half-dozen questions he will ask will be. "But don't the different stations get all mixed up? Don't they interfere with each other and make just a jumble? I don't see how you can keep them from doing it."

The answer is—on a well-designed set, they do not interfere. With proper adjustment of the knobs, one station can be "tuned out" and another "tuned in," or the first can be heard and the second silenced.

"But I don't see how that is

possible." You said that yourself, didn't you?

All right. Let's forget radio for a moment and talk about something so simple that you have noticed it yourself a dozen times.

Let's suppose we are on opposite sides of a pond. On your side there is a fair-sized log floating. On my side there is a little chip.

You throw a stone into the water. It makes a splash and sends out little waves which spread out in circles all over the pond. Those waves pass the log but do not rock it enough to be perceptible. The log is too big. But when the waves reach my chip, they bob it up and down as long as the waves last. Suppose I chop down a tree on my side and it falls squarely into the water. It will make a tremendous splash and will send out waves so big that your log will rock up and down on them.

That is a very rough illustration. Your log is "tuned" to the big waves, but it isn't tuned to the little ones.

That's how radio works. You hear radio carelessly spoken of as "air waves." It isn't. Sound travels on air waves. But the air, or atmosphere, as we know it extends only some hundred miles above the surface of the earth. Beyond that is utter silence so far as human ears are concerned. There is no air to carry an audible sound wave.

But all that vast expanse of space between us and the sun and planets and stars is filled with an extremely tenuous, intangible something to which scientists have given the name of ether. We don't know what ether is but we know there is something there because we know some of the things it does, and we call it ether just as we might have called it X or Y or one of those funny-looking Greek letters that scientists love.

It is in this ether that radio waves are made. And the ether is everywhere — between the atoms of bricks and stones and wood and mortar and glass, and that is why we can set up aerials inside our tightly closed houses and receive wireless signals. They travel on the ether that is distributed all through these materials.

The sending station sends out a signal—which is the stone that makes the splash in this ether. The waves travel everywhere at the tremendous rate of more than 186,000 miles a second — nearly eight times around the earth while your watch ticks four times.

Our receiving sets are "tuned" to receive only the waves of the station we want to hear. You see in every wireless program the announcement of the "wave length" on which it is to be sent. If we only spoke of this length in feet and inches it wouldn't sound so mysterious. But it means the same thing.

You will hear of ocean waves which are thirty-three feet from crest to crest. That is ten meters. Our radio waves are much bigger than that. We can produce them that small, but they are not of much use. Amateurs use 200 meters—about 6600 feet. The concerts are broadcast on 360 meters. That is, the waves made in the ether are about 1200 feet from crest to crest. And so we go on up to 25,000 or 30,000 meters for some of the biggest trans-oceanic stations.

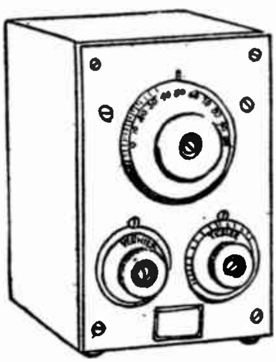
Now, with all the concerts being sent on 360-meter waves, you will say that the illustration of the waves in the pond and the log is bad, for the log would respond to all waves of the same length.

Did you ever notice the difference in the shapes of the waves on water? With a high wind blowing you will find the waves almost straight up and down, or even quite concave on one side, and rounded on the other. You will see some waves with sharp peaks and others with easy curves on the crests. The waves breaking on the beach are different from the rollers out at sea. It all depends on what affects the waves.

So it is in the ether. And we have sufficiently developed the art of radio that our sending instruments can be made to send out waves of a particular shape, and our receiving instruments can be tuned to receive waves of any length and any shape, and do it so sharply that they will give greatest response only to the shape we want to hear and almost ignore the others, even though they be of exactly the same length.

It is adjusting the receiving set to get the waves we want that we call tuning, and by being able to do that we are able, under ordinary circumstances and with good instruments, to prevent what would otherwise be simply an unintelligible jumble of conflicting sounds in the phones.

IV. WHAT WILL IT COST FOR A SET?



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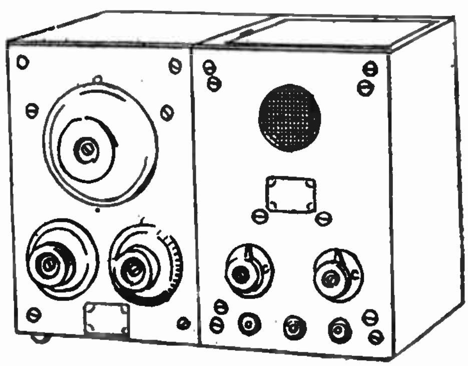

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Typical receiving outfits. On left—apparatus used to "tune" signals. On right—tuner hooked up to audion bulb detector unit which makes signals plainly audible and two amplifying bulbs which make them a great many times as strong as the detector.

Perhaps the question of finances should have been the first one discussed in this series on radio. What, then, will it cost to install a radio set to receive these radio broadcasts?

The answer is necessarily indefinite. Anywhere from $5 to $250. It will depend entirely on what you want to get and your location.

First, you will have to understand that there are two great general divisions among receiving sets. There is the type of set that uses a piece of mineral, or crystal, to receive through. There is the type of set that uses a specially designed incandescent light, known as an audion valve, or bulb, to receive through.

The bulb is by all odds the more efficient—from thirty to several hundred times as efficient. That is to say, insert first a crystal and then a bulb in the same station and the bulb will make the phones give out signals so much louder that there can be no comparison. And the bulb will enable you to hear stations that would not make the slightest sound through the piece of mineral.

There is another aspect of this. Most people who install a radio set want one that will do away with the phones and give the music and speech through a horn, known as a "loud speaker," or one of those phonograph attachments which make your standard box serve as loud speaker.

It is to be understood in the first place that any one who wants such results must positively use the bulb type of receiver. The crystal type cannot be used with a loud speaker with any satisfaction. Why, then, you will ask, bother about the crystal type at all?

Well, the crystal set has its uses. If you are within about five miles of a powerful broadcasting station and want the music and speech for yourself alone, a simple crystal set will answer as an amusement. If you are more than five miles away from the sending station, you might as well give up all thoughts of using a crystal detector.

Turning to the bulb type we strike the expense. For the simplest type of set, with only one bulb, you will have to spend quite a tidy sum, even if you buy the parts separately and assemble the set yourself. There are certain things that are essential and they all cost money.

Here is just a list of the necessities with approximate prices. Pardon the technical names of the things; you needn't bother yet to learn what they mean: it is enough to know that you have to have them so as to get a general idea of the cost. This set is for the best "hook up" to receive the majority of broadcasting stations which send on a 360-meter wave length. It is known as the "regenerative set" and is by all means the most efficient for short waves, from 200 to 500 meters.

Your aerial apparatus will cost about $5.

Vario-coupler, $6.50.

Two variometers, $10.

Variable condenser, $5.

Grid condenser, fifty cents.

Phones, $6.

Six-volt storage battery to light the bulb, $15.

Dry cells for "B" battery, $2.50.

Bulb socket, $1.

Bulb, $5.

Rheostat, $1.50.

There's $58 right there. But, remember that when you have it and it is hooked up and you get that first thrilling, awe-inspiring sound of a human voice coming from four or five hundred miles away, your $58 will seem like a mighty small price to pay for one of the most wonderful sensations that modern science has given us.

Each Sunday night, with a set like this, I have listened to the actual services in a church 370 miles away, with four or five phones connected in the circuit.

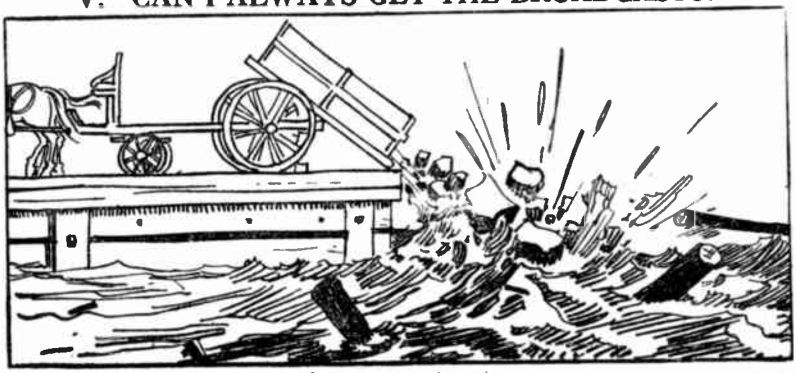
To operate a loud speaking horn or phonograph, you will need what is known as "amplification." That means that you must attach apparatus to build up and increase the strength of the signals received.

There are audion bulbs made for this special purpose and if you use one of them you have what is called "one step of amplification." If you use two amplifying bulbs, you have two steps, and so forth. Few amateurs go beyond two steps and this is usually sufficient to operate a horn or phonograph.

The amplification will cost you about $20 for each step.

Just one word of caution. In pricing standard receiving outfits, remember that they are almost always sold without bulb, aerial outfit, storage battery, "B" batteries or phones. Get the prices of these articles from this list and add to the price of the set to estimate total cost. And, if you buy amplifiers already made up in neat panels, add $6.50 for the bulb for each step.

V. CAN I ALWAYS GET THE BROADCASTS?



Different sized waves in a pond will affect different sized sticks. The ether is like a pond. Lightning and "static" or "atmospherics" are like a cartload of different sized rock dumped into a pond. They make all sizes of waves and rock all sizes of sticks. In other words, static interferes with receiving, no matter what wave length your set is tuned to.

There's one thing about a phonograph that is decidedly in its favor. It's a dependable machine. You know that, if the weather is bad outdoors and you decide to spend a comfortable evening at home, all you will have to do is wind up the machine, put on a record, start it and the music will come forth. And it will do it not once in a while, but 365 days and nights in a year.

And, from that very fact, it leaves nothing to the imagination, there is no element of gambling, of skill, of your machine accomplishing something that Jim Smith's couldn't do. There's nothing in it for you to be particularly proud of and enthuse over.

It must be confessed that, at the present stage of development, radio has not reached this point of dependability. But, for that precise reason, its status today gives it that element of a game of skill or chance that promotes the keenest kind of rivalry and makes for an enthusiasm that is half the fun of it.

Get two radio fiends together and you'll hear, "You ought to have heard me bring in BVD last night. Got him like a ton of bricks. And after he was through I monkeyed around a bit, and what do you think?"

And the second fiend will ask somewhat grudgingly, "Dunno; what?"

"There was RSVP clear as a bell. What d'ya know about that? One thousand two hundred and fifty miles away and you might have thought he was in the next room. That's a great little hook up I'm using. You ought to try it."

This undependability is due to many different reasons, not one of which is sufficiently well understood yet to permit of a solution of the problem.

First there is that bugbear of all radio men, static—atmospherics—strays. These are three names for the same thing. They refer to the discharge of electricity in the air or the clouds. Lightning is a violent and concentrated form of static. But there can be most annoying static without the least sign of weather trouble. Down in tropic waters, from March on through the summer months, I have frequently been unable to read a message because of the continual crashing and sizzling and "frying" in my phones. And this with the sky guiltless of a cloud and the moon and stars fairly blazing in crystal brilliancy.

We have already referred, in these articles, to the radio waves in the ether being like ordinary waves in a pond of water. There are waves of different sizes and shapes and we can tune our receiving instruments to respond to only one size and shape. The ether may be likened to a placid pond. Our transmitting instrument is the means by which we throw a pebble into the pond and start a series of waves out in all directions.

A discharge of static might be likened to dumping a carload of quarry refuse into the pond. There are pieces of stone of all sizes—big and little and medium and tiny and huge. The result is a great splash which sends out waves of all sizes, and no matter how the receiving instrument is tuned, there is a wave of the size and shape to cause it to respond. So that, if the receiver happened to be getting an intended series of waves, the similar waves coming from the carload would interfere and make it impossible to tell which was which.

That will give you a rough idea of what static is.

Static is usually of little trouble in winter in the northern hemisphere and becomes more and more troublesome as summer advances. And, though there have been several so-called "static eliminators" invented, static is still a nuisance and only smiles at our present methods of opposition.

Then there is the phenomenon of "fading signals." You will tune in to get the concert from PDQ and he will start in very QSA, as the wireless bugs say when they mean "strong and clear." Then, without any change in the adjustment of your instrument, he will fade away until you have lost him entirely, and no matter how much readjusting you may do, you will not get him back. And later, perhaps, he will gradually come in again until he is as QSA as any one would wish. Nobody knows why and nobody knows what to do about it.

Monday night you may get the concert from KYW as though you were under the shadow of his aerial. You will make notes of the exact adjustment of your set, and when you sit in Tuesday night you will turn every knob and dial to the place it was the night before. And you may hear just a whisper. You try other adjustments but it is of no use. You hear him and that is all. Again nobody knows why and nobody knows what to do about it. And Wednesday night he may be louder and clearer than he was

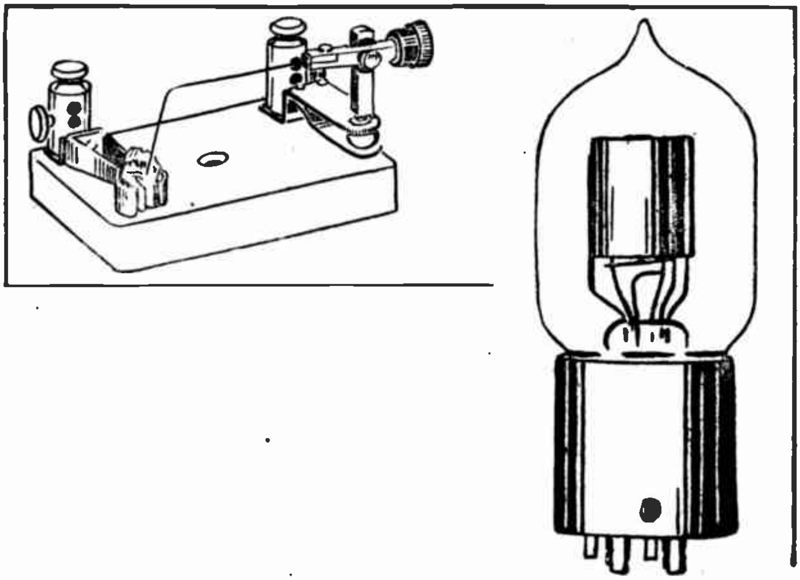
Monday.

I am speaking now of distant stations. If you are located only five or ten miles from a powerful broadcaster, you won't be troubled so much. You can pretty nearly depend on getting it satisfactorily—if static isn't in season and working overtime.

But that is really half the fun of the game. It gives never ending subject of conversation among radio fans, just as the golf bug or the baseball fan or the motorcar enthusiast can talk enjoyably for hours and say nothing of any importance.

This isn't intended to be discouraging. Nine nights out of ten you will get satisfactory results on your receiver, but if you don't, you can compare notes next day with your friends.

VI. WHAT'S ALL THIS ABOUT A "DETECTOR"?



These pictures show the two types of detectors. On the left a crystal—the "catwhisker" kind, with a bit of mineral in a clamp and a thin wire just touching it. On the right, an audion bulb, the modern "Aladdin's Lamp" of science.

We have already spoken of the great difference between the two kinds of radio receiving sets. One kind, we said, uses a piece of mineral called a crystal for a detector; the other kind uses a specially designed incandescent electric light for a detector.

The very word "detector" sounds technical and the average layman, not particularly interested in electricity, will say impatiently. "Oh, cut out these fancy names and let's get down to brass tacks."

But it's so easy to understand the functions of a detector and it's so much better to know about it that a few minutes spent considering the subject will repay any one.

It really shouldn't be called a detector. It doesn't really do the detecting. It simply straightens out the currents in the receiving set so that the telephones and the human ears can detect them.

Radio sets might be likened to the broad main street of a great city. Stand on the pavement and watch the automobiles on the street. There are thousands of them going in both directions—speeding up and down so fast and in such great numbers that it almost makes you dizzy to watch them.

That's the way with the electric currents in a radio set. The current is what is called "alternating"—that is, it swings from one direction to the other and it does it so rapidly as to be almost inconceivable. When an amateur set is working, the current alternates at the tremendous rate of 3,000,000 times each second.

No telephone diaphragm in the world will respond to such inconceivable rapidity. Mechanically, it's impossible. And the human ear, being much like a telephone diaphragm, also refuses to function so fast.

So the clever radio engineers put in their sets a little gadget called a condenser which stores up a lot of these rapid pulsations and, every so often, releases a bunch of them all at once. The ear and the telephone respond best to something like 1000 pulsations a second. They will work up to 10,000, but we'll assume 1000 as best. So we have our condenser chop up the incoming currents into 1000 bunches, much like sausages strung on a long link.

But the pulsations in each bunch are still first one way and then the other. They still go so fast that they would neutralize each other's effects on the diaphragm. So we have to find something to make them all go the same direction — in other words, to eliminate those in one direction and use only those in the other. Then the bunch of one-direction currents act together on the telephone and the ear and we get 1000 pulsations a second, which is just what we want.

The detector is the traffic cop on this one-way street. It is like a water or air or steam valve in its action. It passes current in one direction, but blocks the current coming in the opposite direction.

Using again the simile of the one-way street, the mineral detector is a narrow, badly paved and hilly one-way street. It lets traffic through, but the vehicles can't speed up very much.

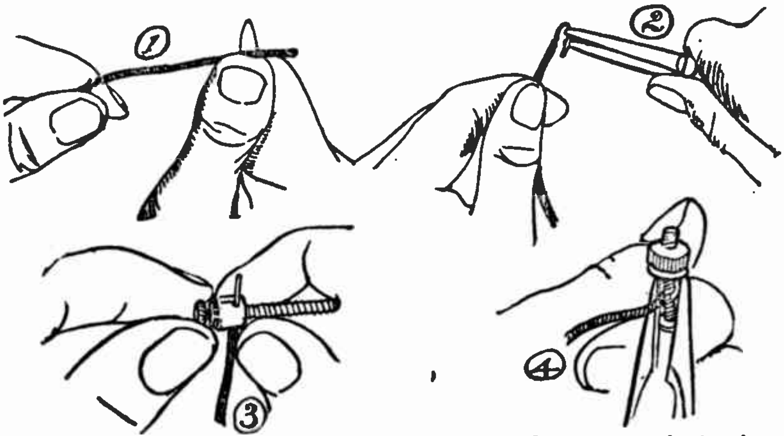
The electric light known as the audion bulb or valve is a one-way street that is wide and smooth and well paved. In fact, it might be said to slope down hill and assist traffic, for it not only straightens out the electric currents, but by means of its own batteries, boosts them along and sends them on their way some thirty or more times stronger than they were when they entered the bulb.

Just as the audion bulb is about thirty times as strong as the crystal, so it is about thirty times as expensive and as complicated.

If you are within about five miles of a big broadcasting station, you can hear the concerts on a crystal—but you can never amplify the signals or put them on a loud speaking horn. The best you can do is to put four or five sets of telephones in the circuit and thus let your friends hear.

With the audion bulb, under favorable conditions, you can hear the concerts for three or four hundred miles and, by adding what is known as amplifiers, you can make the signals just about as loud as you want to—and put them on a horn or phonograph so that everybody in the room can hear them.

VII. BE CAREFUL HOW YOU CONNECT YOUR WIRES.



Be careful of the connections. No. 1—Cut around the insulation with a circular movement of the knife blade; pull insulation off end; scrape wire clean and bright. No. 2—Bend a loop with a pair of pliers and fit it around screw of binding post. No. 4—Bend ends closely together so it will not slip off and then screw down tight on it. No. 3—With some types of binding posts simply insert bare end of wire in the hole and screw down tight.

Even if you buy your radio receiving set complete in a neat polished cabinet, you will have to hook it up to your aerial and ground and your storage and "B" batteries. And there is no cause of failure in sets quite so common as bad connections in these hook-ups.

The electric currents that flow in a radio set are so extremely weak that the least bit of resistance will interfere with them, even to the extent of stopping them entirely.

Loose connections between wires or between wire and binding post will give all sorts of annoyance. And any dirt or grease, even the grease of the skin, will interfere with perfect reception.

To prepare the end of a wire for connection, take the wire between the blade of a penknife and the thumb and, with a circular movement, cut through the insulation all around. Then cut the insulation from the end, leaving the wire exposed.

When you are ready to make the connection, scrape this wire absolutely clean, so that it is bright and shiny. And, in making the connection, it is best not to handle the clean wire much, for the skin has a certain amount of body oil in it (some skin may even have dirt on it, but not yours, of course) and any greasy matter will interfere with the smooth flowing of the weak currents.

If you are using the kind of binding posts that have a top that screws down on the wire, scrape both the base and the lower side of the top until they are shiny and bright.

Then, with a small pair of wire pliers, bend the end of the wire into a loop that fits neatly over the binding post and screw down hard and firm on it.

If you are joining two ends of

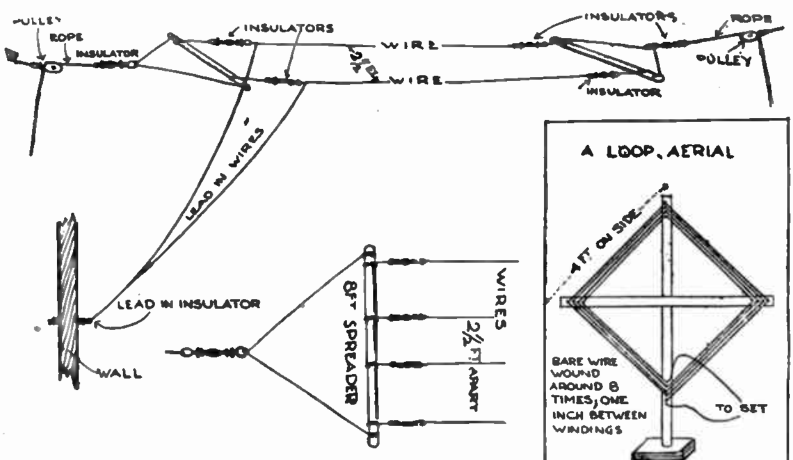
wire together, there is nothing for it but solder. Merely twisting them together is all right if you are using them from your storage battery or your "B" battery, for the currents there are so strong that perfect connections are not essential. But if the wires are in any other part of your set you must twist them together and then solder so as to make a flawless joint.

As a matter of fact, it is well worth while to solder the wire from your aerial to your set and the one from your set to the ground. Even after you have made the careful connection just recommended, it is a mighty good thing to solder them, for it is impossible to have these connections too good. And, if you ever want to disconnect later, it is a simple matter to heat the binding post with a little blow torch until the solder melts and then remove the wire.

It is surprising how many people have never learned to solder and how widespread is the belief that it is a great deal of trouble. It isn't at all; with an outfit costing less than $2 it's fun, and you'll be surprised to find how mighty handy it is to have such equipment around the house for other purposes.

Later we will give an illustrated talk on soldering and prove how easy it is.

VIII. THAT BUGBEAR OF RADIO—THE AERIAL.



Here are some hints on outfitting the aerial to illustrate the instructions given in the accompanying article. The drawings are self-explanatory.

You don't want an outdoor aerial, of course. Nobody does. Everybody is dreaming of the time when a radio receiving set will all be contained in a talking machine cabinet—aerial and all.

There are such sets now. But they are not for the man of limited means or of limited knowledge of radio. They are for the expert who can use staggering looking mathematical formulae and figure out every little detail according to his own peculiar conditions. And it takes an expert to get the best results out of them.

We might as well face the brutal truth at once. For really satisfactory results (if you are a beginner) you will have to have an outdoor aerial. You can get results with an indoor aerial, but they won't compare with the outdoor one.

And how big an aerial will you need? The longest and highest you can put up—within reason, of course. You don't want one 500 feet long. You don't want one 500 feet high.

The ideal aerial for the amateur is a single wire about 125 to 150 feet long and thirty feet high if possible. If you can get only 100 feet in length and twenty-five feet in height, a single wire will still give you mighty good results. If your space is limited so that you cannot get a stretch of 100 feet, you had better use a two-wire aerial. If you are confined to fifty feet or so, use a four-wire. And, whatever you use, get it as high as you conveniently can and, if it is much less than 100 feet long, bring the leading-in wires from the far end.

If you put up an aerial ten feet above the tin roof of an eight-story house, the height of the aerial isn't much more than ten feet, for radio purposes. Try to rig it up so that it is well above roofs and trees, for the branches of trees are great absorbers of radio energy.

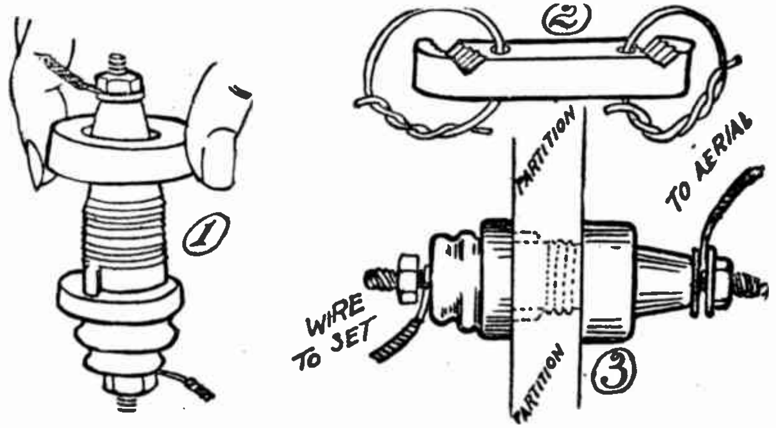
If you use a one-wire aerial, make it fast to the insulator at the far end, pass it through the ring or hole of the near insulator and tie it without cutting it, and bring the free end straight to your wall insulator. That will avoid the trouble of soldering on another wire for a lead-in. If you use two or four wires, string up each of them the same way. Bring them together as near the leading-in insulator as possible and then solder. This is one place where solder is absolutely essential. No twisted connections will do.

If you positively must use an indoor aerial, string four wires in this same way under the ceiling of a garret if you can get a stretch of twenty-five or thirty feet. If you can't you can run a wire around the picture molding of a room, spiral fashion, with each turn about an inch from the others, using a total length of about 200 to 250 feet. Or you can use what is known as a "loop" aerial or one made of two sections of fine mesh mosquito wire, though this latter type is not yet widely adopted.

But remember that, with any of these indoor aerials, you are reducing the strength of the received signals so that you will need several stages of amplifying bulbs to work a loud-speaking horn, and these amplifiers are expensive and require some skill for best adjustment. If you are within twenty miles or so of a broadcasting station you will get fairly good results in phones only, even with a loop. We will describe these different aerials soon.

Aerial wire may be either bare or insulated — it doesn't make much difference. And, if it is solid wire, the bigger the better. The very best aerial wire for ordinary use is the kind sold for the purpose by the electrical stores. It is made of seven twisted strands of bare wire, is easy to handle, not expensive and much more efficient as a gatherer of radio signals than even a very heavy solid wire.

IX. HOW TO RIG UP YOUR AERIAL.



Insulation is the important thing in rigging up your aerial. No. 1 is a "leading-in" insulator and No. 3 shows how it is used. Bore a hole in window frame or in the board recommended in the article, unscrew the cap shown in No. 1, push insulator through hole, screw on cap tight, attach wires as shown and it's done. No. 2 shows an ordinary porcelain cleat used as an insulator for the aerial wire and for the guy wires.

The main secret of success for an aerial is good insulation. Insulating means preventing the weak electric currents from going anywhere except through the wires intended for them. An insulator is a substance through which electricity will not flow.

When you are putting a plumbing system in your house you see to it that the water has an easy flow through the pipes and that there are no bad joints or leaks through which it can escape.

Wires are the pipes for the radio plumbing supply. Bad joints are bad connections between wires. Leaks are where the insulation is poor and the electric current manages to escape from the wire and waste its energy somewhere where it can not be used.

So good connections and good insulation are the prime requisites of an aerial and a receiving set.

Porcelain is a good insulator; so are hard rubber, bakelite, sulphur, parafine, glass and a dozen other substances. Consequently we use one of these substances wherever a wire comes near another object through which it might waste its energy.

In rigging up your aerial these insulators must receive the strictest attention. On each aerial mast or pole you will have a pulley through which you run the rope or clothesline that hauls up the aerial. This rope ties to one end of a good insulator, and the aerial wire is made fast to the other end.

If you have a two, three or four wire aerial, you will have sticks of wood called "spreaders" to hold the wires the proper distance apart. You will have to have a rope tied to each end of each spreader so as to tie the spreaders down horizontal. Each one of these "guy ropes," as they are called, must have an insulator where it joins the spreader. This may seem a useless precaution, but remember that on a damp or rainy day rope becomes saturated with water, and water is an excellent conductor of electricity. The currents received in your aerial wire would enjoy running down the water in the ropes and laughing at your attempts to force them into your receiving set.

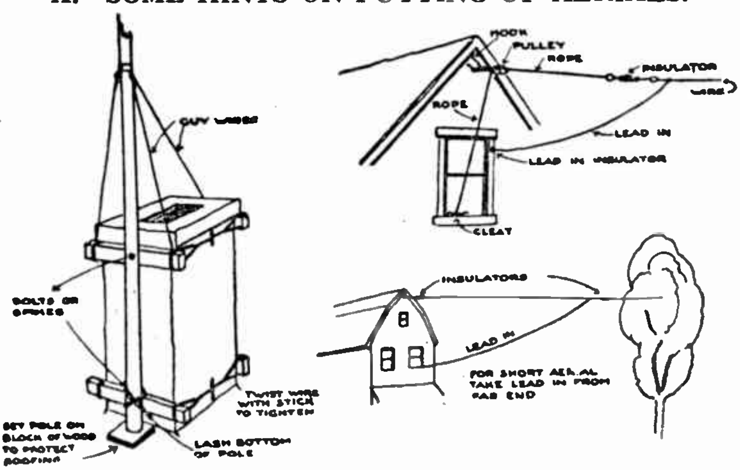
If you want the best, you can buy these insulators made in a form especially adapted for aerial work. They are from three to twelve inches long and are made of the best insulating material and formed with deep corrugations to make the leakage path of the surface as long as possible.

But if you can't afford these luxuries, get some of those porcelain cleats that are made to hold electric wires along the ceilings of buildings. They will answer the purpose very well for the receiving set. It is best to give them a good coating of grease every once in a while so that rain water will run off of them and not collect in such a way as to invite the electricity to leak out of the wire.

Good insulation is also important at the place where your wire from your aerial comes through the wall or window to your receiving set. There are insulators built especially for this purpose, too, and a good one will cost about $2. They are called "lead-in" insulators.

But you can rig one up yourself. Cut a board about two inches broad and long enough to fit snugly into your window frame. This will enable you to close your window down on it tightly when it rains. Bore a hole in this board just big enough to pass through a short length of heavily insulated wire—about No. 10. Solder the lead from the aerial to the outside end and bring the inside end to your receiving set. Or set one of these porcelain cleats snugly over the hole and pass the lead-in wire through, but if you do this you must wrap all that is inside with insulating tape, for there must be no danger of anything touching the bare wire of the lead-in.

X. SOME HINTS ON PUTTING UP AERIALS.



Here are some useful suggestions for rigging up the aerial. The one showing the pole against the chimney is especially useful. Be sure to set the pole on the board shown at the bottom or else it will soon wear a hole in your roofing.

It may seem that we are devoting a good deal of attention to the aerial in these articles. "Oh, hurry up," the average impatient fan will say. "Never mind all that aerial stuff. We'll put up the aerial later. Tell us how to hook up all this radio junk we have bought."

Anybody who feels that way is working backward. The very first thing to decide is just how big an aerial you can place, where you can place it and the construction details of how you are going to rig it up. First, the aerial; later the hook-ups and all about them.

What's the use of buying a crystal detector set and then finding that you've got to use an indoor aerial, after all? You will never get satisfactory results with it. If an examination of your premises proves to you that you must use an indoor aerial or a very short outdoor one, you'll have to arrange to finance an audion bulb receiver with its storage and dry batteries and probably at least one stage of amplification.

Remember this: the less efficient the aerial is, the more expensive and complicated the receiving apparatus necessary. Or, worse, the less efficient the aerial, the less satisfactory the results in the phones.

So determine right now where you are going to put your aerial and make up your mind about every nail and bolt and screw that it will need.

The best aerial for getting the broadcasts is an outdoor one, with two poles high enough to lift the single aerial wire thirty feet from the ground and with as close to 150 feet between the poles as you can get it. But not one man in a thousand in a city can put up such an aerial. So we have to get our ingenuity at work. You can lash a pole behind each of two chimneys if they are fifty or more feet apart. Lash four solid pieces of wood to the chimney first and bolt or spike the pole to two of them—the poles to be in back of the chimneys when you're looking from between them, so that the chimneys will support them against the pull of the aerial.

You can string your wire from under the eaves of the house and run it to a tree or pole or even a back fence.

If you have no right on the roof and have no back fence, you can put two flagpoles out of the two windows farthest apart and string the wires between them, being careful to keep them at least six feet away from the wall of the house. You can even run it in this way from the top story right-hand window to the first floor left-hand window and take your lead in from the end farthest away from your set.

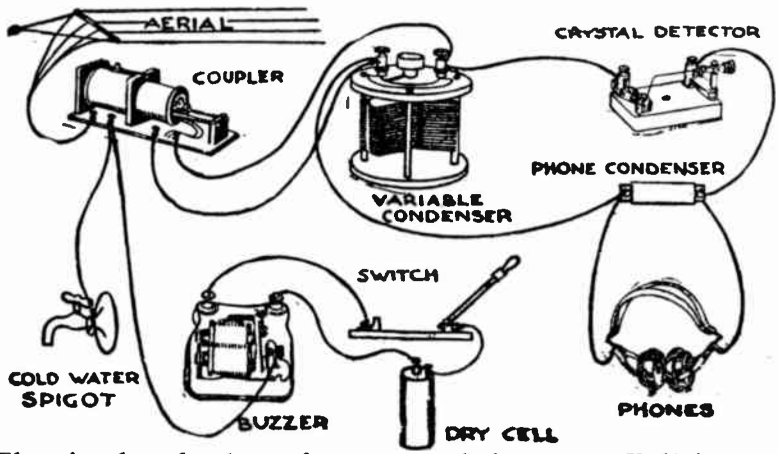
A short aerial ought to have a long leading-in wire, but an aerial 100 feet long or over doesn't need so much.

A single wire will be sufficient if you can put one up at least seventy-five feet long. If your aerial is shorter, use a two-wire aerial, taking the leading-in wire from the far end. If the aerial is to be only fifty feet or less over all, make it a four-wire one and again take the leading-in wires from the far end.

Everything about the aerial must be as strong as you can make it. An aerial offers a lot of resistance to the wind and, if it isn't well put up, the first blow will flatten it.

In putting up an aerial mast against a chimney by the method shown here, be very sure that the chimney is in perfect condition, with no loose bricks or weaknesses of any kind. If there is any doubt about its strength, it must be braced with timber at least 2x3 inches and the mast should have another guy wire to take as much strain off the chimney as possible.

XI. THE BEST WAY TO HOOK UP THAT CRYSTAL SET.



The simplest hook-up for a crystal detector. Full instructions are given in the accompanying article.

There are undoubtedly a great many new enthusiasts who think that this article should have come as the very first one of the series. They've bought a lot of junk or had it given to them, or they've seen it in the stores and made up their minds they are going to buy it, and they have been impatient to know how to wire it together to get the magic sounds of the broadcasts.

I only want to say, for the benefit of these fans, that if they have on this account skipped the articles which have preceded this one, they had better go back and read them first. There's no use hooking up your set until you have some idea what you're going to do with it and the difficulties you are likely to encounter.

We are going to start with the regular crystal detector set. We have already learned that it isn't nearly so efficient or satisfactory as the audion bulb, but it is within the reach of any pocketbook—which the bulb set is not.

And we have warned enthusiasts not to expect results from a crystal more than five miles from a broadcasting station. Right here, let it be admitted that there are a lot of amateurs who are getting fun out of a crystal twenty-five miles from the transmitter. And a friend of mine recently listened to a band concert from nearly a hundred miles away with an ordinary telephone receiver.

These things do happen sometimes. I once sat listening to a concert from 200 miles away, and, as my eyes glanced over the set, I found that the aerial connection had broken and I was hearing the music with no aerial whatever.

These are the freak happenings of radio. They will occur once, but, try as you will, you can never duplicate them. So five miles is a conservative estimate for a crystal, and any one within that distance can be fairly certain of getting results night after night. If you are within twenty-five miles it is worth trying a crystal, for a great deal depends on local conditions. Places within a few miles of each other will get vastly different results in wireless.

The accompanying hook-up is self-explanatory, and is the best for crystal work. It employs several instruments which you can use later when you install an audion bulb.

For purposes of illustration, I have used a loose-coupler, but its place can be taken by a vario-coupler, tapped home-wound basket or spider-web coils, or small honeycomb coils. If your honeycomb coils are not tapped, however, you will have to use another variable condenser and put it in the line between where your aerial comes in from outside and where it joins the set or else between the set and the ground.

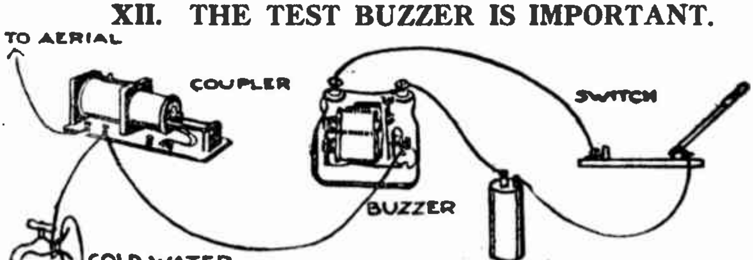
Tapped coils are coils that have a switch on a knob with a blade that can be slid from one switch point to another, each point being so connected that it includes extra turns of the wire in the circuit. That is to "tune" the set to the wave length of the sending station. The variable condenser shown in the illustration does the tuning for the part of the circuit that includes the crystal and the telephones. This part is called the "secondary." The "primary" circuit is the aerial, the part of the coupler to which it is connected and the ground (with the extra variable condenser if you use one).

You can use any of the standard crystals in this circuit, but you will get best satisfaction from the old-fashioned "catwhisker" with a good piece of a mineral that they call galena. You ought to be able to buy the catwhisker and stand for fifty or seventy-five cents and the piece of galena for a quarter.

You will notice a buzzer and push-button and battery in this diagram. That is a very essential part of the hook-up and is used as a tester to make sure that the fine wire of your catwhisker is on a sensitive spot on the galena.

On the next article we will explain this test and also the process of tuning in signals with this hook-up.

XII. THE TEST BUZZER IS IMPORTANT.



Here is the way to hook up a test buzzer. The details of operation are given fully in the accompanying article.

Any man who uses a crystal receiver without a test buzzer is like the dog who sat on a tack and just sat there and howled because he was too lazy to get up. Without a buzzer to assure you that your catwhisker is on a sensitive spot on the crystal, you might turn your knobs all night and not get the faintest breath of a signal. And you would blame the set and say that radio is a fake anyway and the man who sold you the apparatus was a swindler.

It is, of course, possible to work a crystal set without a buzzer. It is possible to do almost anything in radio. The great thing about the buzzer is that it assures you that your contact with your detector is all right. Then, if you don't get signals, you are justified in looking to the set for the trouble.

Neat little buzzers are made especially for this purpose, but it isn't necessary to buy one. An ordinary buzzer such as the boss uses to call the office boy or such as are put on some front doors instead of bells will do excellently. And, if you have an old electric bell, just take off the bell, break off the clapper arm and you are all fixed.

On all such buzzers, there are two binding posts with screw tops for the wires from the battery. You wire one of these posts to your switch or push button and the other to one pole of an ordinary dry cell—not the kind used for pocket flash lamps, but one of the old-fashioned cylindrical ones. Run another wire from the other post of the dry cell to the other screw of the switch or button.

You will notice that the little vibrating arm that does the buzzing vibrates between two coils and a metal upright. Fasten a wire to this little upright, preferably by solder, but a good tight twist will do, and run the other end of the wire to any part of your ground wire. It is usually best to fasten it directly to the ground binding post on your receiving set.

The process is this:

Put on the phones and press the button to make the buzzer buzz, You will probably not hear it in your phones at first. The sound will come obviously from the buzzer. Keep the buzzer buzzing and feel around on the face of the crystal with the catwhisker wire and soon you will strike a sensitive spot. This will be indicated by the sound of the buzzer coming unmistakably in the phones.

Even when you are receiving signals, you should press the button once in a while to make sure that your contact is still good.

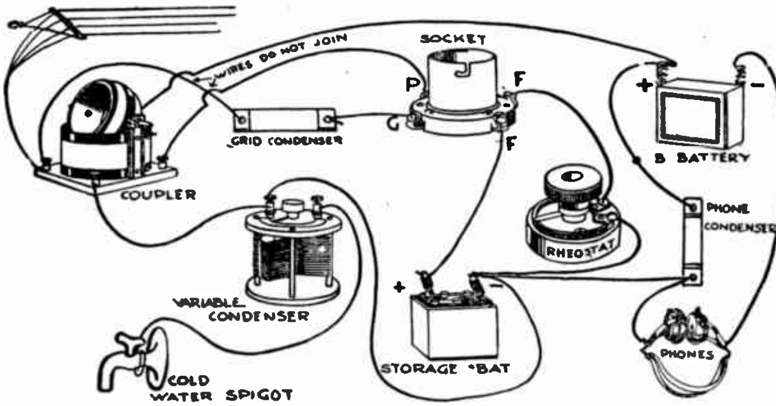
With a good spot found on the crystal, you are ready to "tune in." First move the switch blade or else the slider of the part of your coupler marked "primary" and set it to include about twenty turns of wire.

Then, with the primary left that way, change your "coupling" (pulling inner coil in and out with loose coupler; revolving inside coil with variocoupler or opening apart and closing with flat coils) at the same time, with the other hand, turning the knob of the variable condenser around first one way and then the other.

If you don't get a signal, alter the primary switch or slider to include about six or eight more turns of wire and repeat the process with the other apparatus. Keep on this way, giving yourself all possible combinations, and you will soon hear a signal.

When you do, vary your primary by single turns until the signal is loudest. Then move the coupling a trifle and also the variable condenser to see if you can improve it. If not, you've got it at its best.

XIII. THE SIMPLEST "REGENERATIVE" HOOK-UP.



Here is the easiest hook-up for what is known as a "single circuit regenerative" set. It is fully explained in the accompanying article. You will see the letters "F-F-P-G" on any socket you buy. The two Fs mean filament, the G grid and the P plate.

All radio fans talk about "regenerative circuits." In every radio magazine, you will see it stated over and over again that the regenerative circuit is the best circuit for the reception of signals sent out on such short wave lengths as are used by the broadcasting stations.

I've promised not to be too technical in these articles so we won't go into the details of regeneration too deeply. Whenever you see a diagram of a hook-up stating it is employing this principal, you can go ahead safely and use it whether you understand why it is good or not. And any diagram which shows a coil marked "tickler" is a regenerative circuit. So is one using variometers.

Briefly, the tickler is a coil of any kind used to take the current from the dry cell, or "B" battery, and "feed it back" to the original, or primary, coil that the aerial hooks to—the "feed back" being done in such a way that the battery current, by its own strength, gives added strength to the weak currents coming in through the aerial. The result is a signal built up considerably beyond the strength it would have had if it hadn't been tickled. The tickling seems to make it laugh louder in joy.

You needn't be worried if you cannot quite see how this is done. You can operate a set successfully without a clear idea of it.

Any kind of a coupling coil, if hooked up properly, can be used in the form of a regenerative circuit by the diagram shown here. All coupling coils have two binding posts marked "aerial" and "ground," (which are simply the two ends of one coil known as the "primary") and another pair of binding posts for the coil known as the "secondary."

If you are using a loose coupler or honeycomb coils or home-made spider web coils, simply substitute them for the "variocoupler shown in the diagram.

The secondary coil then ceases to be a secondary and becomes a tickler and the circuit becomes a regenerative circuit.

There is one interesting point

about this, though. If two fellows are using the same aerial, the fellow in one house using one wire and the fellow in the other house using the other, neither one must use this circuit. Any circuit which eliminates the secondary coil becomes what is known as a single circuit hook-up and the odd part of a single circuit hook-up is that, all the time you are using it to receive on, you are, unknown to yourself, sending out a steady stream of oscillations which will cause a loud hum in any nearby aerial and interfere with your neighbor's reception of the broadcasts.

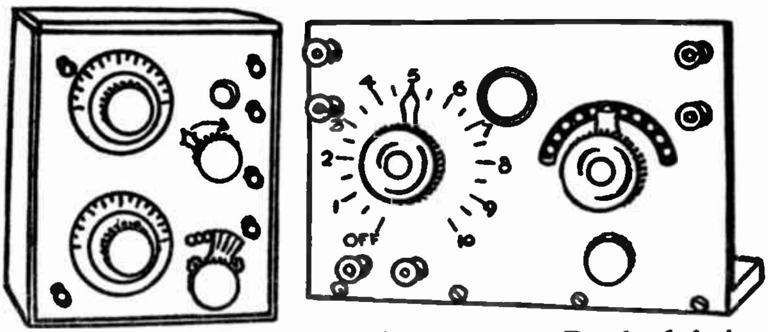
If you and your neighbor are using the different wires of the same aerial or if your neighbor's aerial is very near to your own, you had better sign a truce, both agreeing to use one of the regenerative hook-ups which provide for a secondary coil. Then you won't interfere with each other.

This circuit is not the standard regenerative hook-up which is usually meant by that term. That hook-up requires two "variometers" in addition to the coupler and in that case the extra coil of the coupler is used as a secondary.

The hook-up given here is more complicated in wiring than the usual one but is much simpler in operation. The standard one is simpler in wiring but much more difficult to operate successfully, because it has more adjustments. This one is easier to find signals with but is not so "selective"—that is, if there are other stations sending on the same wave length, it may be impossible to "tune them out" with this hook-up whereas, if you know how to use the standard regenerative circuit, you can tune out almost anything you don't want to hear.

But this circuit is by all odds the best for the beginner and its great advantage is that it is cheaper than the other and that all the instruments used here will also be used in the standard hook-up when you buy your two variometers and try it.

XIV. HOW TO OPERATE THE REGENERATIVE SINGLE CIRCUIT



Here are two typical pieces of apparatus. To the left is a cabinet containing the "single circuit" hook-up explained in the accompanying article. At the upper left of the panel is the knob which turns the "tickler" coil inside the vario-coupler; below that is the knob turning the variable condenser; the four-point switch varies the wave length and the knob with the arrow controls the brilliancy of the audion bulb. At the right is a cabinet for bulb control. The brilliancy control, or "rheostat" is the knob at the left-hand side, and the switch points at the right vary the amount of current used from the "B" battery.

The hook-up given in the last article is not a difficult one to operate. In fact, it is so much simpler than most that the majority of the sets you buy assembled in small cabinets use it or something very like it. And its efficiency is remarkable.

If you are using a loose coupler or a variocoupler, you will have some means of varying the number of turns of wire you employ on the primary coil. It will be by means of a slider or a switch blade which rotates over a semicircle of brass or nickle points, each one of which connects up an extra section of the coil.

With the average amateur aerial, it is best to begin with about twenty turns of wire on a four inch diameter coil if you want to receive the broadcasting stations.

You have two adjustments then to make—turning the knob of the variable condenser slowly all the way around the scale and back two or three times, at the same time performing the same operation with the "rotor," if it's a variocoupler, or drawing the inner coil out all the way and pushing it back. In this way you "feel" around for all possible combinations of adjustments. If you are using the usual loose-coupler, you will also have to vary the switch point on that, ordinarily using about two-thirds as many turns of wire on the inner coil as on the primary. This inner coil, as we have explained, is usually used as the "secondary" but, with this particular hook-up, it becomes the "tickler."

If this brings you no signals, move the primary switch over to the next point and repeat the process until you finally hear the signal you are searching for. Then slightly move the condenser knob until it comes in strongest, then the same thing with the rotor or the movement of the inside coil in and out and then very slowly and carefully try just a tiny bit more current in your bulb by moving the knob of the rheostat. Do this with the utmost care and, the moment you detect a sound of distortion or clicking or moaning or howling, turn the knob back a bit for that sound is a warning that you are putting a dangerous amount of current into your bulb.

It is always best to use the least amount of filament current that will give you satisfactory signals. Never push a bulb to the limit. It will shorten its life if, indeed, it doesn't burn it out completely.

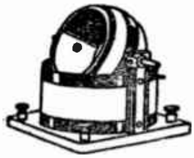
If you are using honeycomb coils in this circuit, you will find the best results for 600 meters with the coil known in the trade as "L 750" as the primary and "L 400 as the tickler and, for the shorter waves "L 400" as the primary and "L 200 as the tickler.

With the home-made spider web or basket woven coils, the primary for the broadcasting stations should have about 60 or 70 turns with the usual amateur aerial and, oddly enough, I have found that the tickler that gives best results is one with between 100 and 110 turns. These are coils wound around a hub two inches in diameter. No definite number can be given, however, as conditions will vary greatly with different localities.

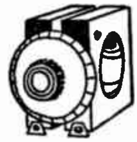
If you are going to use these spider web coils (and they are very efficient and lots of fun to make) I strongly advise making both of 110 turns, tapping each single turn of the inside ten and each ten of the rest. This will give you a variocoupler that is good for nearly 1000 meters with a 100-foot single wire aerial at the average height.

Later we will show how these coils are made and tapped and used. But don't attempt to tap them until you have learned to solder and have an outfit.

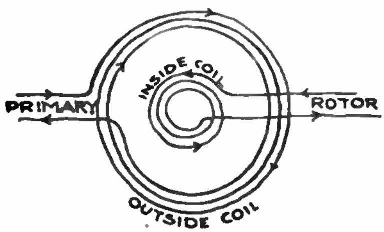
XV. WHAT D'YA MEAN—VARIOMETER AND VARIOCOUPLER?



VARIO-COUPLER



VARIOMETER



The difference between a variocoupler and a variometer. In a variocoupler the wire on the outside winding has no connection with the wire on the inside winding. In a variometer they form one continuous winding, the inner winding being laid around the ball so that it can be turned about inside the outer winding.

It sounds like a mean trick to start out on these radio articles with a promise not to be technical and then begin to talk about variometers and variocouplers and all that sort of thing. But it's simply because the words are new that they sound formidable. They are very easy to explain.

When the automobile first came out, every one was staggered by such words as ignition and carburetion and transmission. Now we eat 'em for breakfast and don't even have indigestion. Radio is the same way.

Everybody already knows what a coil is. When you buy wire or rope in a store the salesman winds it around his hand and his elbow until he has cut off the hundred feet you ordered. You and he may call it a hank of rope, but in electrical parlance it is a coil.

You can take an oatmeal box, which is cylindrical in shape, or an ordinary mailing tube or a round curtain pole and, if you wind a long piece of wire around and around and around it, you have made a coil. A spool of thread is a coil. A ball of twine is a coil, wound criss-cross like the "honeycomb" coils of radio.

If you take one coil of wire and place it quite near another coil and make and break a current of electricity in the first, it will induce a current of electricity in the second, even though the two coils of wire are not joined. The electricity in the first coil sends out magnetic impulses and, when these invisible waves of magnetism cut through the wires of the second coil they "induce" a weaker current of electricity in them. That is what we call "induction" and a pair of coils mounted for this purpose are known as an "induction" coil.

When two coils have no electrical connection—that is, when the wire of one does not actually join the wire of the other—but one induces a current in the other by magnetism, we say that they are "coupled." The two are then called a coupling coil. And when the first of these coils is wound around a tube like an oatmeal or salt box and the second is wound around a small tube or a ball which is made to turn on a shaft inside one end of the first, we call the apparatus a variocoupler. The turning of the ball or smaller coil inside changes or varies the amount of electric current induced in the second by the first. In other words it varies the induction. It also varies other things which we won't talk about just yet.

So that's a variocoupler. Other kinds of coils are really variocouplers in their results, but we have different names to indicate and identify the different kinds.

When the second coil is around a smaller tube and draws out of and pushes inside of the first, we call it a loose coupler.

Two honeycomb coils or two basket or spider-web coils can be used as a coupler and when they are hinged at one side and open apart and close together like the pages of a book, or draw apart like an opening fan, they vary their induction just as a variocoupler does.

But the illustration shows the type of coupler that is always meant when radio fans talk of variocouplers.

The variometer consists of two coils, too, one revolving inside the other, but in this case the two not only act on each other through inducing electric currents, but they are actually physically connected. The electric current goes into and all around the outside coil and the wire where it comes out is directly connected to the wire going into the inside coil and the electricity goes around that one, too. It is like taking a long piece of wire and winding two coils of it and then putting one coil inside the other without cutting them apart.

If you took the variocoupler and made a wire connection from the coming-out wire of the first coil into the going-in wire of the second, you would turn it into a variometer.

And, if you reversed the process and cut the connection between the two coils of a variometer, you would make it a variocoupler.

So don't forget the cardinal fact—the coupler has no actual connection between the coils, the variometer has.

XVI. WHAT DO WE MEAN BY "TAPPED" COILS?

It is always a surprise to a "hard-boiled ham," as they call an old-time radio operator, to talk to a layman, using the most familiar terms of wireless and then suddenly find his listener doesn't know what he means. "You don't know what a 'tapped coil' is? Why, a tapped coil is—is a coil that is tapped. Everybody knows that."

But he finds that everybody doesn't know it. But a tapped coil is really a very simple piece of apparatus and, as it is used in virtually every receiving set, let's spend a few minutes examining one.

But first let's forget wireless and think of ordinary plumbing. You've all seen those coils of water pipe that go into modern heating systems for the rapid heating of water. The more pipe surface you expose to the flames, the more hot water you will get.

Our illustration shows such a heating coil as it might have been built by a man with the nightmare. Suppose we have such a coil, with flames all about it but with different pipes running from the supply tank to different turns of the coil and different other pipes taking the water from different other turns of the pipe and delivering it to the receiving tank, which may be considered the rest of the heating system. Remember that there are flames all around the whole coil and every square inch of its surface is heated.

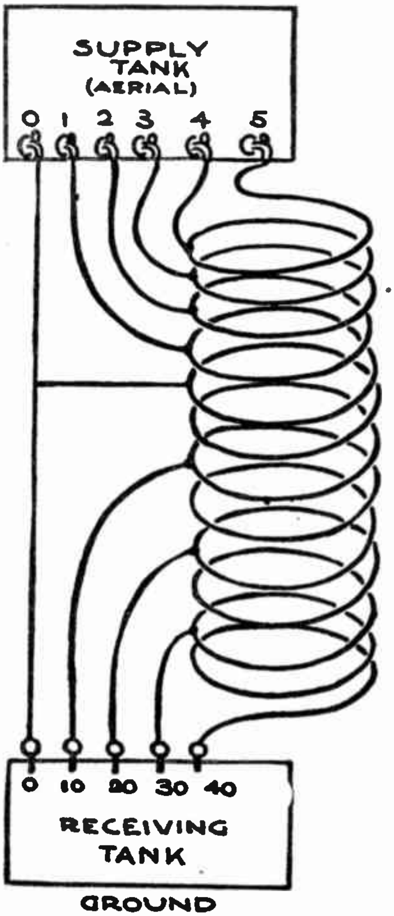
You see spigots on all the pipes from the supply tank and all emptying into the receiving tank.

Now, suppose we open spigot marked "O" from the supply tank and the spigot marked "O" to the receiving tank. Obviously, we aren't going to get any hot water, for the water is going to run straight from the upper tank to the lower because the two "O" spigots are directly connected by pipe.

But (assuming the coil pipe is always full of water), suppose we open supply spigot No. 0 and receiving spigot No. 10. Then, following the pipe connections, we find that the water will run through ten turns of the hot coil and be heated as much as those ten turns can heat it. If we want it a little hotter, we can use supply spigot No. 5 and then we will get the heating effect from fifteen turns of the coil.

If we have ten supply spigots numbered from 0 to 9, and eleven receiving spigots, numbered from 0 by tens to 100, with the two 0 pipes connected, we can get any heating effect from zero to 109 turns.

Now, that's all a "tapped coil" in radio is. The electricity is the water, the wire is the piping and, instead of getting heat from the coil, we get certain electrical effects which give us greater or less wave length. The more turns of coil we use in the pipes, the greater the heat; the more turns of wire we include in the radio coil, the greater the wave length we tune to.



This diagram represents a coil of pipe in a water heating apparatus. There are supposed to be spigots on each pipe at the supply tank and also on each pipe at the receiving tank. And there are supposed to be a great many more turns in the coil than are shown here.

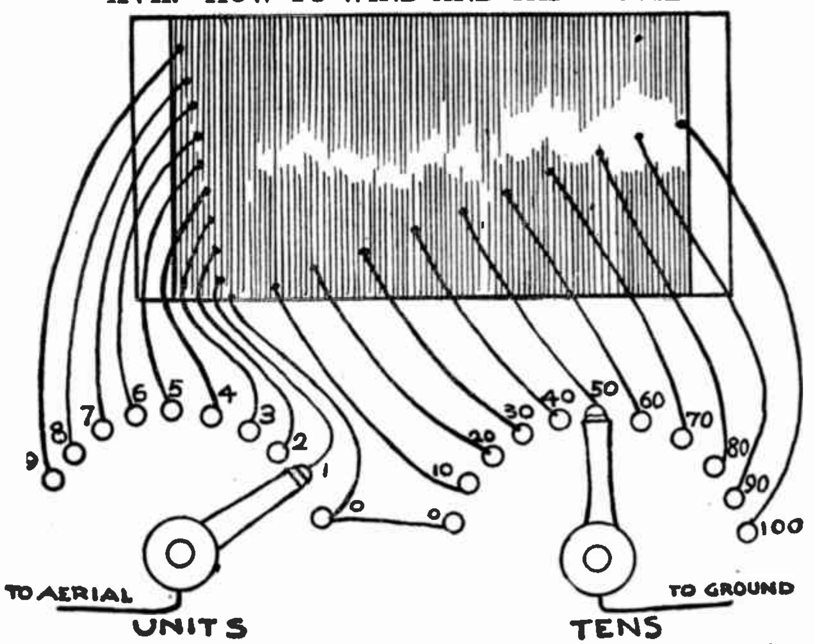
The supply tank in the illustration is the leading-in wire from your aerial. The supply spigots are the "unit" switch points numbered from 0 to 9. The receiving tank is your ground wire and the receiving spigots are your "tens" switch-points numbered from 0 to 100 by tens.

On an ordinary amateur aerial with an ordinary cylindrical coil, you will use something like twenty or thirty turns to get 200 meters and the whole 109 turns ought to give you close to 1000 meters. The broadcast concerts ought to come in somewhere around fifty or sixty. Of course, this is only guesswork, as length, height, number of wires, length of lead-in and ground and local conditions vary the natural wave length of any adjustment. But it will give you an idea of what to expect.

Moving the "tens" switch will usually let you hear the signal more or less faintly. You tune your secondary by changing coupling and condenser until you get best response and then try moving the unit switch of the tapped coil to see if you can still further improve it.

In the next article, we'll see how easy it is to wind and tap such coils as this.

XVII. HOW TO WIND AND TAP A COIL.



This shows how a coil is "tapped" by single turns of wire and by tens. Its operation is explained in the accompanying article.

There are many instruments used in radio which cannot possibly be made by the beginner to be nearly as efficient as the bought article. But the coupler is not one of these. Almost any boy can make a loose coupler, a vario-coupler or spider-web coil coupler to give just as good results as the fanciest and most elaborate looking article in the stores, though the home-made product will probably not have the spick and span, machine-finished appearance of the manufactured one.

The best size tube around which to wind the outer coil for loose coupler or vario-coupler is one having an inside diameter of about four inches. Of course, a regular formica tube made especially for the purpose is by all odds the best. But an oatmeal box or a salt box will give the same results.

It is first necessary to give the box a good coating, inside and outside, with shellac or melted parafine or varnish. If you don't, the pasteboard will later warp with the changes in the weather and one day, your beautifully smooth layer of wire will bulge up and get so loose as to be almost useless.

If you use shellac or varnish (and they are the best) put the coil in the oven over night with a temperature of something around 125 degrees. That will warp it all it is likely to warp.

To wind the coil, borrow mother's hat pin and punch a hole through half an inch from the open end. Use No. 22 double or single coated cotton wire. Double is better. Pass the free end of the wire through the hole, pull about a foot of it inside and tie a knot so that it will not pull out again while you are winding.

There are various methods of handling the wire during this process. Some people mount the coil on some sort of spindle arrangement, hold the spool of wire and turn the spindle. It all depends on how flexible your fingers are and how much you have trained them.

I find the most convenient method as follows:

Get someone to sit down at the far end of the room and hold the spool of thread. Take the coil yourself and walk away to the most distant wall. Then have your friend hold the spool firmly and you, while keeping a good strain on the wire to insure tight, smooth winding, come slowly toward him, turning the oats box all the time and winding the wire on it as close together as possible.

When you have about four turns on, it is time to do the perfecting work. No careless, sloppy winding will do.

From then on, use the thumb nail of the right hand as a guide and, as you wind, keep it constantly pushing the fresh turns in close against the turns already on the box. You will soon get the knack of using the thumb nail so that the wires will lie up against each other perfectly and make almost as good a job as though wound on a lathe.

When you have wound up enough to bring you close to your friend, let him loosen his grip on the spool, you hold the wire firmly on the coil and walk back again to the far wall to start all over again.

But there's one thing that will make this operation less smooth than it sounds. You must provide means of tapping the coil.

Each one of the first ten turns must be tapped and then each ten of the remainder. The best way is to get a small sheet of very thin brass or copper, about the thickness of a good piece of writing paper. Cut, with scissors, about twenty little pieces about an eighth of an inch wide and a quarter of an inch long. Bend each of these in half in the form of a V.

Now, when you come to a place in the wire where you want to make a tap, slip one of these little pieces under and go on winding.

After the coil is all done, you will take a sharp knife, insert the point into each of these, scrape the insulation from the wire inside, slip in the end of the tapping wire and, by dropping a drop of solder, hold coil-wire, V strip and tap wire together in a permanent and perfectly good joint.

The diagram fully explains taps and switches.

THE JUNE "E-Z RADIO."

As you will see by this issue, "E-Z RADIO" is not intended to appeal to experts nor to those who have had extended amateur experience in this new science. It is intended primarily and exclusively for those who know NOTHING WHATEVER about electricity.

The June issue will be of special value to these beginners. It will give complete instructions for building and assembling the simplest and most efficient receiving set, for either crystal or audion bulb receiver, that the novice can make.

This set uses the famous "spider-web" coils and every single step in making and connecting them is shown clearly BY PICTURES, not by confusing diagrams. Any boy can construct the entire apparatus and operate it from these instructions.

In addition there will be articles of general interest, giving valuable advice to those who buy their sets complete but have trouble operating them.

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