The EASY COURSE in HOME RADIO

MAJ. GEN. GEO. O. SQUIER, EDITOR-IN-CHIEF

LESSON VI—HOW TO MAKE YOUR OWN PARTS

BY RAYMOND FRANCIS YATES
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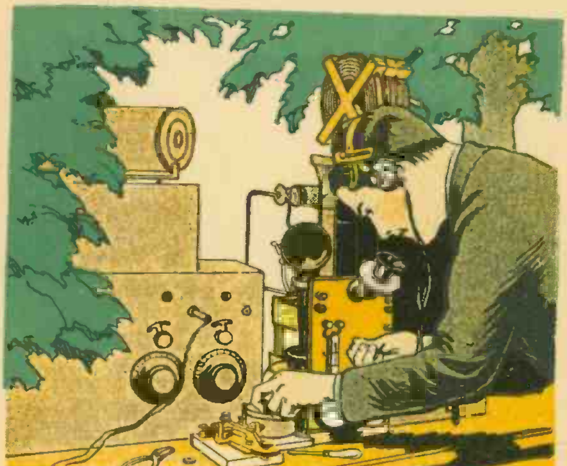

ONE OF THE FOLLOWING SET OF SEVEN LESSONS

1. A GUIDE FOR LISTENERS IN. 2. RADIO SIMPLY EXPLAINED. 3. TUNING AND WHAT IT MEANS. 4. THE ALADDIN'S LAMP OF RADIO. 5. BRINGING THE MUSIC TO THE EAR. 6. HOW TO MAKE YOUR OWN PARTS. 7. INSTALLING THE HOME SET.

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LESSON SIX

How to Make Your Own Parts

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LESSON SIX

How to Make Your Own Parts

Making a Simple Crystal Receiver

IN setting out to make a wireless receiver it is best not to be too ambitious. If we first acquaint ourselves with the construction of the simpler instruments, we shall later find it easier to build and operate the more complicated outfits.

The detector is usually about the first thing that the novice tackles. The detector to be described is clearly illustrated in Fig. 1. To build it purchase the following materials:

2 brass binding posts	.20
1 detector cup	.20
1 large binding post	.15
1 mounted crystal (either galena or silver pyrite.)	.50

A wooden base measuring about 3 in. x 2 in. and ½ in. thick is cut from a piece of well-dried stock. Four holes are drilled in it. If the novice does not have a drill at hand he can burn the holes through with a red-hot nail. Two holes accommodate the small binding posts, and the other two the detector cup and the large binding post. The

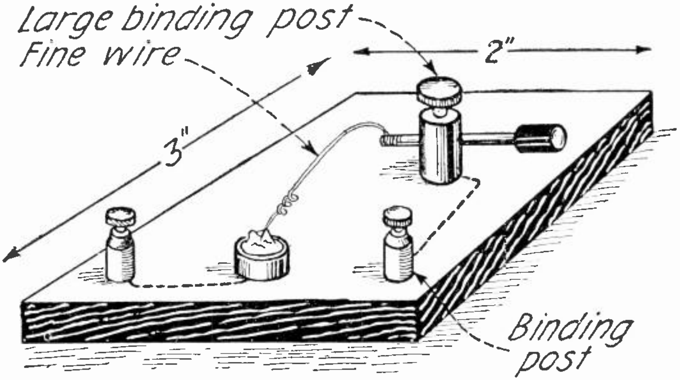


Fig. 1

The details of a simple crystal detector, the parts of which may be purchased at any radio shop.

detector base is well sand-papered and shellacked before the parts are mounted on its surface. It migh be well to counter-sink the holes so that the screw heads will be flush with the surface. It is well to caution the builder here not to use a mineral-bearing paint or varnish on the wood, but rather a good plain shellac.

The connections on the bottom of the base should be made with No. 20 or No. 22 copper wire. The large binding post is connected to one of the smaller ones, and the detector cup is connected to the other small binding post. If two grooves are cut in the bottom of the base with a good sharp knife the connecting wires can be placed in them, so that they will be flush with the surface. After the connections are completed it might be well to cover the bottom of the detector with a piece of felt or other soft material. This will not only make a good-looking job, but it will also act as a shock absorber for the detector.

The device is finished by placing a small brass rod through the hole in the large binding post and attaching a fine brass wire to it. This wire should be curled around a small object a few times to make it more expansible. The opposite end of the small brass rod is provided with an insulating handle. A little wooden knob can be used for this purpose. So much for the detector.

Construction of the Condenser

A fixed condenser of small capacity forms a necessary part of every radiophone receiver. This device is very simple and its construction comes within the ability of even the rankest kind of a mechanic. A pair of small binding posts is all that need be purchased. Ten sheets of tinfoil measuring 2½ in. long x 1½ in. wide should be cut. The tinfoil used to wrap tobacco is satisfactory. Then ten sheets of waxed paper, 2¼ in. long x 2 in. wide are cut. This paper should be of rather a fine grade. Ordinary white paper of good grade can be used if it is soaked in melted paraffine.

The condenser is assembled in the manner illustrated in Fig. 2. First a sheet of waxed paper is laid down on a flat surface. Then a sheet of tinfoil is placed over it. It will be noticed that one end of the tinfoil is allowed to lap over the edge of the paper for a distance of about ⅝ of an inch. Another piece of paper is then laid over the tinfoil and is allowed to take a position directly over the first piece of paper. This forms a sort of tinfoil sandwich, with the tinfoil protruding at one end. Another piece of tinfoil is then laid on top of the second piece of paper. The end of this piece is allowed to lap over the second piece of paper at the opposite end. Then a third piece of paper is laid over the second piece of tinfoil and a third piece of tinfoil laid over the third piece of paper. This last piece overlaps, so that its end will be even with the edge of the first piece of tinfoil. The next piece of tinfoil overlaps at the opposite end. Thus, the tinfoil and the paper are piled up in such a way that there will be five pieces protruding at one end and five at the other. This gives us two sets of tinfoil sheets, each set being separated from the other by the waxed paper.

The pile of paper and tinfoil should be carefully laid between two smooth boards and clamped in position. The boards can then be placed in a warm oven, and the condenser will form a solid block when it is cooled. This is caused by the melting and hardening of the wax.

Two small copper wires are then soldered to the protruding pieces of tinfoil. The edges of the tinfoil sheets should be bent over before soldering is done, since they should all be connected together.

A small cardboard or wooden box, which will accommodate the condenser unit, is then found. If the novice wishes, he can make the box out of thin stock. The condenser is placed in it and the box is poured full of melted paraffine. Care should be taken to see that the wires are not covered but are left protruding. The two binding posts are placed on the cover of the box and connected to the two wires. A little shellac on the outside of the

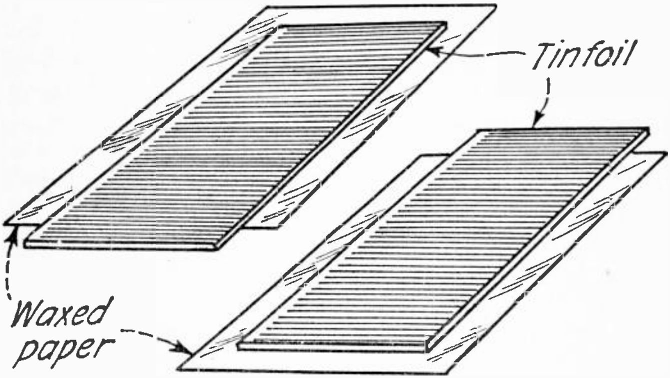


Fig. 2

This illustrates the method used in assembling the fixed condenser. Each tinfoil sheet is separated by a sheet of waxed paper.

container will not only better its appearance but increase its efficiency. The finished condenser is shown in Figs. 3 and 4.

How To Make a Tuning Coil

We shall now pass on to the construction of the tuning coil. The bill of materials for the tuning coil follows:

9 brass contact points	.45
2 binding posts	.20
1 switch arm	.75
3 ounces of No. 24 wire (single cotton covered)	.30

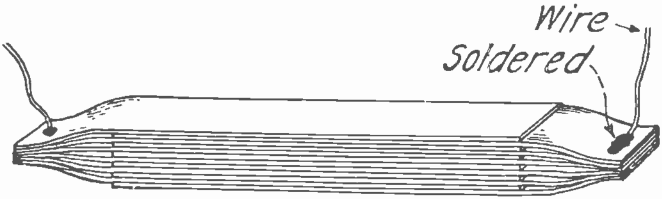


Fig. 3

How the fixed receiving condenser is assembled and the connections soldered.

It is advisable to start the construction of this instrument with the winding of the tuning coil proper. A cardboard tube measuring about 3 in. in diameter and 4 in. long should be used. Two small holes are forced in one end of it with a hatpin. One end of the wire is threaded through these to hold it. The winding is then started. Ten

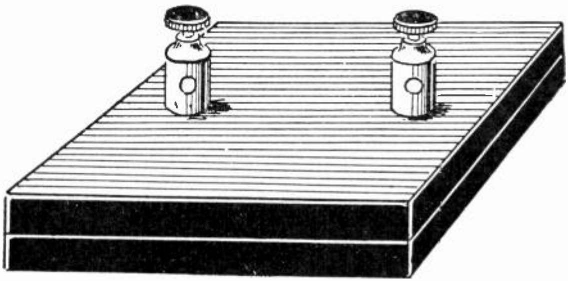


Fig. 4

The fixed receiving condenser assembled in a small cigarette box with outside terminals.

or twelve turns of wire are neatly placed on the tube. The wire should be wound tightly and evenly. After the tenth or twelfth turn a loop is made in the wire. This loop should be about 4 in. long. A small O. K. paper fastener is attached to the wire to hold the loop. The winding is then continued. This method of taking off taps by forming loops saves a great deal of bother in making spliced connections. The same operation is repeated at the next tenth or twelfth turn. Eight loops are made. At the end of the winding two more holes are punched in the tube and the end of the wire is threaded through these. Seven or eight inches is left on this end of the wire to form a connection with the binding post on the tuning coil.

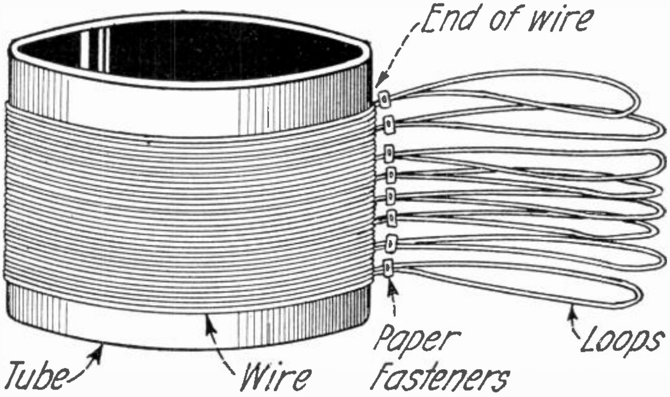


Fig. 5

This sketch shows how the tuning coil is tapped. Each loop is held with a small O. K. paper-fastener.

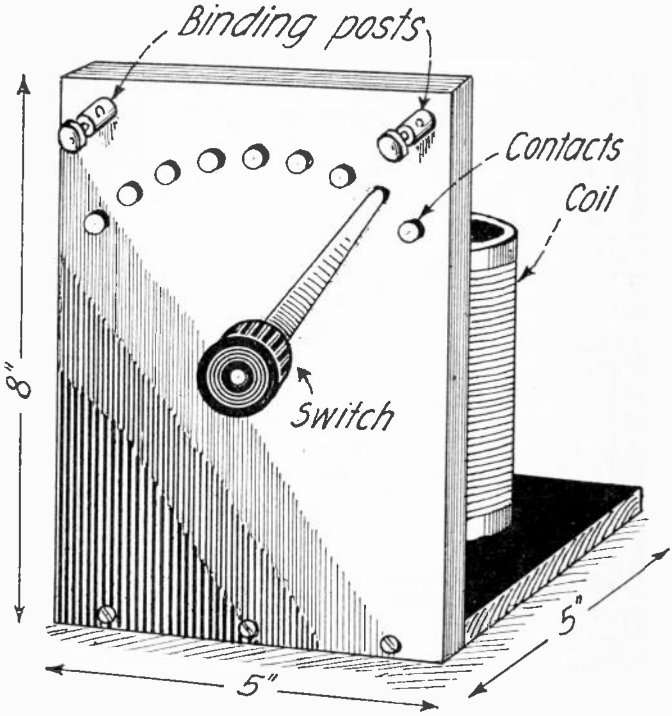


Fig. 6

The tuning coil mounted and ready for use. The dimensions of the panel will be seen in this drawing.

After the coil is wound the cotton covering from the ends of the loops is carefully scraped off, and the tube and winding is covered with orange shellac.

Fig. 5 illustrates the finished winding, and Fig. 6 shows the complete tuning coil. The coil is mounted on a board 5 in. square. This can be done by gluing a few small wooden blocks to the inside of the cardboard tube in such a way that they will also make contact with the board.

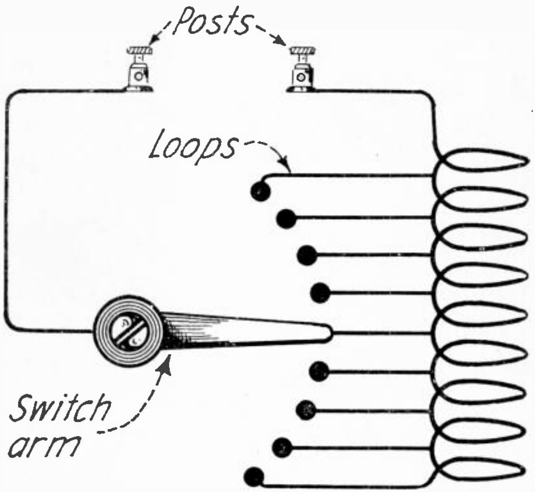


Fig. 7

Diagram of connections for the simple tuning coil used with the first receiving outfit.

A second board measuring 5 x 8 inches is screwed to the first one as illustrated. Before this is done however, the holes necessary for the contact points, the switch arm and the binding posts are drilled. It is also advisable carefully to sandpaper and shellac the board before the contact points are put in place. This will save smearing them with shellac.

The connections of the tuning coil are very clearly outlined in Fig. 7. The ends of the loops are held tightly under the nuts of the contact points. If the novice is handy with the soldering copper he will make no mistake by putting a few drops of solder on each nut.

The tuning coil completes the receiving instruments that are to be used in the first simple radiophone receiver. They are connected as illustrated in Fig. 8. The reader will notice a pair of telephone receivers. This can either be a pair or a single receiver. If a single receiver is used it should be of at least 1000 ohms resistance. The ordinary 75 ohm 'phone is not sensitive enough to use with a radiophone outfit. In case two receivers are employed they should have a resistance of at least 1000 ohms apiece.

The writer wishes to warn his readers at this point not to play with the telephone receivers that they buy. They must keep in mind that the telephone receiver is a very sensitive instrument and it cannot be abused. The receivers should not be dropped or jarred since this weakens the magnets. The cap of the receiver should not be removed too frequently, and after it is removed, the diaphragm should never be lifted off. It should be slid off. If it is lifted it is very apt to be bent. A good pair of telephone receivers will cost from $6 to $15. A single receiver will cost from $3 to $4.

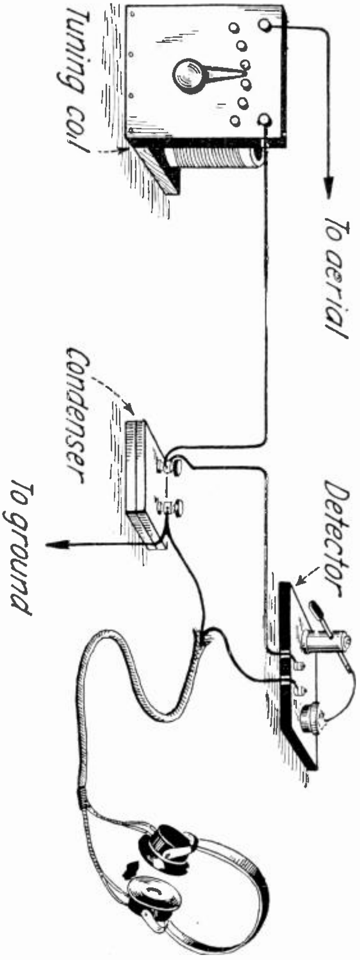


Fig. 8

How the tuning coil, condenser, detector and 'phones of the first outfit are connected to the aerial and ground for reception.

A Buzzer Testing Equipment

Fig. 9 shows how a buzzer testing outfit is installed. This is a necessity to a crystal radiophone receiver since it is by this means, and this means alone, that a detector can be adjusted to a point of maximum sensitivity. The buzzer is simply connected up in the usual way to a door button and a single dry cell. One wire runs from the contact of the buzzer to the ground wire. This wire does not need to make a metallic contact with the ground wire but is simply wound around it. The inductive effect is sufficient to produce a current in a ground wire. We shall come back to the buzzer test later when we consider the operation of the outfit.

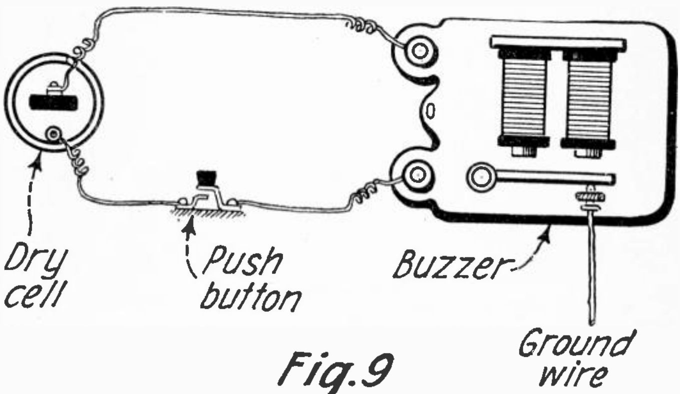
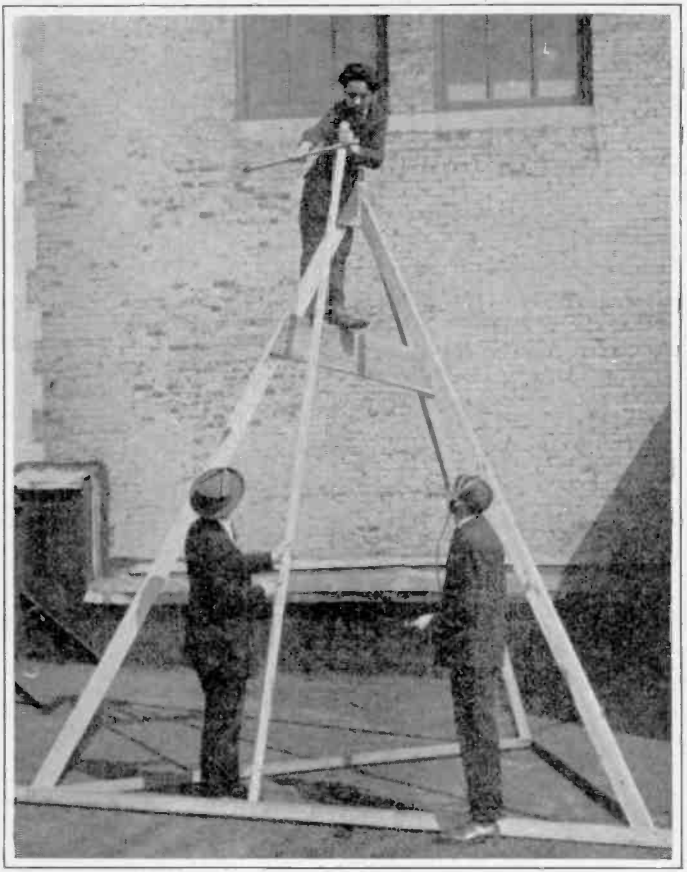


Fig. 9

Connections for the buzzer test used to keep the crystal detector in adjustment.



Sometimes a staunch tripod must be built for an antenna mast of considerable height.

The Aerial and Its Installation

The aerial must be erected before the receiving set can be placed in operation. About the first thing that occurs to a man putting up an aerial is the question, "How high shall it be?" It might be said that the higher the aerial is the better, providing the lead-in wire is not too long. The total length of the aerial wire, the lead-in wire and the ground wire should not exceed 125 feet. We must understand that the lead-in wire and the ground wire must be figured in as part of the aerial system. If these wires are too long the natural period of the receiver will be so high that it will be impossible to receive from the broadcasting stations using the lower wave lengths. The list of material necessary for the aerial follows:

2 galvanized iron pulleys	.20
125 feet of copper-clad or pure No. 14 pure copper wire	.50
1 lightening arrester (approved type)	2.00
2 small aerial insulators	.50
A few feet of rope	.20

Fig. 10 shows all of the constructional details of the aerial. The rope is attached to one end of the insulators and passed through the two pulleys. The wire is then looped through the left-hand insulator and carried to the right-hand insulator. It is looped through this insulator, twisted around itself several times and carried to the tuning coil inside the house. Where the wire passes into the house it is necessary to run it through a porcelain tube, which is in accordance with the underwriters' instructions. The lightening arrester is attached to the outside of the building and connected across the aerial and ground wires. If any heavy charges of static electricity strike the aerial they will jump across the gap of the arrester and flow away to the ground. The ground wire used may be the same as the aerial wire, and it is connected to the water pipe inside the house. It will be necessary to use a ground clamp for this purpose and the pipe should be very carefully prepared before the clamp is placed on it. If the pipe is well rubbed with coarse emery cloth a good clean connection will be made. Ground clamps cost about 10 cents and they are provided with a small screw to which the ground wire can be connected.

There is one best way to do everything. This is especially true of radio. If the little receiving outfit just described is carefully manipulated broadcasted music may be picked up over a distance of twenty-five miles under normal conditions. In some cases it may even reach out to thirty-five miles or possibly forty miles, but of course such a performance could not be depended upon.

The apparatus is connected up as shown in Fig. 8. Ordinary lamp cord can be used or No. 18 bell wire. The ends of the wire are scraped scrupulously clean before they are placed in the binding posts.

The outfit is now ready for reception. The 'phones are placed over the ears and the little catwhisker is placed in contact with the crystal in the detector cup. The buzzer test is then operated. When this is done there will be a distinct hum in the 'phones. The buzzer test will be seen in Fig. 9. A simple doorbell buzzer is connected to a dry cell and a push button. The little catwhisker is then brought into contact with various spots of the crystal surface. Some spots will produce a louder response in the

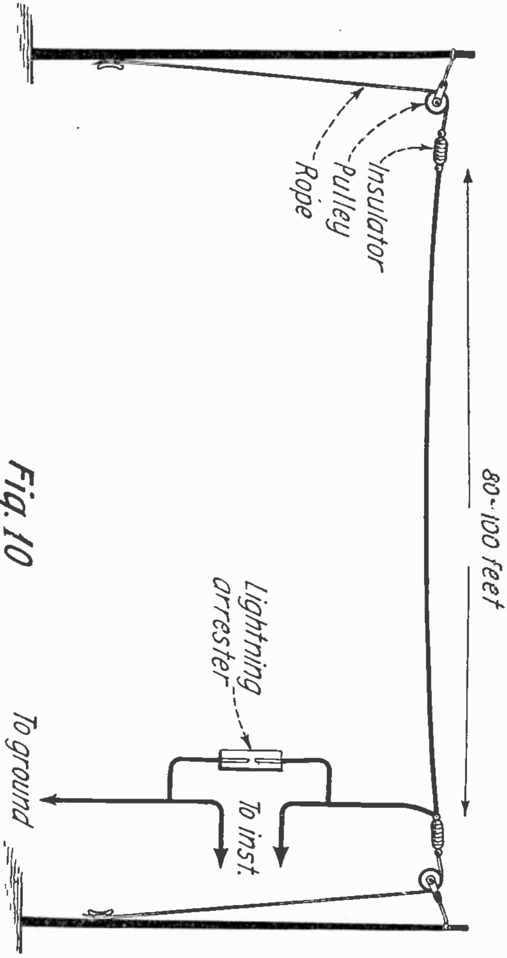


Fig. 10

Constructional details of a simple, one-wire receiving antenna.

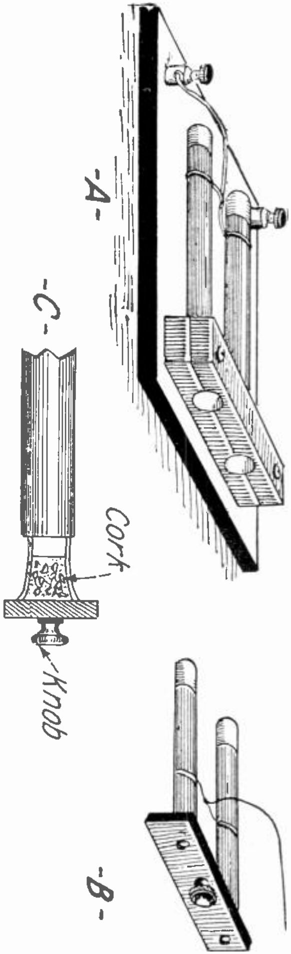
'phones than others, and by working a few moments in this way the detector can be brought to a very sensitive adjustment. This done, the tuning switch on the tuning coil is moved slowly back and forth over the contact points. If there is no response in the 'phones, the detector should be readjusted and the tuning coil again manipulated.

While dwelling on this particular angle of the subject, the writer wishes to warn his readers to take good care of the crystal in the detector if good results are to be expected. Crystals are marvelously sensitive and the least trace of foreign matter on their surfaces will interfere with the successful operation of the outfit. The user should refrain from handling the crystal with the fingers, since such handling will always leave a thin deposit of greasy matter on the surface of the crystal. When the outfit is not in use it is advisable to cover up the crystal with the top of a cardboard box. It will also be necessary to clip a small piece of the catwhisker off to expose a new contacting surface.

How To Make a Variable Condenser

A small variable condenser is a desirable addition to any receiving outfit. Contrary to the general opinion however, a condenser does not increase the volume of the received speech or music. It does, however, add to the selectivity of an outfit which will allow the operator to tune out unwanted stations.

Variable condensers can be purchased at the radio shops, but their cost is prohibitive to many beginners. A good condenser, suitable for the purpose mentioned will cost about $3.75. A substitute can be made for about 50c.



How a variable receiving condenser is made with small test tubes.

Such a condenser is shown complete at A in Fig. 11.

It will only be necessary to purchase four items for this device. They follow:

2 large test tubes	.20
2 smaller test tubes	.20
2 binding posts	.20

The test tubes can be purchased at the corner drug store. The smaller tubes should slide into the larger tubes with as little space between the two as possible. The outside of the two larger tubes is carefully covered with tinfoil. The round ends can be left bare. The tinfoil is held to the tubes by first placing a thin coat of shellac on their surfaces. The shellac should be left until it gets tacky and the tinfoil should then be placed on it. The two smaller tubes are prepared in the same manner.

A wooden base is now prepared to mount the condenser on. Two little wooden clamps are also made to hold the two larger tubes. These pieces are put in a vise and bored out with a brace and bit. The holes should be slightly smaller than the tubes. If a bit of the proper size is not available, a little paper can be wrapped around the tubes to hold them in place.

The smaller tubes are mounted together in the manner shown at B and C in Fig. 11. Two small corks that will just fit the mouth of the tubes are glued to a strip of wood. The tubes are then forced in place and a knob is put on the wooden strip so that the device can be manipulated conveniently.

The two tinfoil coatings or jackets of the tubes just mentioned are connected together by a short length of bare copper wire. The wire is first scraped bare and clean by pulling it through a piece of fine emery cloth. A few turns

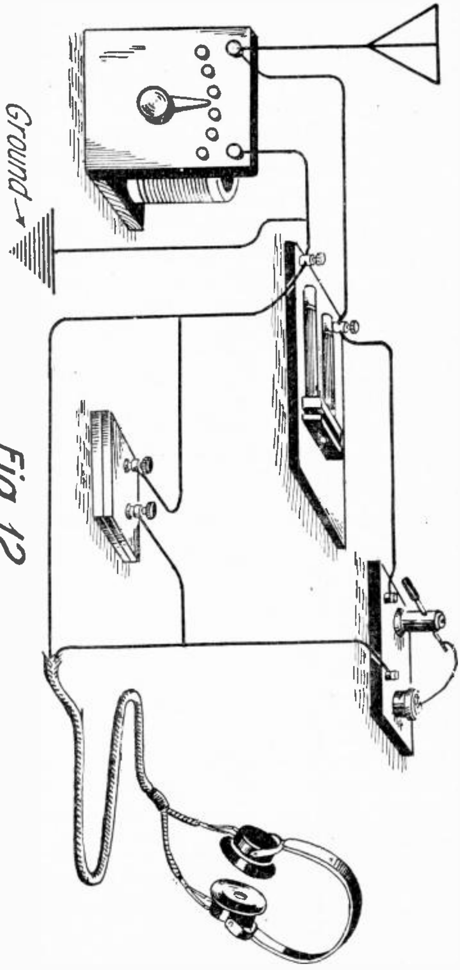


Fig. 12

A receiving outfit employing the variable test tube condenser described in this chapter.

of it are then wound tightly around each tube. The free end of the wire is then carried to one of the binding posts. It might be well to use a piece of lamp cord to connect the end of the bare copper wire to the one binding post. The wire should have plenty of slack in it since the smaller tubes slide in and out of the larger tubes. The two larger tubes are connected together in the same way only the flexible cord is not necessary since they are stationary.

The whole device should be given a coat or two of shellac and put away to dry.

Fig. 12 shows the method of connecting it up in a wireless receiving circuit with the instruments that have previously been described. The presence of this instrument changes the tuning a trifle. After the detector is brought to a sensitive condition both the tuning coil and the variable condenser are adjusted.

How To Make a Loose Coupler

As time goes on the novice will find it advisable to replace his simple tuning coil with what is known as a loose coupler. This is really what might be called an inductively coupled tuning coil. It is a very selective tuning device, and if it is properly and carefully made the audibility of the received music and speech will be increased a trifle.

The bill of materials follows:

2 ounces of No. 24 single cotton covered wire	.20
3 ounces of No. 22 single cotton covered wire	.20

1	switch arm	.75
6	contact points	.30
1	slider rod	.15
1	slider	.20
1	brass rod	.20

A loose coupler has what is known as a primary and secondary. Both of these are wound on separate tubes and can be regarded as independent tuning coils. (See Fig. 13.) One is made to slide within the other, and there is an inductive transference of electrical energy from the primary to the secondary.

The secondary winding is placed on a 3 x 5 inch cardboard tube. The winding occupies a space of 4 inches. The 4-inch space is divided equally into 6 parts, and 6 taps are taken off the winding. The taps are made in the usual manner by looping the wire. After the loop is made a hole is punched in the cardboard tube and the wire loop threaded through it. This is done for each one of the loops since the connections are made inside the tube. After the winding is finished it is given a coat of shellac and put away to dry.

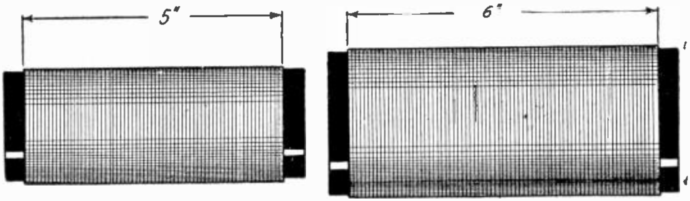


Fig. 13

Dimensions of the coils for the loose-coupled tuner.

In the meantime the primary is wound. Great care should be taken to see that the wire is wound on in the same direction on both tubes. If this is not done the loose coupler will be useless when it is completed. The wire is placed on a tube measuring 6 inches long by 3½ inches in diameter. The winding space is 5 inches long. This is a straight winding job and it is not necessary to take off any taps. This tube is also shellaced and put away to dry.

Unless the home mechanic has a very good tool equipment he will not be able to make the necessary wooden parts for the loose coupler. In that event he can call on the local planing mill for aid. The parts, completely cut, should not cost over $1.00.

The primary is assembled first. Before mounting it on the wooden pieces it will be necessary to scrape the insulation off part of the wire so that an electrical contact can be established between the wire and the slider. A ruler is laid

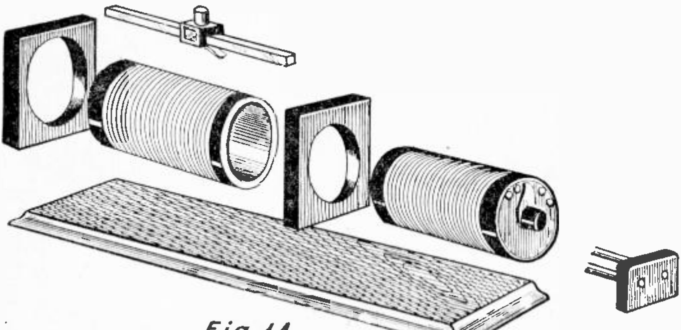
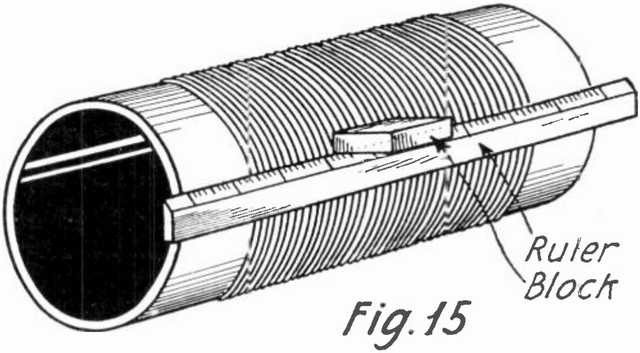


Fig. 14

All of the parts of the loose-coupled tuner and their various positions before assembly.

Photo by Central News

How small a set may be, and still be operative over short ranges is shown by the little apparatus that lies on the table.



This shows a simple method of removing the insulation from the wire on tuning coils before mounting the slider rod

lengthwise along the coil and this acts as a guide for a small block covered with emery cloth. If the emery cloth is rubbed back and forth a number of times, the clean surface of the wire underneath the insulation will be exposed. The method of doing this is illustrated in Fig. 15. After the insulation is removed the little fine grains of copper that lodge between the turns of the wire should be carefully lifted out with the point of a pin. If this is not done the wire will be partially short-circuited and the efficiency of the loose coupler will be low. After the primary tube is mounted in the wooden end pieces and slider and slider rod are attached to the top of the pieces so that the spring on the slider will make contact with the bared wire, two binding posts are placed on the primary. One is connected to the slider rod and the other to one end of the wire. The other end of the wire is left unconnected.

The 6 contact points are now placed in one of the wooden end pieces of the secondary. The loops that were

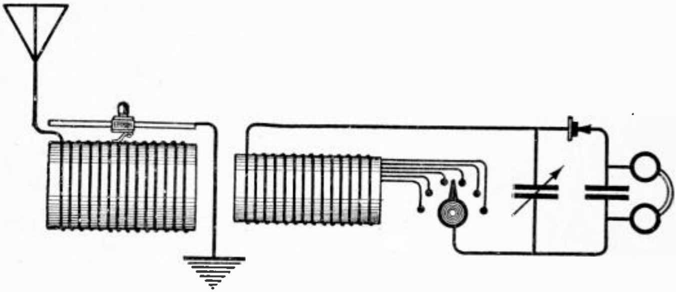


Fig. 16

The connections of the loose-coupled tuner.

made during the winding are then scraped clean and connected to the contact points. This done, the switch arm can be placed in position.

Two holes are cut in the wooden end pieces of the secondary. These holes are drilled exactly in the center and they should be just large enough so that the brass rod will fit into them without binding. This rod is then mounted so that it will be possible to slide the secondary of the loose coupler into the primary. Two binding posts are then placed on the front of the loose coupler and the necessary connections are made to the secondary by a piece of lamp cord. The lamp cord is lead into the interior of the tube through two small holes drilled in the front piece. The lamp cord should be long enough to allow the secondary to slide along the rod for a distance of 6 or 7 inches.

When this work is finished the loose coupler will be ready to be used. The finished coupler is illustrated in Fig. 17. It is connected in the manner shown in Fig. 16.

Tuning is accomplished very easily with the loose coupler. First the slider of the primary is adjusted until something is heard in the 'phones, then the secondary is worked in and out of the primary and the secondary switch adjusted until the proper position has been reached. When interference from other stations is noticed it is often possible to eliminate it by adjusting the loose coupler very carefully. When a variable condenser is used in a loose coupler in a secondary circuit it is always placed directly across the secondary winding. If the novice uses this combination he will find it very easy to tune out unwanted telegraph signals unless powerful stations are nearby. In that event what is known as forced oscillations will be received and any amount of tuning and manipulating will be futile.

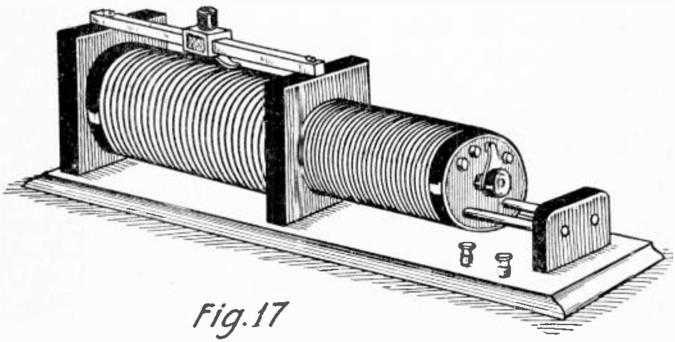


Fig. 17

The loose-coupled tuner assembled and ready for use.

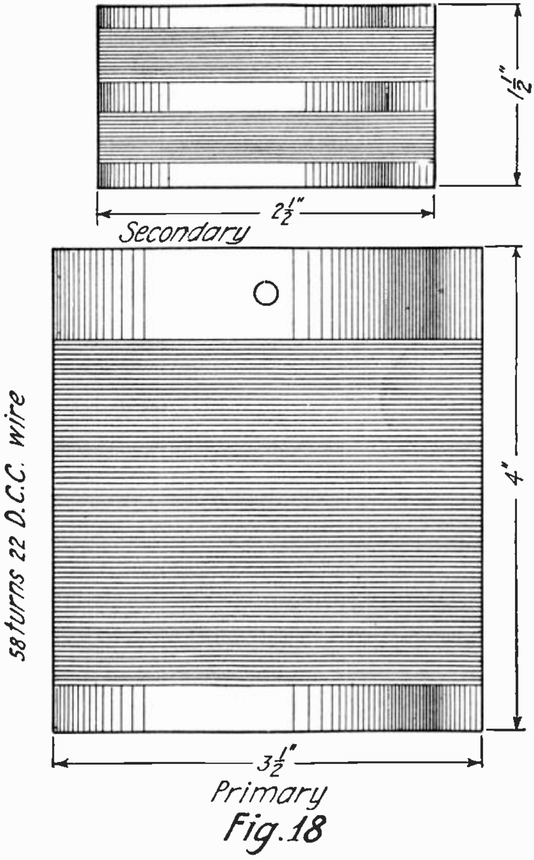
Construction of a Vario Coupler

A vario coupler is very similar to a loose coupler. However, it is much more easily constructed since none of the parts that enter into its make-up require special tools. The list of parts that must be purchased follows:

1	hard rubber knob with pointer..	.30
1	short length of brass rod	.10
2	switch arms	1.50
11	contact points	.55
2	ounces of No. 24 single cotton covered wire	.20
3½	ounces of No. 22 single cotton covered wire	.25

The primary of the vario-coupler is shown in Fig. 18. It consists of a tube of cardboard or insulating material approximately three and one-half inches long and four inches high. It is wound with 58 turns of No. 22 covered wire in one even layer. This winding is tapped as follows: the 1st, 10th, 20th, 30th, 40th, 50th, 52nd, 54th, 56th and 58th turns. This will give a tap every ten turns for the first 50 turns, and a tap for every 2 turns up to the 58th. Thus there are ten taps in all, five "tens" and five "unit" turns, which allow a regulation down to the nearest double turn. The tapping is diagonal along the tube so that the work of tapping close turns will not be so hard and so that it will be easier to make the connections of the primary to the taps on the panel. The method of making the taps is a familiar one and need not be described again.

A quarter inch hole is drilled about one-half inch from the top for the secondary shaft bearing. It should be located along a diameter so that the secondary coil will be



The dimensions of the coils used in the vario-coupler.

concentric to the primary and will not rub against its sides.

The secondary is more simple than the primary. It consists of a piece of tubing about 1½ in. long and of such a diameter as to allow it to rotate freely within the primary tube. A tube of about 2½ in. diameter will be the right size. It is wound with 50 or 60 turns of No. 22 or No. 24 covered wire in two equal sections, separated about ¼ inch. A ¼in. shaft is fitted to the secondary tube and fastened there with lock nuts. The shaft projects through the hole of the primary, and a knob and dial may be fastened on the end. Connections from the secondary winding to the rest of the circuit is effected through the use of two flexible pieces of lighting cord twisted around the shaft and lead

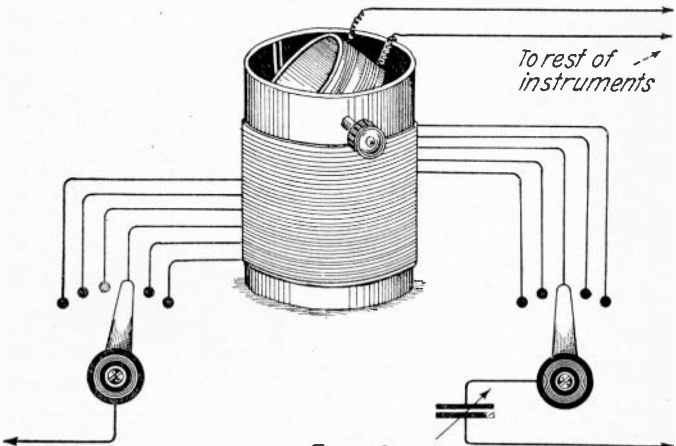


Fig. 19

The connections for the vario-coupler.

between the secondary and the primary tubes. This is sometimes called a "pigtail" and insures positive contact with the winding without any fear of loose contacts. Enough slack in the pigtail should be provided so that the secondary can be rotated freely 180 degrees.

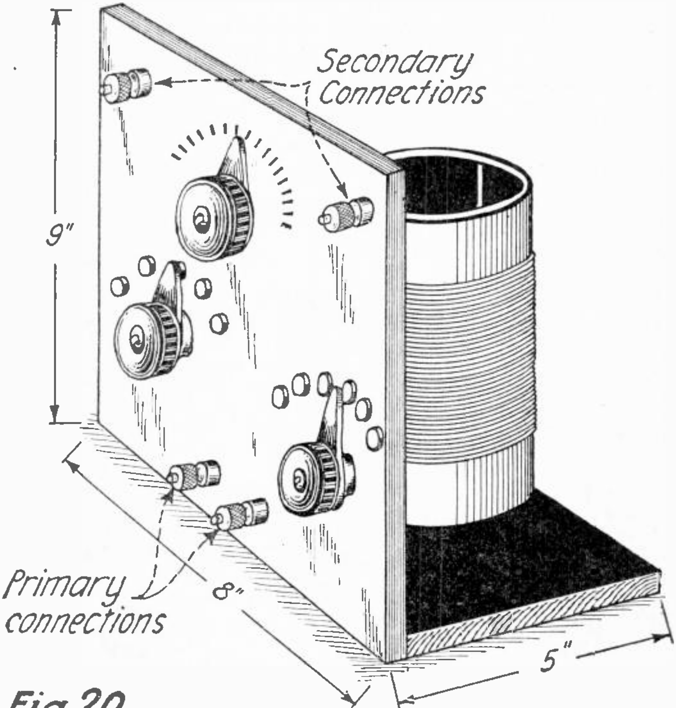


Fig. 20

The vario-coupler mounted ready to be connected in a receiving circuit.

A 3 in. rotor ball, such as are available in the supply stores today, will make an excellent secondary. It should be wound to capacity and the usual connections made to the end of the wire. A shaft is provided and a neat, efficient looking vario-coupler will result.

The connections of the primary are clearly shown in the diagram, Fig. 21. The "tens" taps are connected to the ground knob switch, while the "unit" taps are connected to the aerial knob switch. The finished instrument is shown in diagram Fig. 20.

The next section will tell how to build a variometer and full details of operation of the instruments will be given.

How To Build a Variometer

For the amateur builder who would construct every part of his receiving set the variometer described in this section can be easily made and will work very well. While it will not be as good as the stator and rotor ball types shown in the stores, it will fill all the requirements of the home-made receiver. The construction is shown in Fig. 22.

If enough tubing has been left over from the primary 3½-inch tube, a short piece of about 1½ in. can be used for the stator winding, and a piece the same length about 2¾ in. in diameter can be used for the rotor. Any size tube between 3 and 4 inches can be used if it permits the rotor tube to rotate freely without touching the stator.

These tubes are wound in much the same fashion as the secondary of the vario coupler. The stator and the rotor have 40 turns of No. 24 wire each. These are wound in 20 turn sections with ¼ inch space in the middle for the

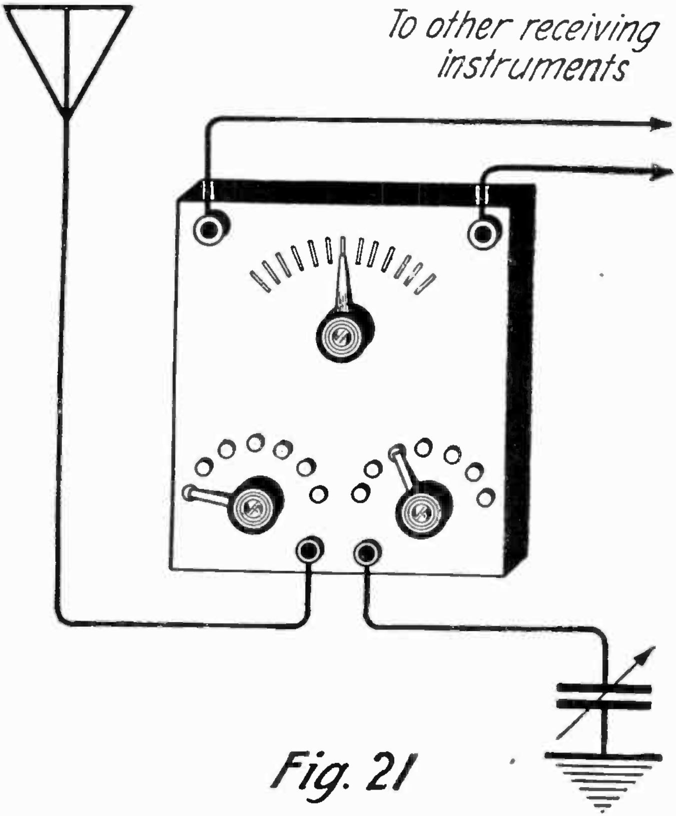


Fig. 21

The vario-coupler is connected in the receiving circuit in the manner shown.

shaft. Almost any size wire between No. 20 and No. 24 can be used provided one allows the same number of turns on both the stator and rotor.

The variometer is really a continuous winding on two tubes one being placed inside and made to revolve within the other. When the two coils are so placed that the two windings are as one their fields will add to each other and will be helping each other. The connections will be seen in Fig. 23. If the inside coil is moved through 90 degrees the fields will not help each other. If the rotor is continued revolving around through 180 degrees the coil will be opposing its entire field against the field of the stator and there will be a negative effect, i. e., the resulting field will be less than in any other combination. In the tuning coil the slider permits the use of more or less turns of wire in the circuit and the switch knob provides similar means with the tapped coil. They take more or less "inductance" in or out of the circuit to allow tuning in to a station's wave length. The variometer accomplishes this purpose without taps, loose wires or contacts.

The rotor is mounted on the rotor shaft, which provides a means of turning the coil through 180 degrees. It is easily fastened with lock nuts. A knob and dial can be fixed on the end so that the variometer can be set for any particular value. The two windings are connected in series, with the end of one winding connected to one end of the other with the two free ends, one on each coil, providing the terminals for connections to the instrument. Flexible connections are made for the rotor so that positive contact is assured. A piece of flexible lamp cord wound around the shaft and brought out will provide ample means for doing this.

The windings on the stator and rotor should be carefully shellacked and the tubes may then be mounted as shown in Fig. 24. An ordinary composition or wooden knob is attached to the rotor shaft and an old clock hand can be used for a pointer. Two binding posts are mounted at the

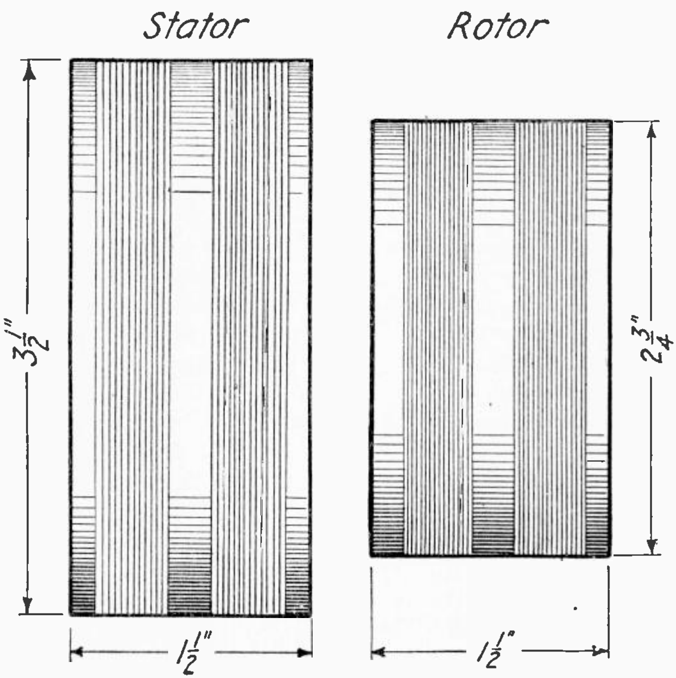


Fig. 22

Dimensions of the variometer coils and tubes.

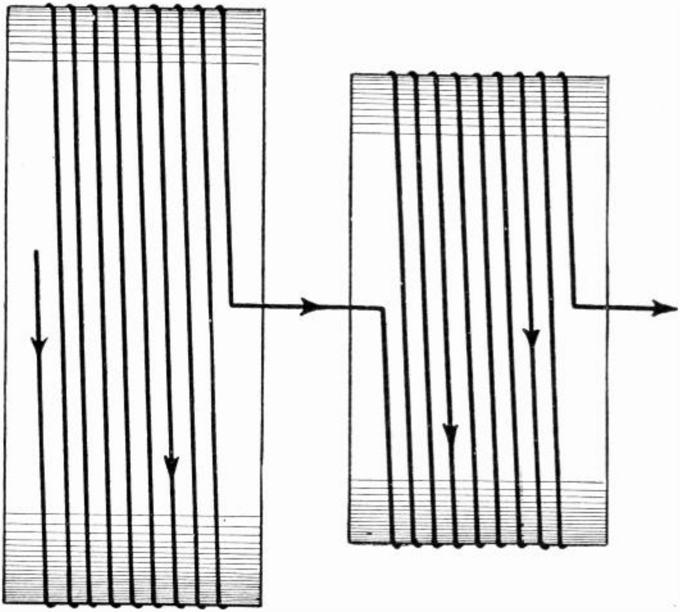


Fig.23

Illustrating the method of winding the wire on the variometer tubes.

top of the panel. The complete instrument is pictured in Fig. 25.

Since variometers are easy to build, the beginner will do well to construct two of them since, they are often used in a circuit together. In fact, the vacuum tube circuit described in the next chapter employs two of these instruments.

How To Make a Vacuum Tube Receiver

After the beginner gains experience with crystal outfits he has a desire to try his luck with vacuum tubes. Since the principle of the vacuum tube is altogether different than that of the crystal detector the method of operating it is also different. It will be necessary to purchase the following items to assemble a vacuum tube receiver:

1 filament rheostat	1.50
1 B battery	2.50
1 6-volt storage battery	15.00
1 vacuum tube detector	5.50
1 vacuum tube socket	1.50

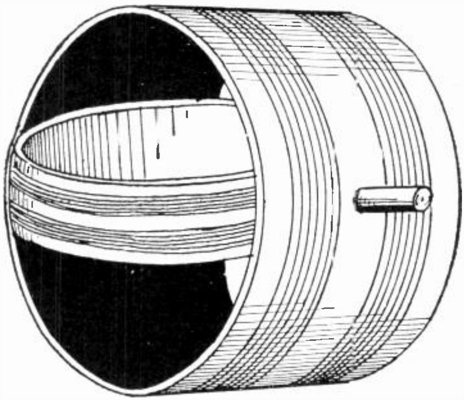


Fig. 24

How the small coil of the variometer is arranged within the larger coil.

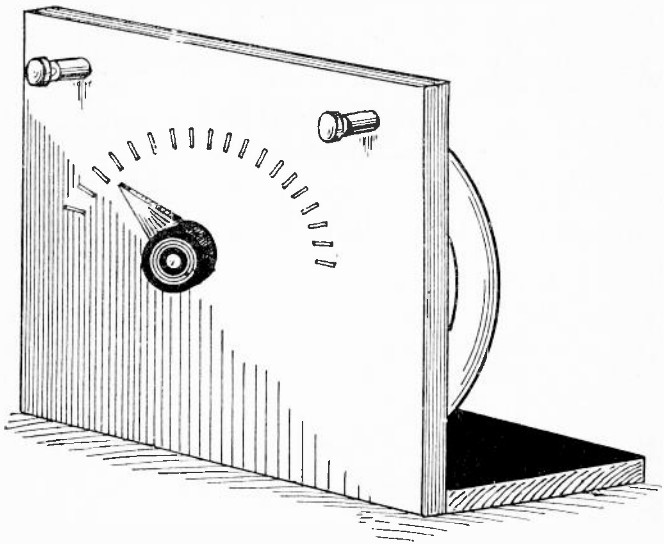


Fig. 25

If the builder wishes he may mount the variometer as illustrated in the sketch.

The circuit diagrammed in Fig. 26 employs two variometers, three variable condensers and the vario-coupler that was previously described. The variable condenser used in this circuit should be the manufactured product, since the capacity of the condenser described heretofore will not be sufficient. Movable plate condensers having 23 plates should be used. These will cost from $2.50 to $3.00 apiece unmounted. The variable condenser shown in the ground

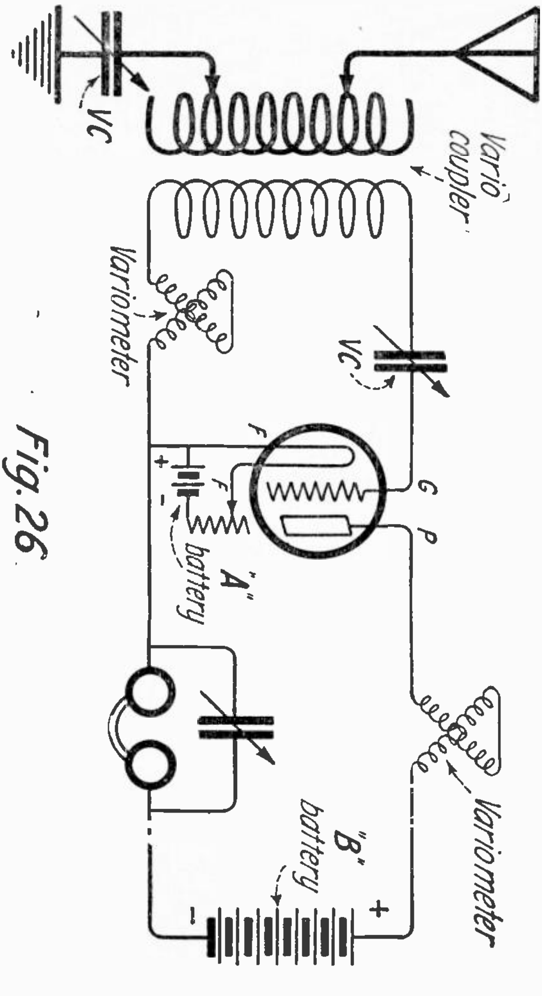


Fig. 26

Circuit diagram showing the connections for a simple regenerative outfit, employing two variometers and one vario-coupler.

circuit can be dispensed with if the novice's pocket-book breaks down under pressure.

In connecting up the vacuum tube the beginner should take care to see that the positive pole of the "B" battery, which is plainly marked, should be connected to the plate of the vacuum tube. The terminals on the socket in which the vacuum tube is placed will be marked G P F F . The P means plate and the positive pole of the battery is connected to this terminal. The G stands for grid while the F F means the filament terminals. Care should also be

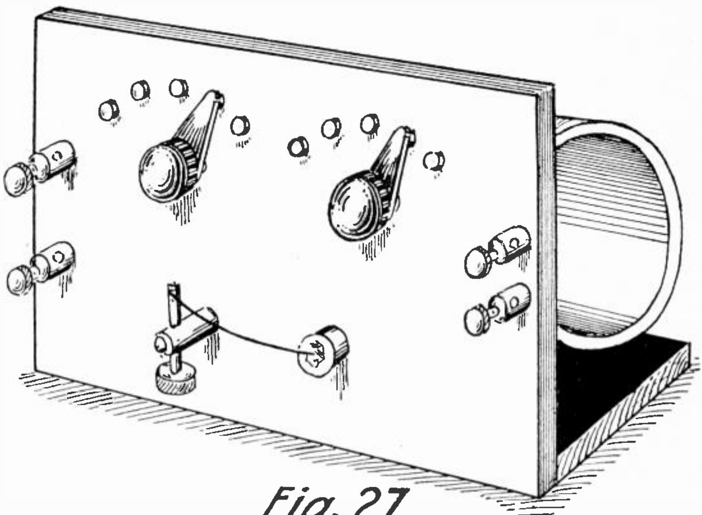


Fig. 27

A simple crystal receiver with the controls mounted on a small wooden panel.

taken to see that the positive and negative terminals of the A or storage battery are connected to the corresponding filament terminals. The positive terminal of the storage battery is connected to the filament terminal marked positive.

To operate this outfit the vacuum tube is first lighted. This is done by turning the handle on the filament rheostat until the filament glows. So many beginners believe that the sensitivity of the vacuum tube is increased by burning the filament as brightly as possible. This is by no means true. The filament of the tube should be burned at a point where maximum response will be heard in the 'phones. If too much current is allowed to pass through the vacuum tube filament its life will be shortened.

After the vacuum tube filament is lighted adjustments are made on the primary and secondary of the vario-coupler. Further adjustments will have to be made on the two variable condensers and the two variometers. After the signals or music is tuned in with these instruments further adjustment of the filament temperature by means of the filament rheostat may be advisable.

How To Make a Portable Receiver

When vacation days approach, the camper wonders what kind of a small radio outfit he can make to accompany him on his trip. The little outfit herein described is "just the thing." It is easy to make, light in weight and functions nicely. It will be found serviceable up to distances of twenty-five miles if conditions are favorable.

To construct this receiver, which will meet all the needs of the broadcast listener, the following material will be needed.

A piece of well-seasoned wood 4 x 5 x ¼ inches for the panel.	
A piece of wood 4 x 5 x ⅞ in. for the bases.	
A cardboard tube 3 in. in diameter and 4 in. long	.20
A quarter of a pound of No. 22 S. C. C. magnet wire	.25
A crystal detector	1.25
A telephone receiver	2.00
Ten contact points	.50
Two switch knobs	1.50
Four binding posts	.40
Antenna equipment	1.00

The tube, on which the winding is to be made, is first shellacked and left to dry or baked in the oven. This will insure a good stiff, moisture-proof tube, which will not be affected by weather conditions.

Sixty turns of No. 22 single cotton-covered wire are evenly wound in one layer on the prepared tube. A hole is punched through the tube ¾ in. from the end to furnish a starting point for the winding. Ten turns are taken, and then a tap is made; that is a loop about 3 in. long is made, the wire scraped clean of insulation and a knot is tied or twisted in the loop. This method holds the wire securely at the tapping point, and the winding may be continued. "Taps" are taken at every tenth turn for fifty turns of wire, then the operation is repeated every two turns for the last ten turns, making in all five taps of ten-turn units

Photo by Keystone

The set held in the boy's hand was made at home. It is about as big as a safety razor box. The skeleton of an old umbrella serves as antenna. Of course such a set has but a very short range.

and five taps of two-turn units, or ten taps for sixty turns of wire.

A neater and better job may be done if the builder is handy with the soldering iron, by soldering short lengths of wire to bared sections of the winding and soldering these to the contact points. This method of tapping the coil will enable the operator to tune in a station down to the shortest double turn.

Any combination may be made by turning either the "tens" or the "unit" turn switches. A thin coat of shellac on the winding will prevent it from loosening.

The panel (See Fig. 27) holds the controls for tuning, the detector and also the terminal connections. The two knob holes are laid out with the contact point holes in a well-balanced layout. The detector is placed below both knobs and the binding posts are conveniently located at the right- and left-hand sides of the panel.

The loops from the taps are either fastened with nuts on the shank of the contact points or soldered directly to them. The "tens" taps are fastened on the left knob switch section, and contact points, beginning with tap No. 1 and Nos. 2, 3, 4 and 5 in sequence, so that a clockwise rotation of the switch will increase the number of turns of wire in use.

The same procedure is followed for the unit turns. The left knob switch is connected with the binding post going to the aerial and the knob to the right is fastened to the detector. To complete the wiring, follow out the wiring diagram given in Fig. 28. Fig. 29 shows the portable receiver mounted in a small box.

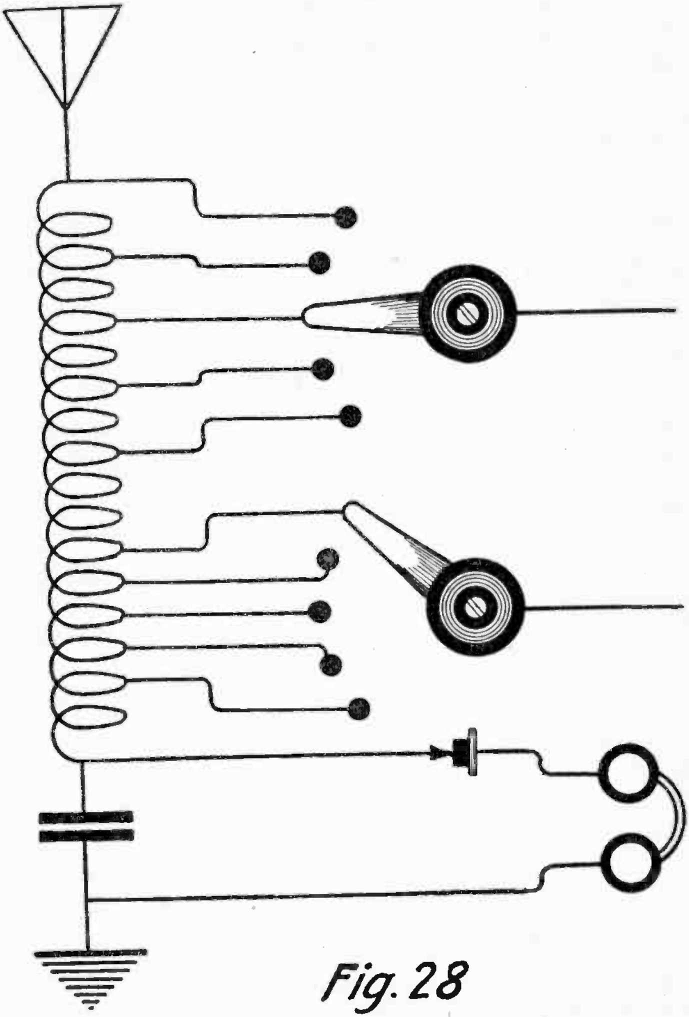


Fig. 28

Connections for the simple crystal receiver.

Simple Detector

A crystal detector may be made or purchased, as the builder wishes. The type described consists of a crystal holder, which is essentially a testing clip which grips the galena crystal and holds it rigidly in position. The "catwhisker," the purpose of which is to search the surface of the crystal for the most sensitive spot, is made of a small length of fine copper or phosphor-bronze wire.

This wire is attached to the end of a rod fitted with a small insulating knob. The catwhisker is controlled by this knob. The rod is passed through the hole of a binding post, and the set screw serves the purpose of locking it in position. This detector is easily made and adjusted.

The condenser may be any type of stopping condenser. The fixed condenser previously described will be entirely suitable.

A single 1000 ohm receiver may be connected to the right hand binding posts. A double set is desirable, of course, although signals may be brought in even with a 75 ohm receiver.

For best results, receivers of high resistance should be used.

After all connections have been made and carefully gone over to guard against breaks in the circuit, it is connected with the antenna and ground system as shown. The telephone receivers are connected to their respective posts and the detector is set.

When signals are heard, first adjust the "ten" knob until they come in with maximum strength. Then the unit knob switch is adjusted until the best response is obtained from the whole receiver.

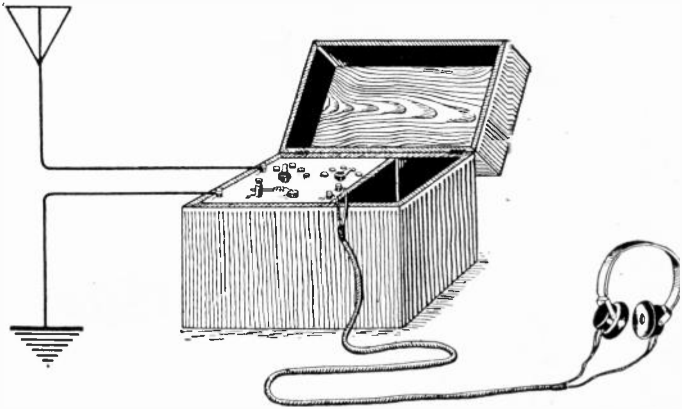


Fig. 29

The crystal receiver mounted in a small cabinet.

The "tens" switch knob is for coarse adjustment and the right knob is used for fine tuning. This will permit closer tuning and louder signals.

With an antenna of from 50 to 100 feet the builder should have no difficulty in receiving broadcast concerts with this little set.

Testing Coils and Condensers

Many times when the experimenter makes a piece of apparatus he desires to make sure that the instrument is well connected. If signals do not come through when it is tested on his receiving circuit, there is something wrong. However, the trouble is not always easy to locate,

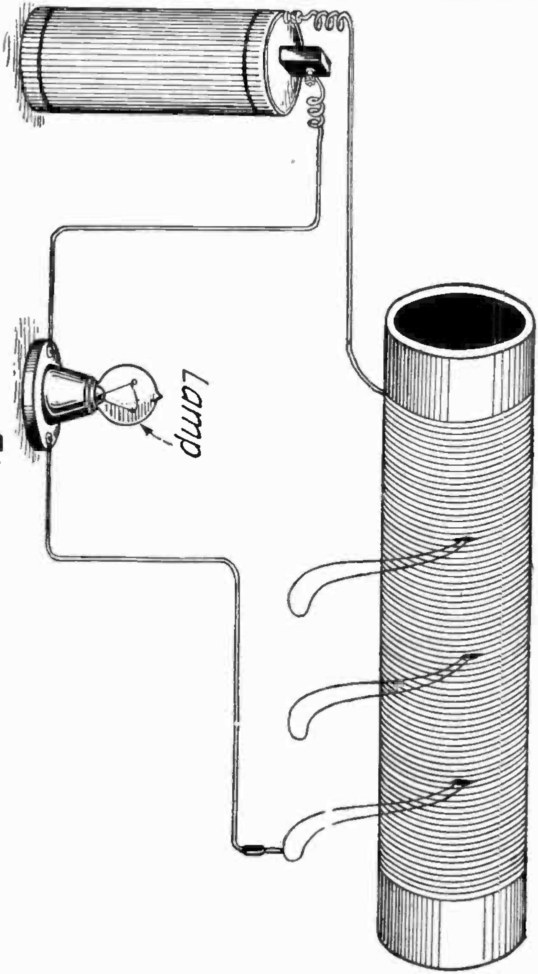


Fig. 30

How to test out a small tapped coil with a miniature lamp and a dry cell.

and it is sometimes the least suspected piece of apparatus that is not functioning.

The windings of coils sometimes cause a great deal of trouble, due perhaps to imperfect contact or a broken circuit, and this difficulty is hard to locate.

Coils and windings can be tested by inserting the winding in an electrical circuit with a battery and a small light. (See Fig. 30.) If the light glows and continues to dim as the slider or switch arm is pushed over, everything is alright, and the builder can go ahead with his hook-up. If the light does not glow, or if it goes on and off when the switches are moved over the contact points something is wrong. It may be that the arms are making imperfect contact and they should be cleaned and tightened, or there may be no contact between the wire and the contact points. Be sure to solder every tap to the contact points, which absolutely assures one of good contact. If the light does not glow at all, there is an open circuit somewhere, and the job might as well be done all over again.

There is an easy way to test the small fixed condenser to see (See Fig. 31) whether it is all right for use in the receiving circuit. The testing apparatus consists of a pair of telephone receivers and a battery. The condenser is connected in series with the telephones and battery. The tip of the telephone is touched to one of the terminals of the condenser. If the condenser is all right there will be a faint click. Should a loud click be heard the condenser is "shorted." That is, one of the plates from one side is touching the plate on the other side and therefore could not hold an electric charge.

A pair of telephones may be given a test for sensitivity by moistening the tips and touching them together. A

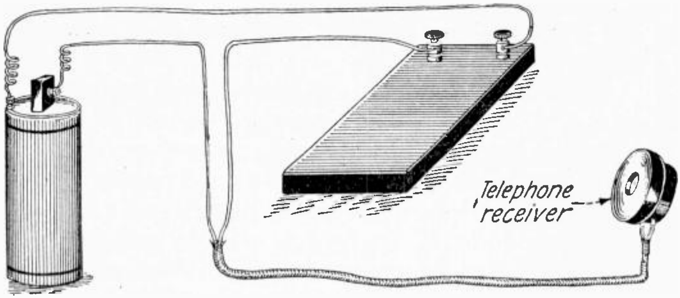


Fig. 31

How to test out a condenser with a dry cell and a telephone receiver.

click will be heard. A loud click if the 'phones are very sensitive. Another test for 'phone sensitivity may be made by placing one tip on the tongue and holding the other about half an inch away. When the tip is brought in contact with the tongue a click will be heard. This indicates that the 'phones are in good operating condition and fairly sensitive.

Making a Grid Leak

One detail of the vacuum tube receiver that is often neglected and little understood, is the grid leak. A set which brings in faint signals can often be improved by careful adjustment of the grid leak.

The grid leak is nothing more than a resistance shunted across the grid condenser. A grid leak may be made by making pencil marks between two binding posts, or by doing this with a carbon ink. It may also consist of a regular graphite or carbon resistance of given value.

Many of the vacuum tube receivers on the market today are provided with grid leaks which are either enclosed with the grid condenser or of the pencil line type. The first is not adjustable but the second can be adjusted with good results. It is the claim of some manufacturers that a standard resistance of one megohm will take care of all ordinary requirements, and they incorporate it with the condenser into a neat unit.

The reader may ask, "Is a grid leak necessary? What is its purpose?" To answer these questions we must first consider the vacuum tube. With each wave train the grid of the vacuum tube has more negative charges piled upon it. There would be no objection to that were it not for the fact that this accumulation of negative charges on the grid opposes the flow of electrons from the filament to the plate, making the tube less efficient.

The charge becomes so great that it leaks off through the walls of the condenser or of the tube itself, and the tube operates normally again. However, the trouble is that the charge does not leak off fast enough, the tube chokes and is rendered almost useless.

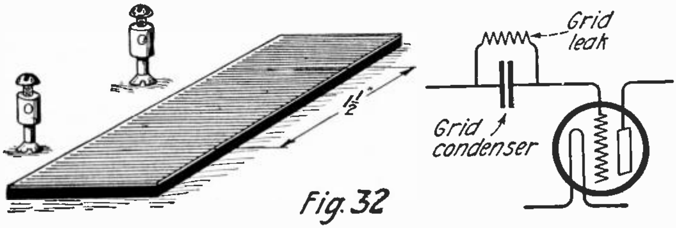


Fig. 32

Construction for a simple grid leak.

The leaking of this extra charge is helped along by the lacing of a high resistance path in the circuit. The charge will then easily leak off and will not be allowed to accumulate and cause inefficient operation. Such a resistance is called a "grid leak." It has an average value of about one megohm.

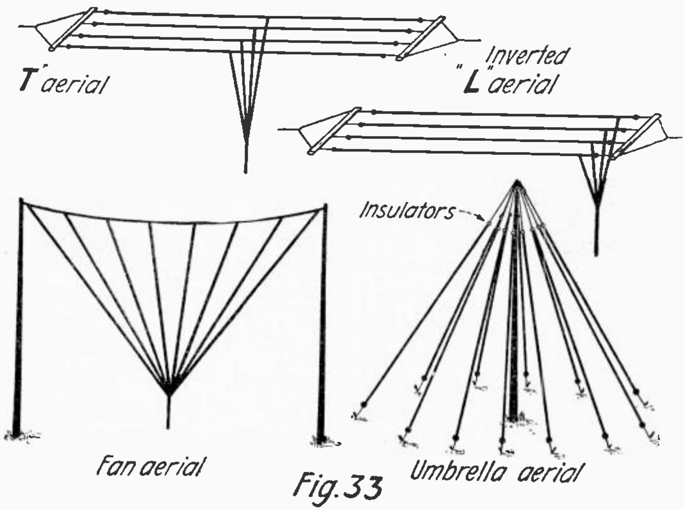
The building of a grid leak is a simple matter. (See Fig. 32.) The necessary materials are: 2 binding posts, a piece of fibre, wood, hard rubber or bakelite. Holes are drilled for the binding posts about 1½ inches apart on the 2 x ¾ in. strip. The binding posts are connected to the terminals of the grid condenser and the grid leak is carefully adjusted as follows: A pencil with soft lead (No. 2 pencil is good) is used to draw the lines which are going to form the high resistance path for the leak. After several lines are drawn the effect upon the signal strength in the 'phones is noticed. More lines may be added or some erased until the proper value is reached. The pencil lines must extend from under one binding post to under the other, otherwise the path is not complete. When trying for the correct value it is better to place a piece of paper between the binding posts, and if the correct number of lines are found they can be redrawn on the fibre.

Proper adjustment of the grid leak and plate voltage will result in increased signal strength. When the tube is changed and a new one used it may be necessary to change the value of the leak. The grid leak value is not critical, it is about one megohm and is shunted across a grid condenser with a value of .0005 mfds. Various resistances can be had with a little experimentation.

Different Types of Aerials

The length of wire which connects the aerial with the receiving apparatus is called the "lead-in" and may be connected at the end or the middle of the aerial. When at the end, the aerial is known as the "L" type and when placed in the middle it is called the "T" type. (See Fig. 33.)

There have been many other types evolved, each with its particular use. The vertical aerial has already been described. This may be converted into a "fan" type by having many wires strung on a horizontal cable and converging at the lower end, where the station is located. This type of aerial is not used much at present, although some



Different types of receiving aerials.

of the amateur long distance work has been done very successfully with them. Another type is known as the "umbrella" and the wires spread from a central pole in all directions. This type has been used a great deal in military portable sets, since it is easily erected and the wires can be made to serve as guy wires as well as conductors.

Calculating the wave-length of an antenna system is an easy matter. For the simple, vertical aerial, the wave-length is roughly four times its total length. For the "L" and "T" types the constant 4.2 is used and the length is taken from the outer end of the antenna to the end of the ground wire. If the length is taken in feet it should be divided by 3 to convert it into meters.

This, of course, is only approximate measurement.

Directional Effect

Receiving aerials may have directional effects. That is, it will be noticed that signals from various transmitting stations will come in stronger from some points of the compass than from others. This is especially true of the "L" type of antenna, which will receive the strongest signals from the direction opposite that toward which the free end is pointing. To get the strongest signals from any given station, the receiving antenna should be so placed that its free end will point opposite to the free end of the transmitter. This fact has been given attention in the installation of the transatlantic high power stations which use directional antenna only.