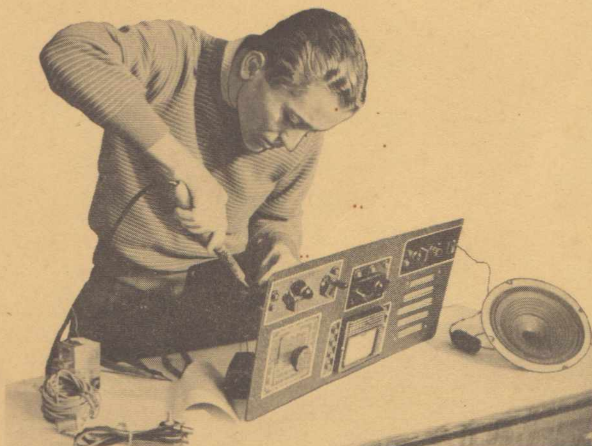
AUSTRALIAN RADIO & TELEVISION COLLEGE PTY. LTD.

PRACTICAL RADIO COURSE



of

HOME PRACTICAL INSTRUCTION

Lesson No. 6

THIS Radio Course of practical home instruction is the result of many years experience, and months of final experimental work by some of Australia's most competent Radio engineers. It is designed so that you acquire a thorough and most comprehensive practical Radio training by building up the kits which are supplied with these lessons. When the course is finished, and all the kits have been built up into the final unit, you will possess a complete professional outfit of Radio testing apparatus, which in itself is not only worth far more than the money you pay for it, but which will also enable you to earn many times its actual value from the Radio work you can perform with it.

CONSTRUCTING A TWO-VALVE RECEIVER, AND WAVE TRAPS.

This lesson will show you how to:—

HOME PRACTICAL INSTRUCTION

LESSON No. 6

Doubtless many of you will have been looking forward eagerly to the time when you would be able to create an actual radio receiver. Although there is a certain satisfaction to be obtained by constructing a multimeter and performing other experiments as we have done recently, this does not by any means match the thrill of hearing radio signals from a receiver we have created with our own hands. This applies especially if the receiver is the first one we have ever built.

I know that for many of you it will be your first attempt at set-building, and consequently I would urge you to read this lesson through very thoroughly before actually commencing construction of the set, so that you will be able to make a thoroughly satisfactory job of it and will not be disappointed by its failure to operate, after you have completed it.

One word of warning. You must not be over-enthusiastic, because after all, this receiver will only contain two valves and as it has to provide enough output to drive a loudspeaker, naturally its sensitivity is somewhat restricted and it will only perform reliably when operated within about 30 or 40 miles distance of a broadcasting station. Alternatively, as described later in the lesson, it is practicable for those living more than about 30 or 40 miles from a broadcasting station to construct an alternative coil which will cover some of the short-wave stations instead of those on the ordinary broadcast band. The range of the receiver when tuned to short-wave stations is much greater than when operating on the lower frequencies between 550 and 1,500 k.c., and it may be quite possible to hear signals from short-wave stations several hundred or even several thousand miles away in a good location with an efficient aerial and earth.

This brings us to another important point, the fact that the receiver will only perform satisfactorily when used with an efficient aerial and earth connection. Many modern radio receivers, operated from power mains and employing a large number of valves, will perform extremely well indeed from a very inefficient aerial and without any earth connection at all. This is possible because of the fact that radio frequency signals from the aerial circuit are able to pass through the aerial coil in the receiver and then back into the power mains through stray condenser effects in the receiver. These signals ultimately find their way to earth through the power mains wiring, and it makes little difference to the performance of a receiver whether an actual earth connection is used with it or not. These conditions definitely do not apply in the case of battery-operated receivers. Because there is no connection to the power mains, it is imperative that a good earth system be employed. The loudness and clearness of signals heard from the receiver will depend on the strength of radio frequency current passing through the primary winding of the tuning coil. This, in turn, is determined by the efficiency of the aerial and earth system in collecting radio energy. The aerial will be efficient if it is as high as possible and as long as possible. However, no matter how efficient the aerial is, no appreciable amount of current will be able to flow through the aerial primary winding unless there is attached to the earth terminal of the receiver a wire which will efficiently conduct the current to the ground itself. This wire, by means of a length of metal piping or a large sheet of metal, must make an efficient connection with moist earth so that the resistance of the earth system will be kept to a minimum and so that it will be possible for radio frequency current to pass freely through the primary coil.

Details of an aerial and earth system are contained further on in the Lesson.

The first thing to do on unpacking your kit of parts is to check the materials supplied against the following Parts List:

1 type 1S5 valve.
1 valve socket.
1 2 megohm ½ watt resistor.
1 .5 megohm ½ watt resistor.
1 .0001 mfd. condenser.
1 .001 mfd. condenser.
1 double gang tuning condenser.
1 large knob.
2 lengths of tubular coil former.
2 metal brackets for mounting coil formers.
1 coil of 34 gauge enamelled copper wire (thin).
1 coil of 28 gauge enamelled copper wire (medium).
1 coil of 19 gauge enamelled copper wire (thick).
1 45 volt B Battery.
6 ⅜″ x 8 BA bolts and nuts.
4 1¼″ x ⅛″ Whit. bolts and nuts.
1 doz. soldering lugs.
1 yd. nylex tubing.

After having unpacked the parts you should carefully examine the valve to see that the glass has not been broken. The valve has been tested thoroughly immediately prior to having been packed in your Kit and definitely left the College in perfect condition. Provided that the glass has not been broken during transport, it is certain to be in good condition when it reaches you. However, you will probably want to satisfy yourself that the filament is intact, and this may be done by using your Ohmmeter with its test leads plugged into the socket marked "Low Ohms". On touching the other ends of the test leads to prongs 1 and 7 on the valve base, these are the prongs with the extra wide spacing between them, you should obtain a reading of approximately 20 ohms. In testing, it is necessary to avoid applying any sideways pressure to the valve prongs, as this may crack the glass base and it would probably be safer to plug the valve into the valve socket supplied before making the test. The multimeter test leads may then be applied to lugs 1 and 7 on the valve socket.

Next, you should carefully examine the two gang tuning condenser. Remove it from its carton and see that the plates rotate freely without the moving plates actually touching the fixed plates at any position.

If you are doubtful as to whether the moving plates do actually touch the fixed plates or not, you may make a simple tester by wiring a flashlight lamp and the 1.5 volt section of the 4½ volt battery in series as explained in experiment 5 of Lesson No. 2. The connections are shown in Figure 7 of that Lesson. The two lengths of wire which act as test leads may be applied one to the frame of the tuning condenser and the other to one of the long connecting lugs protruding from the centre of the end of one section. As the plates are slowly rotated the lamp should not light. If it does so, it shows that a short circuit exists between the two sets of plates of the condenser. Having tested one section you should proceed to test the second section in a similar fashion. Here again, of course, the lamp should not light.

Before making the tests, you should touch the two test leads together for a moment to see that the lamp will glow if a short circuit exists between the test leads.

The only other part which should be tested at this stage is the 45 volt battery. To do this, plug one test lead into the negative terminal of your multimeter and the other one into the socket marked "Plus 50 volts." When the ends of these test leads are applied to the connecting lugs on the battery, you should obtain a reading of at least 42 volts.

TWO-VALVE RECEIVER.

The first unit to be constructed from this kit of parts is a two-valve battery-operated receiver, the circuit of which is shown in Figure 1. Before commencing the actual construction of the receiver, we shall follow the path of signals through it on the circuit diagrams.

Radio waves from broadcasting stations, passing between aerial and earth, have the ability of inducing an alternating voltage in the aerial and earth system so that an alternating current passes to and fro between aerial and earth. In passing through the primary winding of the coil, fluctuating magnetic lines of force are produced around this coil and these spread out through space. The moving magnetic lines of force

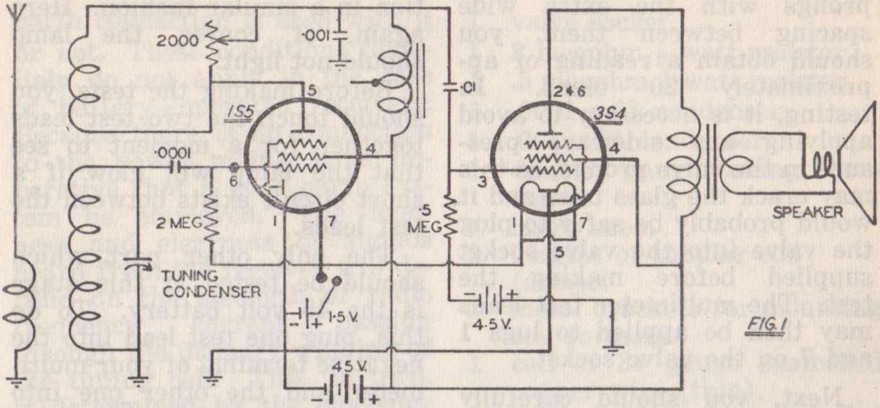


FIG. I

from the primary winding will pass through and induce a voltage in the turns of the secondary coil. A large number of voltages transfer to the secondary coil at any one time, due to the fact that there will probably be signals from many transmitters received by the aerial and earth system. However, with a tuning condenser set to a certain point, there is only one frequency at which the condenser's reactance will equal the reactance of the coil, and at this frequency only will it be possible for large amounts of radio frequency current to circulate in the tuned circuit composed of the secondary winding of the coil and the tuning condenser. The current circulating to and fro in this circuit will generate a voltage which will be applied through the .0001 mfd. condenser to the grid of the 1S5 valve.

The purpose of the 1S5 valve is to act as a detector, that is, it is employed to remove the audio frequency programme from the radio frequency carrier wave and to make the audio frequency signals available for application to the grid of the second valve.

To enable the 1S5 valve to operate as a detector, it is necessary to have a condenser and resistor in its grid circuit. The .0001 mfd. condenser isolates the grid from the tuning circuit, and the 2 meg. resistor completes the grid circuit back to the filament. This causes the valve to operate as a "Grid Leak Detector".*

The 1S5 valve is really two separate sets of elements in the one glass envelope. The valve is known as a diode-pentode because it contains both a diode section and a pentode section. The diode section consists of a small metal plate surrounding the upper portion of the filament. This small rectangular plate measuring about ¼″ by ⅛″ is probably visible through the upper portion of the glass en-

*** See A.R.C. Service Engineering Lesson No. 32.**

velope of your valve. You may notice a very fine white coloured filament wire extending upward at a slight angle through the diode plate. In constructing this particular receiver, we will not be employing the diode section but will do so in later tests.

The pentode section is contained further down in the glass envelope and consists of three grids and a plate surrounding the vertical filament wire at the centre. It is this pentode section which we will use as a detector in the two-valve receiver.

The radio frequency signals are applied to the control grid of the valve, the screen grid is connected to the positive terminal of the B Battery, to assist electrons in travelling across the space from the filament to the plate, the suppressor grid is already connected inside the valve to the filament, and in the plate circuit we will have pulsations of electrons representing both the radio frequency carrier wave and the audio frequency programme.

In a very simple type of receiver it would be possible to dispense with the radio frequency portion of the plate current by means of a condenser such as the .001 mfd. condenser, drawn near the top of the diagram, and to simply pass the audio frequency signals by means of the choke, .01 mfd. condenser and .5 meg. resistor to the grid of the output valve. However, by employing what is known as "Regeneration" we can substantially increase the amount of amplification provided by the first valve and thus improve the performance of the set.*

REGENERATION.

By passing the plate current of the 1S5 through a small coil winding placed near the main tuning coil, the radio frequency variations in the plate current will produce magnetic lines of force around the "Reaction" winding, and these in turn will spread out and generate a radio frequency voltage in the tuning coil. If the reaction coil is connected correctly, the energy fed back into the grid circuit will add to that already provided by the radio signals and will thus increase the strength of voltage available for the grid of the valve. By this means the strength of the voltage can be increased several times and thus the sounds from the loudspeaker made several times louder than they would be if regeneration were not used.

If too much energy is fed from the plate circuit back into the grid circuit, the valve will provide a signal for itself, and will generate a radio frequency voltage. In other words, it will act as an "oscillator" and will generate a radio frequency voltage at the frequency of the tuned grid coil. This is easy enough to understand because it will be realised that the valve amplifies the signals applied to its grid so that much more

* See A.R.C. Service Engineering Lessons 35 and 36.

energy is available in the plate circuit than is necessary to represent a signal for the valve's grid. If sufficient of this energy from the plate circuit is fed back by means of the reaction coil to the grid coil, a valve can quite easily supply a strong enough signal for its own grid to enable the grid to continue to produce changes in plate current which in turn will continue to feed energy back into the grid circuit. Thus, the valve generates a radio frequency voltage of its own accord. When this happens, the valve is said to be "oscillating" and you will find that if you attempt to tune in any broadcasting station you will hear a very loud piercing squeal which changes in pitch as you alter the tuning condenser slightly. The squeal itself is not the voltage generated by the valve but is the result of the oscillating voltage mixing with the signals from the broadcasting station. When two frequencies combine with one another in this way they produce a third frequency equal to the difference between them and it is this third frequency which is audible as a squeal or howl.*

A loud squeal accompanying a radio signal would not be very entertaining or enjoyable and consequently it is necessary to reduce the amount of regeneration until the energy fed back from the plate circuit to the grid circuit is insufficient to cause the valve to oscillate. Under these conditions the amount of energy fed back will strengthen the signals applied to the grid but will not be great enough to cause any annoying squeal and so we will hear the signals clearly. To control the amount of energy fed back into the grid circuit, you will observe that a 2,000 ohms potentiometer is connected in parallel with the reaction coil. When this potentiometer is turned so that it has no resistance it forms a complete short-circuit across the reaction coil, and all the energy in the plate circuit will pass directly from the plate to the .001 condenser and on through the wiring without having passed through the reaction coil. As the value of resistance in the potentiometer is increased, a greater and greater proportion of the plate energy will be forced to pass through the reaction coil and so the amount of reactance will be increased until eventually oscillation will occur. The ideal setting for the reaction control is at a point just before oscillation occurs, that is, just before squeals accompany the programme.

If no whistles are obtained, even with the potentiometer turned fully on, try reversing the connections to the reaction coil by exchanging the coil wire going to lug 5 on the 1S5 valve socket with the one going to the centre tapped transformer.

The audio frequency changes in plate current pass through the reaction coil or 2,000 ohm

* See A.R.C. Service Engineering Lessons 21, 35 and 46.

potentiometer without causing any appreciable effect, and continue to pass on through the choke. In passing through this they produce an audio frequency voltage drop across it which is applied through the .01 mfd. condenser to the grid of the 3S4 valve.

The .01 mfd. condenser is necessary to prevent the positive voltage, from the B battery, which is present at the upper end of the choke, from reaching the grid of the 3S4 valve. As explained earlier, it is necessary to have a negative voltage or "negative grid bias" applied to the grid of a valve and the .01 condenser provides a means of stopping the positive voltage from reaching the grid but at the same time allows the signal voltages to act through it and to be applied to the valve's grid. The 3S4 valve then amplifies these signals and passes them on to the loudspeaker, where they are converted into sounds.

The purpose of the .5 megohm resistor connected to the grid of the 3S4 is to allow a negative voltage from the 4½ volt battery to act through the .5 megohm resistor and to reach the valve's grid. This is the negative bias referred to earlier.

AERIAL AND EARTH CONSTRUCTION.

As pointed out earlier in the Lesson, the loudness of signals produced by this set and the distance from which signals may be received will be determined almost entirely by the effectiveness of the aerial and earth system. Therefore, you should endeavour to make your aerial installation as high as possible and as long as possible.

In Kit No. 1 you were supplied with a coil of aerial wire, 25 ft. long. You were also supplied with a coil of thicker wire with heavy installation, to be used as a lead-in for joining the aerial itself to the receiver. This lead-in wire was 30 ft. long, which will permit the construction of an aerial up to about 20 ft. in height, leaving

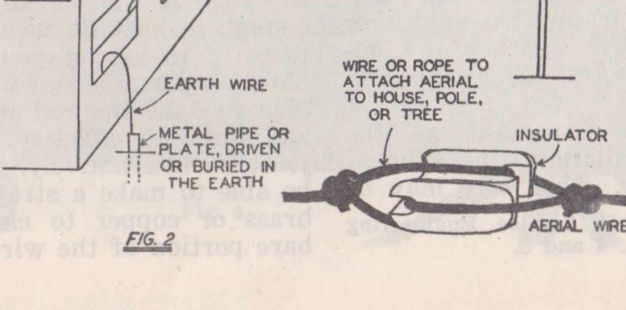


FIG. 2

some for an earth wire. Of course, it may not be possible for you to make your aerial as high as this but you should endeavour to make it as high as possible.

The ends of the aerial will, of course, be attached to an insulator, one at each end, and then short lengths of hook-up wire, lead-in wire, aerial wire or rope, can be used to join these insulators on to two masts, two trees, or portion of your dwelling and a tree or mast. The general arrangement of the aerial system should be as shown in Figure 2.

Details of the method of attaching a lead-in wire to the aerial and also to the insulator are shown in Figure 7 of Practical Lesson No. 1, and it is desirable that you refer back to this to make sure that you connect it in the proper fashion.

In running the lead-in wire from the aerial wire down to the receiver's aerial terminal, it is desirable that you keep it clear of any trees or bushes or portion of the building itself as far as possible. If it is hanging near any of these objects, the wind may blow it backwards and forwards so that the insulation becomes scraped off the wire. You will find then that, when the bare wire touches any other object in wet weather, the signals will vary considerably in strength.*

Just as important as the aerial installation is an efficient earth wire. This wire may be portion of the lead-in wire which may be attached to the receiver's earth terminal at one end and its other end soldered or clamped to a piece of metal piping or metal rod driven down into the earth. This metal pipe or rod should preferably be about six feet long, but if you cannot procure such a long piece you may be able to do with a shorter piece about three or four feet long.

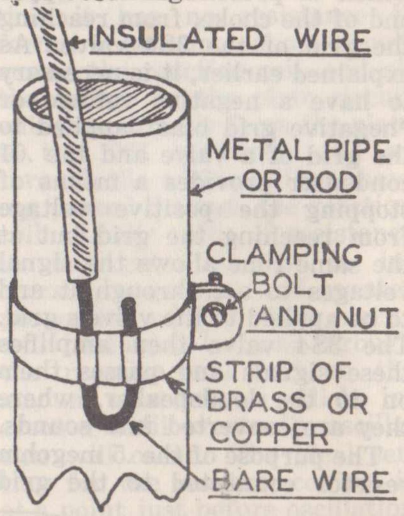


FIG. 3

You may experience some difficulty in soldering the end of the wire to such a heavy rod, as the soldering iron supplied to you is not really large enough to heat up such a large piece of metal. If you have a blow lamp available, you may be able to heat the rod with this and form an effective soldered joint, or alternatively, you may be able to make a strap out of brass or copper to clamp the bare portion of the wire to the

* See A.R.C. Service Engineering Lessons Nos. 4 and 5.

metal rod. Figure 3 shows how this may be done.*

You can proceed with the installation of your aerial and earth system at the same time as you are constructing your receiver so that the aerial and earth will be ready when your receiver is completely built.

* See A.R.C. Service Engineering Lesson No. 4.

ASSEMBLING THE RECEIVER.

You will be able to follow the location of the various parts from Figures 4, 5 and 6. You will observe that the controls and centre tapped choke remain in the same position as in the audio oscillator described in Lesson 5. The valve socket, however, should be moved to the other side of the chassis as shown in Figure 4.

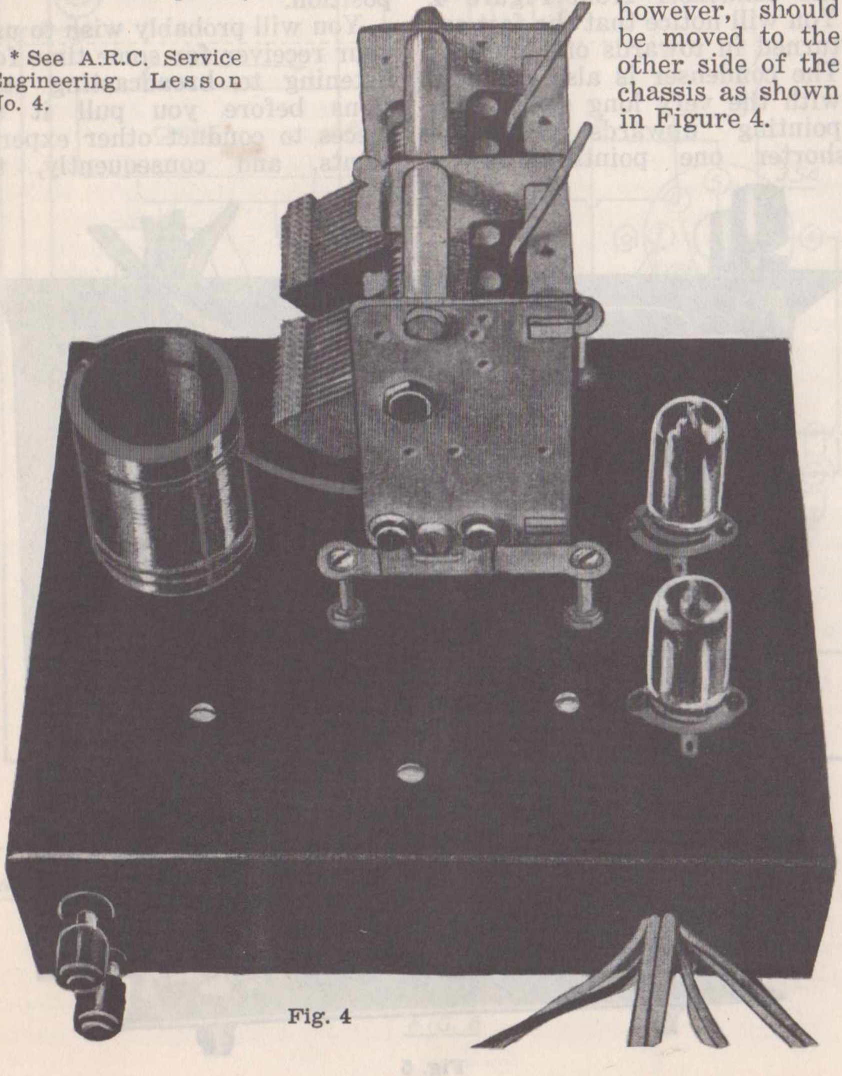


Fig. 4

When you unpack the tuning condenser, you will find that the box also contains two metal mounting feet and four screws for attaching these to the condenser. You will be able to see the way in which these mounting feet are attached to the condenser from Figure 4. You will notice that the feet are turned in towards one another. The condenser is also mounted with the very long solder lugs pointing upwards and the shorter one pointing downwards. After attaching the mounting feet to the ends of the condenser, place the condenser on the chassis and see that the holes in the mounting feet are in line with those on the chassis, but do not actually bolt the condenser directly into position.

You will probably wish to use your receiver for some time for listening to broadcasting stations before you pull it to pieces to conduct other experiments, and consequently, to

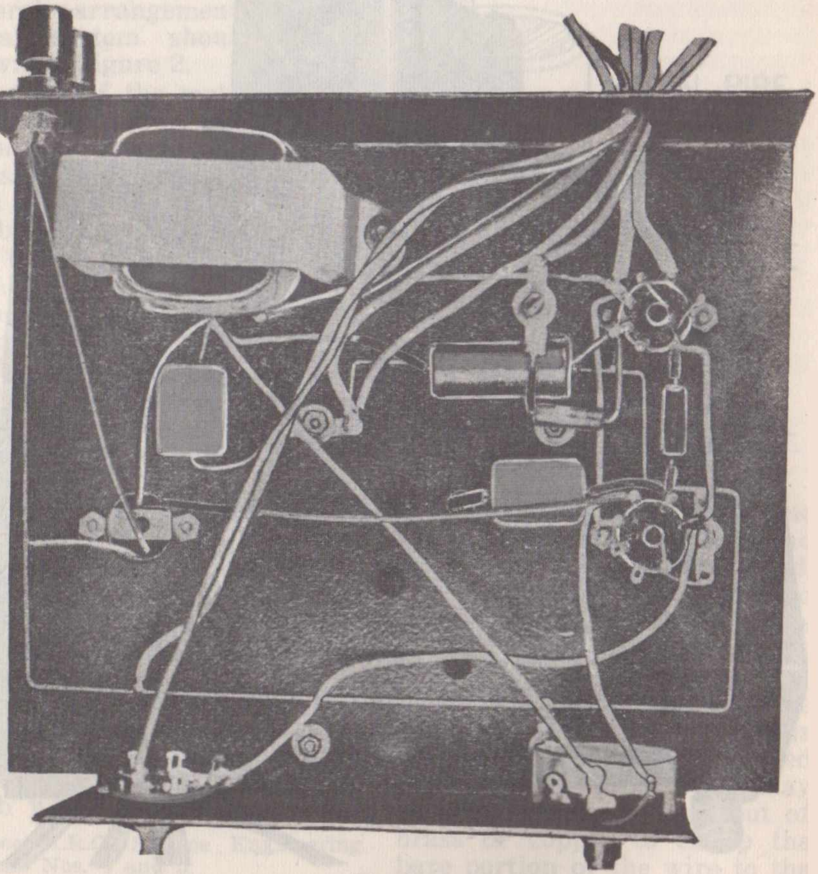


Fig. 5

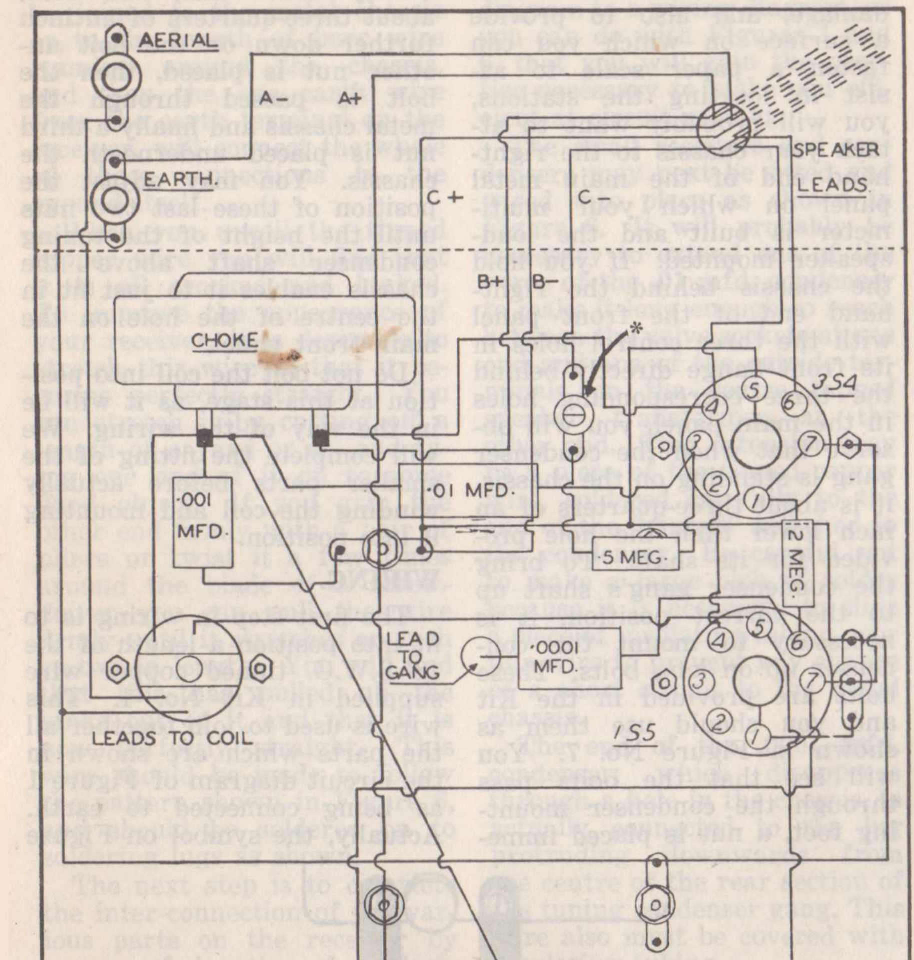


FIG. 6

*INSULATE FROM CHASSIS

protect the receiver from damage, and also to provide a surface on which you can fasten a paper scale to assist in locating the stations, you will probably want to attach your chassis to the right-hand end of the main metal panel on which your multimeter is built and the loudspeaker mounted. If you hold the chassis behind the right-hand end of the front panel with the three control holes in its front flange directly behind the three corresponding holes in the main panel, you will observe that when the condenser gang is standing on the chassis, it is about three-quarters of an inch lower than the hole provided for its shaft. To bring the condenser gang's shaft up to the correct position, it is necessary to mount the condenser up on long bolts. These bolts are provided in the Kit and you should use them as shown in Figure No. 7. You will see that the bolts pass through the condenser mounting foot, a nut is placed immediately under this, and then, about three-quarters of an inch further down on the bolt another nut is placed, then the bolt is passed through the metal chassis and finally a third nut is placed underneath the chassis. You may adjust the position of these last two nuts until the height of the tuning condenser shaft above the chassis enables it to just fit in the centre of the hole on the main front panel.

Do not bolt the coil into position at this stage, as it will be in the way of the wiring. We will complete the fitting of the smaller parts before actually winding the coil and mounting it into position.

WIRING.

The first step in wiring is to fit into position a length of the 18 S.W.G. tinned copper wire supplied in Kit No. 1. This wire is used to join together all the parts which are shown in the circuit diagram of Figure 1 as being connected to earth. Actually, the symbol on Figure

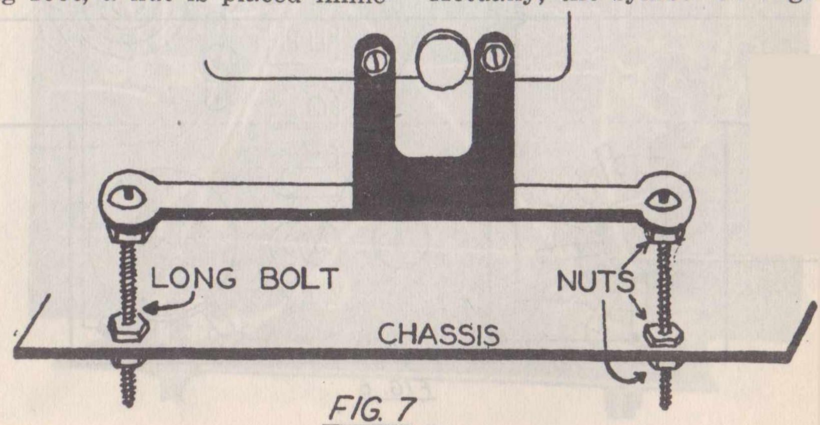


FIG. 7

No. 1 means that they are all to be joined to the metal chassis or to the length of bare wire running around the chassis, and then the one earth wire from the earth terminal on the receiver, will connect the whole of these connections to the ground itself.

When you uncoil the tinned copper wire you will find that it is all crooked and kinked. To improve the appearance of your receiver, it is desirable to stretch this wire so that it becomes perfectly straight. You can stretch it by cutting off a length of a yard or so, and tying one end of it on to some fixed object. If you grip the other end firmly with a pair of pliers or twist it a few times around the blade of a screwdriver you can pull the wire firmly until it stretches an inch or two in length. You will find that this has pulled all the kinks out of it and that it is now perfectly straight. This wire should be made to follow the pattern shown in Figure 6, and should be soldered on to soldering lugs as shown.

The next step is to complete the inter-connection of the various parts on the receiver by means of lengths of hook-up wire, with the exception of the coil and the small resistors and condensers. In carrying out this wiring, you should follow the wiring diagram of Figure 6 but also follow the wiring on the circuit diagram of Figure 1. It is essential for you to become thoroughly proficient at reading circuit diagrams, and it is only by relating a circuit diagram to a wiring diagram, as you can do with Figures 1 and 6, that you will gain the practice necessary to make you efficient at circuit reading.

The small resistors and condensers may next be fitted and wired into place as shown in Figure 6. It will probably be necessary to extend one of the wires of the .01 mfd. condenser to make it long enough to reach between the valve sockets at one end and one of the outside terminals on the centre tapped speaker transformer at the other end. This extension may be a piece of the tinned copper wire, soldered carefully to the end of the "pigtail" attached to the condenser. Be careful not to make a large blob of solder because it is necessary to slide a piece of insulating tubing over this wire to prevent any chance of a short circuit to the metal chassis.

The end of the .0001 mfd. condenser, which disappears through a hole in the chassis, is actually connected to the lug protruding downwards from the centre of the rear section of the tuning condenser gang. This wire also must be covered with insulating tubing.

Near the centre of the tuning condenser, you will see a brass wire "wiper" which presses against the shaft. Solder a length of tinned copper wire to this near the bottom end and solder the other end of the wire to the 18 gauge tinned copper wire running around the underneath side of the chassis.

COIL WINDING.

If you examine the two coil formers supplied, you will see that one has a number of small holes distributed over its whole length. This is the one on which we will wind the broadcast coil. The two large holes near one end are for bolting the former to its mounting bracket. A little further in from the end you will see two small holes side by side. Take the thinnest wire provided (34 gauge) and thread about four or five inches down, from the outside to the inside through one hole, then up through the other, then down through the first hole again. This will secure one end in place. Now wind 15 turns of wire neatly, side by side; cut the wire, leaving 7 or 8 inches for connecting and thread the end down one of the small holes near where the winding ends, up through the neighbouring hole, and down again.

This winding is the aerial primary winding, the point from which you started will later be connected to the bare tinned copper earth wire and the end where you finished will be connected to the aerial terminal on the rear of the chassis.

The best method of winding the coil neatly by hand is to unwind about 8 feet of the wire and, after threading the first end through the former as described above, fasten the other end to some fixed object such as a door handle or nail in the wall. If you stretch the wire taut (be careful not to break it) any kinks will be drawn out of it. Now roll the former around in your hands, rotating it so that the top of the former turns towards you and see that the turns of wire fall neatly side by side. Of course, you will have to walk slowly towards the fixed end of the wire as you wind it. When you have wound the 15 turns, hold the wire in place with one thumb while you cut it and thread the end through the other holes. Be careful that the end does not slip, allowing the coil to unwind or become loose on the former.

The centre winding is the "grid coil" or "tuning coil". Take the middle sized wire (28 gauge) and thread it through, back, and through the next pair of holes, leaving about 3 or 4 inches projecting on the inside. It is necessary to wind 90 turns of this wire; a length of about 36 feet. As you will probably not have sufficient room to stretch out 36 feet of the wire in one straight length, it will probably be necessary to stretch out a shorter length, wind on some turns and then stretch a further length. Of course the wire must be in one continuous length throughout this winding. Do not attempt to join the wire part of the way along the coil. If the wire should break unwind it and start again.

After winding 90 turns neatly side by side the winding will spread over about 1¼ inches and you will find another pair of holes through which the end may be threaded. Pass this wire down through one hole and up through the other so that it protrudes outward from the coil instead of finishing inside the former as the other ends have done. This end only has to reach over to the lug protruding downwards from the centre of the rear section of the tuning condenser, where the .0001 mfd. condenser connects so it need only be about 3 or 4 inches long.

The third winding is the "reaction" coil and is wound near the top of the former, between the remaining pairs of holes. It consists of 45 turns of the thin wire and its ends should finish on the inside and should be 7 or 8 inches long. Be especially careful to wind this in the same direction as the tuning coil. That is, if you look at the top of the former and the top turn of the turning coil is in a clockwise direction then the top turn of the reaction coil should also be in a clockwise direction. It does not matter whether both coils are wound in a clockwise or anti-clockwise direction as long as they are both wound the same way.*

MOUNTING AND WIRING THE COIL.

One of the coil-mounting brackets can be bolted over the large hole near the right-hand end of the chassis by means of two of the 8BA bolts and nuts provided. Leave these bolts and nuts loose for the moment. The coil should be placed gently over the bracket, the ends of the wires passing down each side of the bracket. When the coil is in position so that the large holes in it are in line with the holes in the bracket, it can be fastened to the bracket by means of two $\frac{1}{8}''$ Whitworth bolts, supplied with Kit 5. Nuts will not be needed as the bracket is threaded. Do not make the screws too tight or the former may crack. Now tighten the 8BA screws holding the bracket in place.

Commencing from the bottom of the coil, the lower end of the aerial coil and the lower end of the tuning coil should have the enamel covering carefully removed by means of a small piece of the sandpaper supplied with Kit 1. These ends are then soldered to the 18 SWG tinned copper earth wire under the chassis. The upper end of the aerial coil should be threaded through a 5-inch length of insulating tubing, to prevent it short circuiting to the edge of the hole in the chassis or to the coil bracket, the end cleaned and soldered to the aerial terminal.

The upper end of the tuning coil should be threaded through a piece of tubing, cleaned and soldered to the lug on the tuning condenser to which the .0001 mfd. condenser also connects.

* See A.R.C. Service Engineering Course Lessons No. 35.

The lower end of the reaction coil is passed through tubing, cleaned, and soldered to pin 5 on the 1S5 valve socket. The upper end of this coil is threaded through tubing, cleaned, and soldered to the end of the centre tapped transformer to which the .01 and .001 mfd. condensers connect. The connections to the coil are shown in Figure 8.

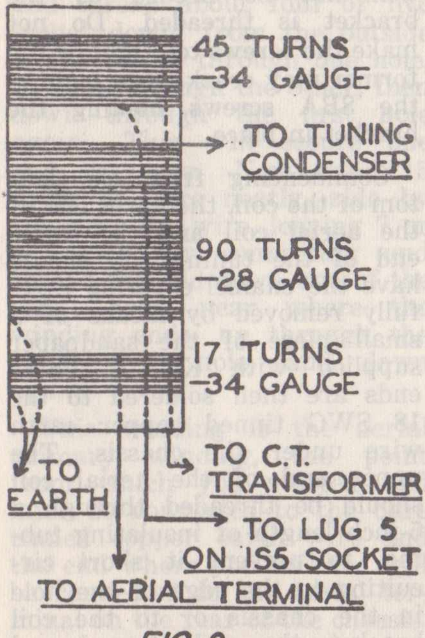


FIG. 8

BATTERY LEADS.

Having now completed the construction of the set itself, it is necessary to make provision for connection to the batteries. You will require three pairs of leads to connect to the three batteries and a fourth pair to join the output valve to the loudspeaker. These pairs of wires can be made by cutting off lengths of hook-up wire about 18 inches long. One wire of each of the three pairs of battery leads will connect to the bare tinned copper earth wire running around the chassis. These wires will be the wire connecting to the negative side of the 1.5 volt A battery, the wire connecting to the negative side of the 45 volt B battery, and the wire connecting to the positive end of the 4½ volt C battery.

The wire for the positive side of the A battery should be cut a little longer than the rest because it has to have one end connected to the On-Off Switch mounted on the front flange of the chassis. The wire for B plus starts from pin No. 4 on the rear socket, that is, the socket to the 3S4 valve and the wire for C-4½ starts from one end of the .5 meg. resistor connected to the grid of the 3S4.

The six wires should be twisted together to form three definite pairs and paper or cardboard labels should be fixed to the ends of the wires so that there will be no chance of confusing them when connecting them to the batteries.

If you do not label these wires carefully, you may find that at some later time, when you are connecting them to the batteries, you may make a mistake and connect the wires for the A battery on to the B battery. In this case, the 45 volts from the B battery would be applied to the filaments of the valves and would burn them out.

A pair of wires for conveying signals to the loudspeaker should be joined one on to pin 4 and the other on to pin 6 of the 3S4 valve socket. Their other ends, of course, will connect to the transformer mounted on the loudspeaker.

CONTINUITY TESTING.

Before actually connecting the battery leads to the batteries, it is desirable to make tests to see that there are no short circuits in the wiring which would ruin the batteries. Turn the switch on the front panel to the "ON" position and plug your test leads into the socket marked "High Ohms" on your multimeter. Before using the multimeter, touch the ends of your test leads together and adjust the needle to zero, at the right-hand end of the meter scale, by means of the zero adjuster. Now separate the ends of the test leads and firstly connect them to the two wires you have labelled for connection to the A battery. The needle should not move away from the zero position on the scale. If it does do so, it shows that there is a short-circuit between the wires and this must be rectified before you connect the wires to the battery. If a reading is obtained, the short-circuit could be caused by a mistake in connecting the wires to the wrong position in the receiver, by your choosing two of the wires which connect to the chassis of the receiver for the A battery instead of one of these wires and one from the switch or defective insulation, allowing the wire itself to touch the metal chassis where it passes through the hole in the back flange of the chassis.

After having tested the A battery wires, repeat the test with the test leads joined to the two wires you intend connecting to the B battery, and again to the two wires you intend connecting to the C battery. In all of these tests there should be no movement of the meter's pointer.

The tests outlined above should, of course, be made without the valves plugged in their sockets but with the loudspeaker connected.

Having satisfied yourself that no short-circuit exists in the wiring, you may now attach these wires to the terminals on the batteries. The wires to the C battery should connect one to the positive terminal and the other to the terminal marked "—4.5".

TESTING VOLTAGES.

Before inserting the valves in their sockets, there are some further tests to make to confirm that the wiring is carried out correctly, and that there is no chance of damaging the valves. These tests are made with one of the test leads inserted in the socket marked "+ 50 volts", and the other inserted in the minus socket of your multimeter.

Touch the negative test lead to pin 1 on the 1S5 valve socket and the positive test lead to pin 7. You should obtain a reading corresponding to 1.5 volts. As this voltage is measured on the 50 volt scale of your instrument, the needle will only move about 1½ graduations away from zero.

Next, touch the negative test lead of your meter to pin 5 on the 3S4 valve socket and the positive test lead in turn to pins 1 and 7. In both positions you should obtain a reading of approximately 1.5 volts.

Touch the positive test lead to the bare earth wire running around the chassis, and touch the negative test lead to the end of the .5 meg. resistor away from the valve socket. The meter needle should move about 4½ graduations across the scale. If by any chance the meter needle moves backwards, to the left of zero, this indicates that you have reversed your connections to the C battery, and you must change them so that the needle moves up the scale. Now touch the negative test lead to pin No. 3 on the 3S4 valve socket. Here the meter needle should move very slightly up the scale but only for a distance of about one-quarter or half of one division. If by any chance the needle moves to the left of zero instead of moving up the scale, this would indicate a faulty .01 mfd. condenser or a strand of wire or an excessive amount of flux joining pin 3 on the 3S4 valve socket either to pin 4 or to pin 2. If the needle does move to the left, firstly examine the valve socket carefully and see that no flux or strand of wire is bridging the socket lugs just mentioned, and if everything appears to be in good order there, disconnect the .01 mfd. condenser from socket lug No. 3. If the needle moves in the correct direction when this condenser is disconnected, this definitely confirms that the condenser is faulty, and a new one must be procured before you attempt to use the receiver.

For the remainder of the tests, the negative test lead from your multimeter may be attached, by means of one of the push-on alligator clips, to the 18 gauge tinned copper earth wire. The positive test lead should be moved from one point to another as outlined below, and should give the following approximate readings. On socket lug No. 4 of the 3S4 valve socket, the meter should indicate the full voltage of the B battery. As this battery has not been used, it should have a voltage of at least 42 volts. On pin 6 of the 3S4 socket, the reading should be about 1 volt less than that at pin 4. As you connect the meter to this point, you should hear a very faint click from the loudspeaker. If no reading is obtained at point 6, this would show that you have forgotten to connect the wires to the loudspeaker transformer.

On lug No. 4 of the 1S5 valve socket you should obtain the same reading as at lug No. 4 on the 3S4 valve socket. At lug No. 5 of the 1S5 valve socket you should obtain a reading about 1 volt less than that at lug No. 4. With the test leads touching pin No. 5 of the 1S5 valve socket, rotate the 2,000 ohm potentiometer on the front panel. As you turn the shaft, the meter pointer should not move. If it moves back about two further divisions on the scale, this would show that there is a break in the reaction winding of the coil.

Having confirmed that all the voltages are correct, you may now insert the valves in their sockets. Take especial care to see that the 1S5 valve only fits into the socket near the front of the chassis and the 3S4 into the rear socket. If you accidentally plug the valves into the wrong sockets it is almost certain that the 1S5 valve would be ruined and it is quite possible that the 3S4 valve also would be spoilt. The aerial and earth wires may now be connected to the terminals on the back of the chassis.

The final test is to touch pin No. 6 on the 1S5 valve socket with your finger. As the filament switch is already turned on, as soon as you place your finger on pin No. 6, you should hear a peculiar squealing or humming sound from the loudspeaker. If there is no sound at all, not even a click, there is a fault in the set, and you must carefully check over the wiring and, if necessary, repeat the tests outlined above with the voltmeter, to determine where the fault exists. If you do hear a squealing or humming sound when you touch pin No. 6, this shows that everything is in order and that there is every probability of the receiver picking up signals from a broadcasting station.

TUNING.

Turn the potentiometer on the front panel, about two-thirds of the way in a clockwise direction. Slowly rotate the tuning condenser, listening carefully at the loudspeaker for any sound from broadcasting stations or for any whistle. If you hear a shrill whistle which changes in pitch as the tuning condenser is moved slightly, set the condenser to a point where the whistle is loudest and deepest in pitch. Turn the potentiometer in an anti-clockwise direction until the whistle just ceases. As soon as the whistle ceases you should hear a programme from the broadcasting stations clearly. The potentiometer is used as a volume control, and if the signals are unpleasantly loud you can reduce them in loudness by turning the control further in an anti-clockwise direction. The loudest signals will be obtained when this control is set into a position just before the whistle starts.

If you live within about thirty or forty miles of a broadcasting station, you should receive the signals quite clearly. If, however, you live further away you may experience some whistles as you slowly turn the tuning condenser, but on turning the potentiometer shaft until these whistles just cease, the speech or music may be so soft that you can hardly hear it or you may not even hear it at all. In this case, the receiver is probably working quite well, but because of the fact that it employs only two valves, its range is restricted, and as the radio signals are so weak it will not operate correctly until we have added an extra valve to it, as explained in a later Lesson.

Another method of obtaining reception in remote locations is to replace the tuning coil with another one containing fewer turns so that short-wave stations can be received. The range of the receiver when tuned to short-wave stations will be much greater than when tuned to the ordinary broadcasting stations. The method of winding a short-wave tuning coil is explained a little further on in the Lesson.

If the receiver will pick up signals from a broadcasting station, you must not expect them to be as loud as those received by radio sets operating from the power mains. This receiver you have just constructed employs only a 45 volt battery to operate it, and only two valves, and consequently with these limitations it cannot produce very loud signals. The signals from nearby stations should be almost as loud as those provided by any other battery-operated set but, of course, no battery-operated sets will produce signals as loud as those produced by sets working from power mains.

OPERATING THE 1S5 as a TRIODE.

Once your receiver is operating correctly, it is interesting to try the effect of operating the 1S5 valve as a triode. This will confirm that triode valves are not capable of producing as much amplification as are pentode valves. As the receiver was originally constructed, the 1S5 was employed as a pentode, but you can easily alter the connection to make it work as a triode by disconnecting the wire from socket lug No. 4, and instead joining Lugs 4 and 5 together. When you do this, you will find that the receiver will still function but the signals will not be quite as loud. You should then restore all the connections as they were originally.

When operating the receiver from the small 1.5 volt battery as an "A" battery, the current drain imposed by the valves on this battery is rather heavy, and the battery would only last for about eight hours of operation before becoming completely discharged and useless. If it is your intention to make use of this receiver for listening to broadcasts for long periods of time, it would be desirable for you to purchase locally, or have supplied to you, a much larger size of 1.5 volt battery. The larger battery must, of course, have a voltage of 1.5, otherwise it will damage the valves, but the larger the battery is physically the longer it will last before becoming discharged. One type of battery which is quite suitable is the large round type of cell measuring about 6 inches high and about 2½ inches in diameter. This type of cell should last for about 400 hours of operation.

Although the B battery supplied has a voltage of only 45 volts, it is possible to operate the valves with up to 67.5 volts supplied to their plates and screen grids. If, however, a 67½ volt battery is used in place of the 45 volt battery, it is most important that the C battery be changed for one which will provide 7½ volts bias. This increase in bias may be obtained by connecting another 3 volts battery in series with the 4½ volt battery, or by using a 7½ or 9 volt battery in place of the 4½ volt battery. Under no circumstances should you apply 67½ volts to the receiver unless you increase the bias to 7.5 volts.

SHORT WAVE COIL.

As mentioned earlier, the range of the receiver, when operated with the coil you have already constructed, will vary, depending upon the efficiency of the aerial and earth installation and also to a large degree on the nature of the country surrounding the receiver. On the ordinary broadcast band of frequencies one can expect a range of about 30 to 40 miles, but, if you do not live within about 30 or 40 miles of a broadcasting station, then it will be desirable to construct a short wave coil, which will permit reception from stations at a much greater distance, due to the higher carrier frequencies involved.

A short wave coil is very similar to the coil you have already constructed with the exception that the numbers of turns on the windings and the spacing apart of the windings is different.

A suitable coil which will permit tuning from approximately 30 meters, which is equivalent to 10 megacycles to approximately 90 meters, which is equivalent to 3.3 megacycles, is illustrated in Figure 9.

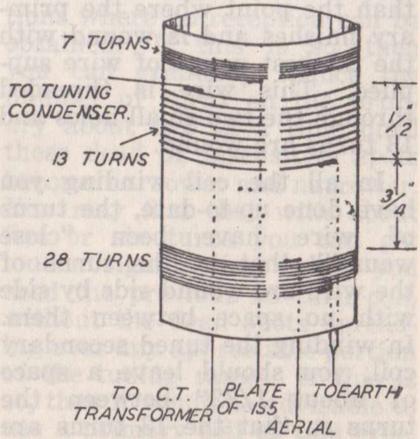


Fig. 9

On the second coil-former supplied to you, you will find a number of holes in slightly different positions from those on the former you have already used.

Again, at one end you will find two fairly large holes for attaching the coil-former to the bracket which mounts it on the chassis and near these, two small holes close together at which you can start the aerial primary winding. This coil is wound with the thinnest gauge of wire supplied in the kit, that is, No. 34 gauge. The method of winding is similar to that for the earlier coil you constructed and the primary winding consists of 28 turns of wire wound closely side by side. After you have finished winding the 28 turns you will find that there is a pair of small holes provided, through which you can thread the wire to secure the end.

The secondary coil commences ¾″ further along the former than the point where the primary finishes and is wound with the thickest gauge of wire supplied. This wire is threaded through the two small holes and 13 turns are wound.

In all the coil winding you have done up-to-date, the turns of wire have been "close wound", that is, the turns of the wire are wound side by side with no space between them. In winding the tuned secondary coil, you should leave a space of about 1/32″ between the turns so that the 13 turns are spread out over a length of ½″ and so that the last turn finishes level with the small holes which are provided ½″ away from where the coil started. If you unwind about 6′ of this wire and attach one end of it to some firm object, as described earlier, pass the other end through the two small holes at the points at which the winding commences and then, keeping the length of wire taut and straight, rotate the former slowly in your hand, you will be able to wind the turns parallel with one another, leaving a small space between the adjacent turns and you will not experience any great difficulty in spreading the 13 turns over the ½″ length. It is necessary to keep the wire fairly tight when winding, otherwise, when you finish off, the turns will be loose and will move together or away from one another, so that the spacing is not regular and even. If you experience any difficulty in winding the turns tightly enough, so that they remain evenly spaced apart on the former, then you may move them into their correct positions and cement them in place with a few small drops of glue, liquid cement, melted wax or other such substance. However, to keep losses to a minimum, it is desirable to use only a very small amount of any of these substances and, rather than paint the whole winding with glue or some cement, it is preferable to apply only small spots of it here and there, if it is necessary to use it at all.

After completing the secondary winding, there should be a space of ⅛″ before the third coil, known as the reaction coil, is wound. This coil consists of 7 turns of the thinnest wire and will finish a little over ⅛″ from the other end of the former.

The method of connecting the coil to the receiver is exactly the same as that for the broadcast coil you have used. On substituting this coil for the other coil you will find that the receiver becomes capable of tuning in short wave stations and you will doubtless be able to receive signals from stations great distances away.

AERIAL COUPLING.

Once you have the receiver working satisfactorily with the short wave coil, you can undertake quite a number of experiments with various types of aerial primary coils to obtain the best possible results from the particular aerial and earth installation you are using. The use of a primary coil of 28 turns spaced ¾″ away from the secondary will give good results with most aerial and earth systems without the receiver failing to oscillate when the 2,000 ohm potentiometer is turned fully on. The closer the aerial primary coil is moved towards the secondary coil, the louder the signals will become, but if the primary is moved too close to the secondary, you will find that at certain positions of the main tuning condenser, the receiver will not break into oscillation when the 2,000 ohm potentiometer is turned fully on and consequently there will be weak or "dead" spots across the tuning range.

To enable you to experiment with other aerial primary windings, you will find two additional sets of small holes placed between the position occupied by the primary winding you have already wound and the 13 turn secondary winding. You can use a further link of the thin wire to wind up primary coils of varying numbers of turns between these sets of holes. The closest set of holes is only ⅛″ away from the secondary, and I suggest that you commence with 15 turns of wire placed between these holes. This will probably be too many and you will possibly find that although you can obtain good reception at certain points on the tuning condenser there are other positions where no reception can be obtained. If this is so, then you can gradually reduce the number of turns on the primary about two at a time until these dead or insensitive spots become narrower and narrower. You may find that with about five or six turns you can get louder signals than when you used the previous 28 turn coil, without the dead spots spreading over any appreciable portion of the tuning range. If this is so, then it would be advisable to use a primary coil of this type, because it suits your aerial and earth system better than the 28 turn coil. Of course, in experimenting with this alternative primary winding, you should disconnect the two ends of the 28 turn coil from the aerial terminal and from the 18 gauge tinned copper earth wire and connect the two ends of the newly wound primary in their places. The end of the primary nearest the secondary winding should be connected to the 18 gauge earth wire and the end remote from the secondary should be connected to the aerial terminal.

Whilst you are experimenting with the number of turns on this new primary winding, you will probably find it much easier to hold the aerial end of the primary in place with a piece of adhesive paper, sticking plaster, a drop of molten wax or similar means, instead of threading the wire laboriously through the small holes in the former every time, then passing it down through the hole in the chassis and soldering it to the aerial terminal. If you temporarily hold the last turn of the wire in place you can scrape the enamel from the end of the wire and twist or solder it to the lead-in wire from your aerial without resorting to the use of the aerial terminal until you have determined the best number of turns. Once you have arrived at the best number of turns, then you can solder the wire in the normal fashion to the aerial terminal.

TUNING TO OTHER FREQUENCIES.

By using a secondary winding of 13 turns, the tuning will cover from approximately 30 meters to 90 meters, as previously explained.

If you wish to experiment with secondary windings containing other numbers of turns, you will be able to extend the tuning range to either higher or lower frequencies.* By winding more than 13 turns on the secondary, you will be able to tune to lower frequencies or longer wave lengths, but if you wind more than about 20 turns on the secondary you will find it necessary also to increase the number of turns on the reaction coil, otherwise the receiver will not oscillate and will not be sensitive when the 2,000 ohm potentiometer is turned fully on.

Similarly, if you are experimenting with fewer than 13 turns in an endeavour to tune to shorter wave lengths than 30 meters or higher frequencies than 10 megacycles, then you will also need to reduce the number of primary turns and the number of reaction turns approximately in proportion. The number of turns on the reaction coil should normally be about half the number of turns on the tuned secondary coil for best results.

* See A.R.C. Service Engineering Course Lessons 15 and 17.

WAVE TRAPS.

The purpose of a wave trap is to absorb some of the energy produced by an extremely powerful nearby station, which, under certain circumstances, may cause interference with the reception of other stations. For example, if you happen to live within about two or three miles from a powerful broadcasting station, you will probably find that its signals spread over a considerable distance on the tuning dial and its programme is heard at the same time as the programme from other stations which you may wish to receive.

Probably the most effective cure for this form of trouble is to purchase a more efficient type of receiver, in which the tuning circuits are sufficiently selective to reject the powerful interfering signals and permit the reception of weaker signals from more distant stations on nearby frequencies. Another remedy, which is often very effective, is to construct a simple wave trap which will absorb a considerable amount of energy from the carrier wave of the powerful, interfering station without seriously weakening the strength of signals from other stations. As you will learn further on, there are several different wave trap circuit arrangements which can be employed, but all of them operate on the same fundamental principle of absorbing or reducing the signal energy from the powerful interfering station to which they are tuned and leaving the signals from other stations relatively unaffected.*

If you have a radio receiver at your disposal, apart from the one you have just constructed out of the kit of parts supplied to you, it is an excellent plan for you to carry out the following experiments, so as to learn as much as possible about the behaviour of wave traps, whether your receiver suffers from interference by powerful signals or not. Even if you do not experience any interference with the reception of weak signals, it is worth while conducting the experiments, because at some time in the future you may be confronted with this problem, either in your own receiver or some other receiver which you are called upon to repair or adjust.

Of course, if you have no receiver, apart from the one you have just built from your kit of parts, it will not be possible to carry out experiments with the wave traps at this stage, for the reason that it is necessary to use the tuning coil and the condenser supplied to you to construct the wave traps and if you use these for constructing the wave traps, then you will not be able to have the wave trap operative and your receiver functioning at the same time. Therefore, if you do not have another receiver available, on which you can test the wave traps, it is sug-

* See A.R.C. Service Engineering Course Lesson 42.

gested that you leave these experiments with wave traps until some later stage when you do have a receiver available.

TYPES OF WAVE TRAPS.

The type of wave trap which proves most efficient in weakening the signals from an unwanted broadcasting station carrier wave will depend upon the type of coil used in the particular receiver with which it is to be employed and also to some degree on the impedance of the aerial and earth system from which the receiver operates.

Many radio receivers designed for the reception of broadcasting stations employ an aerial coil with a primary winding consisting of only a small number of turns. One often finds about 10 to 25 turns employed as the primary winding. This type of primary winding is known as a "low impedance" primary and usually operates most effectively in conjunction with a wave trap when the wave trap is a type known as a "rejector circuit".

On the other hand, some radio receivers are equipped with aerial coils in which the primary winding consists of a very lage number of turns, usually several hundred, wound in a bobbin or "pie" and spaced ¼" or more from the secondary. These primary windings are known as "high impedance" primaries and usually operate best in conjunction with a wave trap known as an "acceptor circuit". However, four types of wave traps are described in the following pages and it is suggested that you construct each type and observe the effectiveness of each.

For our first wave trap we will employ the tuning coil we constructed to enable our receiver to tune to broadcast stations, together with one section of our tuning condenser. As only the tuning condenser and coil are involved, it does not matter whether you have both the coil and tuning condenser mounted on the chassis or whether you remove the coil and tuning condenser from the chassis and use these two parts on their own. If you already have the short wave tuning coil mounted on the chassis and intend to continue using the set as a short wave receiver after completing your wave trap experiments, it will probably be better at this stage to remove the tuning condenser from the chassis and employ it together with the broadcast coil, on their own, for making up the wave trap. On the other hand, if the broadcast coil is already mounted in place on the chassis, then it will be easier to leave it there and to perform the wave trap experiments with both the coil and tuning condenser mounted on the chassis. If you intend using the coil and tuning condenser alone, then the coil can be attached by means of one of the mounting brackets, to any one of the spare holes appearing in the back plate of the tuning condenser.

The connections for our first wave trap are shown in Figure No. 10. The main tuning coil consisting of 90 turns of 28 s.w.g. wire is connected to the

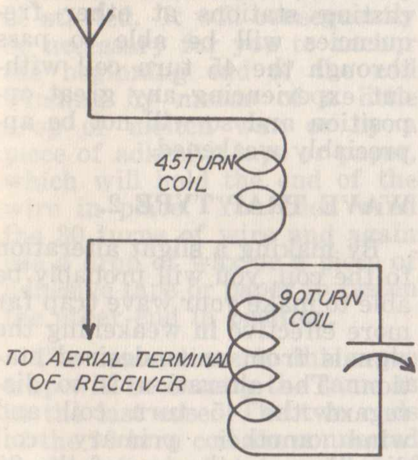


Fig. 10

rotor and stator plates of one section of the tuning condenser. No other connection is made to the tuning condenser or to the 90 turn winding of the coil.

The aerial is connected to one end of the 45 turn coil which was previously the reaction coil when used with the receiver. The other end of the 45 turn coil should be connected to a wire long enough to reach to the aerial terminal of an ordinary radio receiver. The original aerial primary winding of 15 turns is not required in this experiment, but need not be removed from the former.

Tune the radio receiver to some broadcasting station operating on the frequency band between 550 and 1,500 kilocycles. Notice carefully the loudness of the signals, then slowly rotate the shaft of the tuning condenser connected to the wave trap. As you gradually rotate this shaft you will find one setting of the tuning condenser where the signals from the broadcasting station are reduced considerably in strength. If you leave the tuning condenser at this particular setting, it will reduce the strength of signals from that particular station, but will not appreciably affect the strength of signals from any other stations. If the station's frequency to which you have tuned the trap is one which has been previously causing interference with the reception of other stations on your receiver, then the inclusion of the wave trap should reduce the amount of interference. The amount by which the loudness of the signals decreases, when the trap is tuned to resonance, will depend, as previously explained, on the type of aerial coil fitted in the receiver and on the aerial and earth systems. It will also depend on whether the receiver you are employing is equipped with an automatic volume control system or not. If the set has an A.V.C. system, then the reduction in loudness will not be very noticeable, but the reduction of interference with stations on nearby carrier frequencies will be effective.

When you first connect the aerial to the reaction winding on the wave trap coil, it should be connected to the end furthest away from the 90 turn coil. The end of the 45 turn coil nearest to the 90 turn coil should connect to the receiver's aerial terminal. After trying the wave trap with these connections, quickly reverse the connections to the ends of the 45 turn winding, so that the aerial is connected to the end nearest to the 90 turn coil and the receiver's aerial terminal is connected to the end furthest from the 90 turn coil. Notice carefully whether the performance of the wave trap is more effective in reducing signals from stations with this method of connection.

The principle of operation of this type of wave trap is that, when the 90 turn coil is tuned to resonance by the tuning condenser, current produced by signals from the station you are attempting to weaken will circulate readily in the tuned circuit consisting of the 90 turn coil and the tuning condenser. As the current flows to and fro around this circuit, it produces magnetic lines of force which spread out from the 90 turn coil and develop a voltage in the 45 turn coil. This voltage will act in such a manner that it will oppose the flow of current from the aerial through the 45 turn coil to the aerial terminal of the receiver and so will weaken the strength of the signal current reaching the receiver. This current can only flow in the circuit consisting of the 90 turn coil and tuning condenser at the frequency at which the circuit is resonant. This current will only develop a high voltage in the 45 turn coil at that one particular frequency and consequently this voltage will oppose and weaken the signals at this frequency only. Current produced by signals from broadcasting stations at other frequencies will be able to pass through the 45 turn coil without experiencing any great opposition and so will not be appreciably weakened.

WAVE TRAP TYPE 2.

By making a slight alteration to the coil, you will probably be able to make your wave trap far more effective in weakening the signals from an undesired station. The alteration is to disregard the 45 turn coil and wind another primary coil directly over the top of the 90 turn winding as shown in Fig.

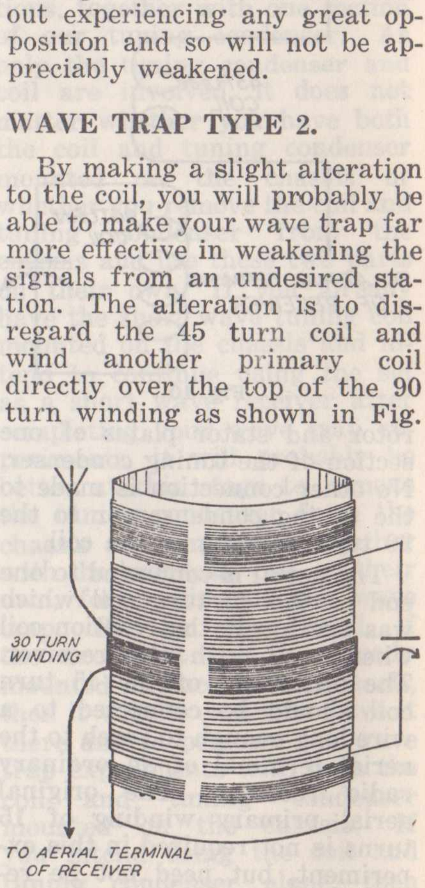


Fig. 11

11. This primary coil should consist of 30 turns of the fine,

34 s.w.g. wire wound side by side exactly over the centre of the 90 turn coil. Because the coil is wound over the centre of the 90 turn coil, it will not be possible to provide any small holes in the coil-former through which the ends of the wire may be started. It will consequently be necessary for you to anchor the beginning end of the coil winding by means of a little drop of molten wax or by a piece of adhesive tape or paper, which will hold the end of the wire in place. You then wind the 30 turns of wire and again use a drop of wax or a piece of adhesive tape or paper to fasten the other end in position.

The connections to this wave trap will be exactly the same as in the last case. The two ends of the 90 turn coil are connected to the rotor and stator plates of the tuning condenser section, the end of the 30 turn coil nearest to the reaction coil is connected to the aerial, the end of the 30 turn coil nearest to the aerial primary winding is connected to the receiver's aerial terminal. As in the last case, it is a good idea to experiment by reversing the connections to the ends of the 30 turn coil to determine which method of connection proves most effective.

The performance of the wave trap will be similar to the trap described previously. When the receiver is tuned to a broadcasting station, if you slowly rotate the tuning condenser of the wave trap, you will find one setting at which the signals are weakened and you should notice carefully whether this second type of wave trap is effective in making a greater reduction in signal strength than the first one. You will probably find that it is more effective.

This second type of wave trap will probably prove effective regardless of whether it is used with a receiver employing a low impedance or a high impedance aerial primary winding.

WAVE TRAP TYPE 3.

Our next experiment consists of using the same coil, that is, with the 30 turns wound over the centre of the 90 turn coil, the only alteration being to connect a wire from the metal frame of the tuning condenser to the earth terminal of the radio receiver with which the wave trap is being used. If the receiver is equipped with a high impedance aerial coil, then the addition of this earth lead will probably make the trap more effective. As before, connections to the end of the 30 turn coil should be tried firstly in one direction and then reversed and tried in the other direction.

The three wave traps described so far have all been known as "rejector circuits" because the action in each case has been that current, circulating in the tuned circuit, has developed a voltage in the primary winding which has opposed the passage of current from the aerial to the receiver and consequently tends to reject signals at the resonant frequency of the wave traps.

WAVE TRAP TYPE 4.

Our next experiment consists of a wave trap which employs an "acceptor circuit". In this wave trap the 90 turn winding on the coil only is used in conjunction with one section of the tuning condenser. The single coil winding and tuning condenser are connected in series with one another as shown in Figure 12, one end of the coil

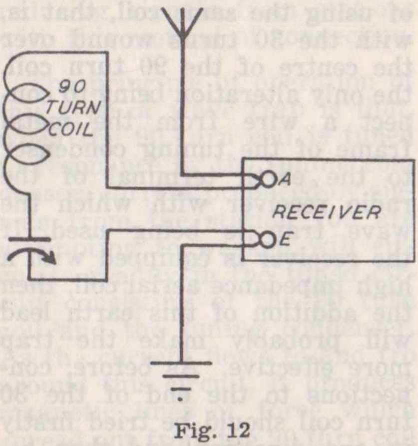


Fig. 12

being connected to the receiver's aerial terminal and the other end of the condenser to the receiver's earth terminal. The aerial itself is, of course, also connected to the receiver's aerial terminal.

This type of wave trap is especially effective with receivers in which the aerial coil has a high impedance primary winding. Its action is that, when the receiver is tuned to a certain station and the wave trap condenser is also rotated to tune the 90 turn coil to resonance at the same frequency, the reactance of the 90 turn coil will be exactly neutralised by the reactance of the tuning condenser in the wave trap, so that there remains no reactance to oppose the passage of signal current from the aerial directly through to earth.- The only opposition remaining in the 90 turn coil and tuning condenser is the small amount of resistance present in the coil winding, and this is so low that practically all the signal energy at the resonant frequency will pass through the 90 turn coil and condenser to earth instead of flowing through the aerial coil in the receiver. In this way, the wave trap circuit accepts the signal and the receiver is deprived of most of the signal current.

At other signal frequencies, the reactance of the 90 turn coil and that of the wave trap tuning condenser will not neutralise one another, so there will remain a considerable amount of reactance in the wave trap circuit which will prevent a large proportion of the current passing through the wave trap to earth and consequently, instead, this current will pass through the receiver's aerial coil in the normal fashion and signals from other stations will not be appreciably weakened.

As mentioned earlier, these experiments with wave traps should be executed thoroughly and the results noted carefully, if you have another receiver with which the wave trap may be tested. Although you may not wish to use the wave trap yourself, you will learn quite a lot about the performance of tuned circuits from these experiments and, at the same time, you will then know how to construct an effective wave trap if you need to do so at some time in the future to prevent interference in your own receiver or in some other receiver you are called upon to repair.

The wave trap experiments we have performed so far have all employed the 90 turn coil for tuning purposes, so that the wave trap can be made effective at any frequency within the broadcast band; that is, at any frequency between 550 and 1,500 kilocycles.

If, by any chance, you experience interference in a short wave receiver, due to extremely powerful signals from some nearby short wave transmitting station, then you can construct an effective wave trap using one of the four methods outlined above, but employing fewer turns than 90 for the tuning coil. The exact number of turns on the tuning coil will depend on the frequency at which you wish the wave trap to be effective. The number of turns on the primary winding for use with wave trap type 2 or 3 should be about one quarter of the number of turns on the tuning coil.

REFERENCE, KITS 6, 7 & 9.

NOTE:

Coil winding wires are required for use with Kits 6, 7 and 9. To avoid three separate winding processes,we supply with Kit No.6 all the wire necessary for the three kits. Although it is necessary to use this wire economically, ample is supplied for all three kits.

On the parts lists in Kit instruction booklets 6, 7 and 9, the wires are identified by gauge number and comparative diameter, i.e. No. 34 (thin), No. 28 (medium) and No. 26 (thich).

In Booklet No. 6 parts list a coil of No. 19 wire is shown for which No. 26 has now been substituted. All references in this and other booklets to No. 19 wire should be changed to No. 26.

should be executed thoroughly and the results noted carefully. If you have another receiver with which the wave trap may be tested. Although you may not wish to use the wave trap yourself, you will learn quite a lot about the performance of tuned circuits from these experiments and, at the same time, you will then know how to construct an effective wave trap if you need to do so at some time in the future to prevent interference in your own receiver or in some other receiver you are called upon to repair.

The wave trap experiments we have performed so far have all employed the 30 turn coil for tuning purposes, so that the wave trap can be made effective at any frequency within the broadcast band; that is, at any frequency between 550 and 1,500 kilocycles.

If, by any chance you experience interference in a short wave receiver due to extremely powerful signals from some nearby short wave transmitting station, then you can construct an effective wave trap using one of the four methods outlined above, but employing fewer turns than 30 on the tuning coil. The exact number of turns on the tuning coil will depend on the frequency at which you wish the wave trap to be effective. The number of turns on the primary winding for use with wave trap type 3 or 8 should be about one quarter of the number of turns on the tuning coil.

KITS 6, 7 & 9. REFERENCE,

NOTE

Coil winding wires are required for use with Kits 6, 7 and 9. To avoid three separate winding processes, we supply with Kit No.6 all the wire necessary for the three kits. Although it is necessary to use this wire economically, ample is supplied for all three kits.

On the parts lists in Kit instruction booklets 6, 7 and 9, the wires are identified by gauge number and comparative diameter, i.e. No. 34 (thin), No. 28 (medium) and No. 26 (thick).

In Booklet No. 6 parts list a coil of No. 19 wire is shown for which No. 26 has now been substituted. All references in this and other booklets to No. 19 wire should be changed to No. 26.

Lesson No. 6

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