INSTRUCTIONS FOR PERFORMING RADIO EXPERIMENTS 61 TO 70

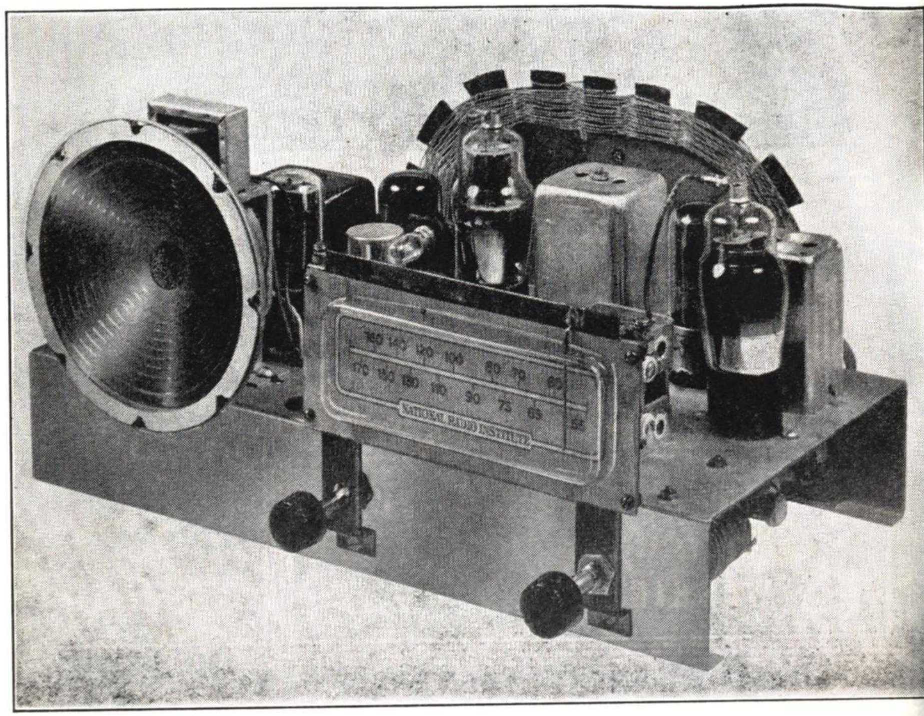
7RK-AC

NATIONAL RADIO INSTITUTE
ESTABLISHED 1914
WASHINGTON, D. C.

PIONEER HOME STUDY RADIO SCHOOL

NRI

COURSE IN PRACTICAL DEMONSTRATIONS OF RADIO FUNDAMENTALS



This is the 5-tube superheterodyne receiver, complete with dynamic speaker and calibrated dial, that you build from parts supplied in this and previous Kits.

NATIONAL RADIO INSTITUTE

WASHINGTON, D. C.

1949 Edition

A LESSON TEXT OF THE N. R. I. COURSE WHICH TRAINS YOU TO BECOME A RADIOTRICIAN & TELETRICIAN

(REGISTERED U. S. PATENT OFFICE) (REGISTERED U. S. PATENT OFFICE)

NPC6M1049

Printed in U. S. A.

Instructions for Performing Radio Experiments 61-70

Introduction

THE practical experiments you have just successfully completed have demonstrated many fundamental principles of radio. As you built up and operated the various circuits, you gained the practical experience so necessary to your training as a Radiotrician—experience in soldering, proper placement of parts and wires, assembling circuits from schematic diagrams alone, accurately adjusting various tuned circuits to resonance with a given frequency, and dismantling equipment without damaging the component parts. You are fully qualified, therefore, for the final phase of your practical training.

You are now going to build a 5-tube superheterodyne, broadcast-band receiver that is typical of thousands of commercially manufactured sets. You will find a photograph of the set on the opposite page, and its schematic diagram on page 28. As you see, it has a loop antenna, a two-gang tuning condenser, and a loudspeaker, all on a single chassis, just like a commercial set. When you have it finished and in operation, you will have visible evidence of your technical ability that you will be proud to show to your friends.

Furthermore, when you put the set through its paces and learn its operating characteristics, you will come to know about what sort of performance to expect from similar commercially manufactured sets. A serviceman must know what to expect of a receiver in the way of normal reception, for otherwise he will be uncertain if a repair has restored operation to normal.

You are going to get a great deal of enjoyment out of building this set, for here is a piece of equipment you won't tear down as soon as you have built it up. It will be lasting evidence of your technical knowledge and practical ability, so take plenty of time, and do the job right.

The assembly instructions have been carefully laid out for the greatest convenience in soldering the many connections, and the proper placement of the various parts. Follow these instructions, checking your work against the pictorial diagrams, just as carefully as you did your regular experiments.

Contents of Radio Kit 7RK-AC

The parts included in Radio Kit 7RK-AC are illustrated in Fig. *1*, and listed in the caption underneath. Check the parts you received against this list to be sure you have all of them.

If any part in your Radio Kit 7RK-AC is obviously defective or has been damaged in shipment, return it to NRI *immediately* for replacement.

Tubes. Two new types of tubes are supplied to you in Radio Kit 7RK. The type 6A8GT is an octal-base, pentagrid converter tube designed to function as both the local oscillator and the mixer-first detector in superheterodyne receiver circuits. Its filament draws .3 ampere at 6.3 volts.

A glance at Fig. *2A*, which shows the socket connections for the type 6A8GT, reveals that this tube has five grids, in addition to the filament (heater), cathode, and plate elements. This makes electron coupling between the oscillator and mixer circuits possible. The grids G_O and G_A work with the cathode as a triode oscillator; grid G_A functions as the oscillator anode, and grid G_O as the

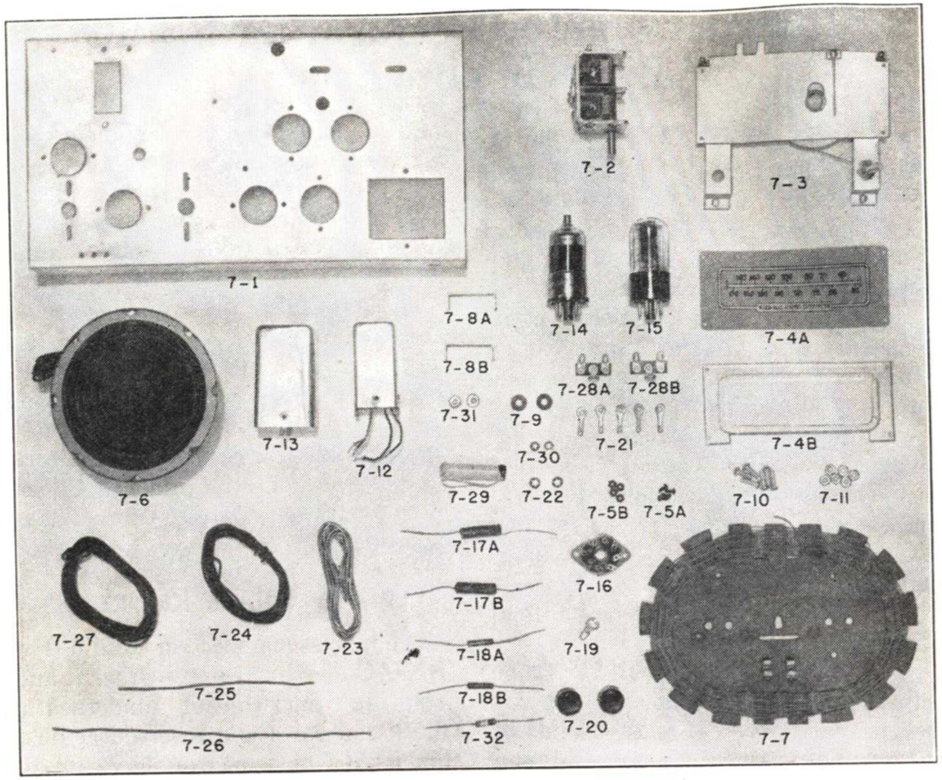


FIG. 1. The parts included in Radio Kit 7RK-AC are shown above, and identified in the list below. The parts used in this receiver which were supplied in previous Kits are listed on page 4.

Part No.	*Description*
7-1	One chassis.
7-2	One 2-gang tuning condenser.
7-3	One tuning-dial mechanism.
7-4A	One calibrated scale.
7-4B	One clear vision scale cover.
7-5A	Four 1/4-inch long, 4-36 mounting screws.
7-5B	Four hexagonal nuts for 4-36 screws.
7-6	One 5-inch dynamic speaker with output transformer.
7-7	One loop antenna
7-8A,B	Two mounting brackets.
7-9	Two flat fiber washers.
7-10	Six 3/8-inch long 8-32 screws.
7-11	Six hexagonal nuts for 8-32 screws.
7-12	One pre-tuned and sealed 456 kc. i.f. transformer.
7-13	One aluminum i.f. transformer shield can.
7-14	One 6A8GT tube.
7-15	One 6K6GT tube.
7-16	One octal tube socket.
7-17A,B	Two .01-mfd., 400-volt tubular paper condensers.
7-18A,B	Two .0005-mfd., 200-volt tubular paper condensers.
7-19	One grid clip for octal tube.
7-20	Two control knobs.
7-21	Five solder lugs.
7-22	Two No. 8 shakeproof lock washers.
7-23	One roll of rosin-core solder.
7-24	One 8-foot roll of red hookup wire.
7-25	One 6-inch length of green hookup wire.
7-26	One 10-inch length of blue hookup wire.
7-27	One 12-foot roll of black hookup wire.
7-28A,B	Two terminal strips.
7-29	One 1500-ohm, 3-watt resistor.
7-30	Two No. 6 shakeproof lock washers.
7-31	Two No. 6 flat washers.
7-32	One 100,000-ohm, 1/2-watt resistor.

oscillator control grid. The stream of electrons which passes the anode grid varies at the oscillator frequency. This varying electron stream is further controlled by the r.f. signal voltage on grid *G* (the top cap). Thus, variations in plate current are due to the combination of the oscillator and signal frequencies.

The type 6K6GT tube is an octal-base power pentode. Its filament draws .4 ampere at 6.3 volts. With 250 volts on the plate and screen grid elements, and a control-grid bias of about —18 volts, this tube is capable of producing sufficient output to drive the loudspeaker of your 7RK receiver. Its socket connections are shown in Fig. 2B.

Tuning Condenser Gang. As you learned in your regular Course, the oscillator and preselector circuits must track each other throughout the tuning range, with the oscillator frequency being above that of the preselector by exactly the i.f. value at all times. In the tuning condenser supplied to you in this Kit, proper tracking throughout the tuning range (550 to 1700 kilocycles) is obtained by the use of specially shaped plates in the oscillator section. Two small trimmer condensers (one on each section) are provided for fine adjustment of the capacity of each section. The correct adjustment of these trimmers will be discussed in detail in the section of this Manual covering the alignment of the receiver.

Gang condensers are instruments of precision that should be looked upon with respect. They are made and adjusted by experts to very close limits of uniformity so that your receiver will have the best possible tracking and dial calibration accuracy. To give these condensers the greatest possible protection when handling them or when working on the chassis on which they are mounted, keep them closed. This means keep the plates fully meshed. Never bend a condenser plate unless you know in advance exactly what will happen as a result.

Loop Antenna. Incoming signals are picked up by the loop (tuned to the desired frequency by the large section of the variable condenser gang), and are fed directly to the 6A8GT oscillator-mixer tube. For the reception of distant stations whose signal strength in your locality may be quite low, a single turn of wire around the loop frame has been brought out to Fahnestock clips so that an antenna can be used to in-

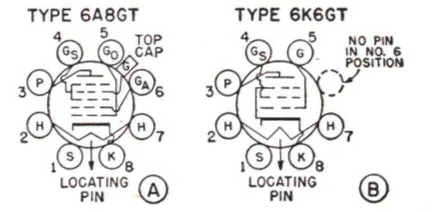


FIG. 2. Socket connections for the types 6A8GT and 6K6GT tubes supplied in Radio Kit 7RK-AC as they appear when you look at the bottom of the sockets. Note that the control grid element of the type 6A8GT tube is brought out to a cap on top of the tube.

crease the amount of signal pickup. (The other clip can be connected to a ground if desired.)

I.F. Transformer. The shielded i.f. transformer in Radio Kit 7RK is known as an "input" i.f. transformer because it is designed especially to work between the oscillator-mixer and the first i.f. stage in conventional superheterodyne receiver circuits. To help you align the receiver without the aid of a signal generator, this transformer has been adjusted at the factory to 456 kc., and then sealed. *Do not under any circumstances remove the seal and change the adjustment of either trimmer until we tell you to do so.*

Loudspeaker. The loudspeaker furnished in this Kit is an electrodynamic unit having a field-coil resistance of 1000 ohms. Its voice coil is coupled to the 6K6GT output tube by means of an impedance-matching transformer. To offset the effect of hum voltage induced in the voice coil from the field coil, a special hum-bucking coil has been placed on the field pole piece and connected in series with the voice coil and low-impedance secondary winding of the output transformer. A special bracket has been welded to the field coil frame to make it easy to mount the speaker on the chassis.

Chassis. The folded piece of metal known as a chassis, on which are mounted the various electrical components, is one of the most important parts of a radio because it holds the parts in the correct physical relationship to each other. As examples—tube sockets must be placed so as to keep the circuit paths between stages as short and as direct as possible, and yet provide adequate isolation between grid and plate circuits; also, the power transformer must be located far enough away from high-gain circuits so that the transformer's magnetic field will not induce hum. The correct positions for the various parts of the NRI receiver have been carefully worked out, and the chassis has been punched accordingly so that one stage logically follows another with a maximum of isolation (to prevent feedback), with short leads, and without undue crowding of the parts. *As you wire up the set, place your resistors, condensers, and circuit wiring exactly as specified so that you will not nullify the effects achieved by this careful planning.*

Reconditioning the Old Parts

The first step in assembling your receiver is to dismantle *completely* your 4RK power pack and CHASSIS A and CHASSIS B of Experiment 60. DO THIS RIGHT NOW. Take care not to break resistor and condenser leads; save all the bolts and nuts and rubber grommets; then thoroughly clean and test the following parts:

- **Oscillator coil (Part *6-5*).**
- **I.F. transformer (Part *6-6*).**
- **Grid cap for octal tube (Part *5-3*).**
- **Power transformer (Part *4-3*).**
- **Power cord (Part *3-11*).**
- **Pilot lamp socket (Part *4-8*).**
- **1000-ohm potentiometer (Part *3-8*).**
- **250,000-ohm potentiometer with ON-OFF switch (Part *6-8*).**
- **Electrolytic condenser with mounting wafer (Part *3-3*).**
- **Both 6-lug terminal strips.**
- **ALL tube sockets.**
- **ALL fixed condensers.**
- **ALL fixed resistors.**

Tube Sockets. First remove all excess solder; then scrub the bottom surface vigorously with an old toothbrush which has been dipped in a solvent such as Carbona (carbon tetrachloride) or Varsol. If any of the lugs are broken, you should get new sockets.

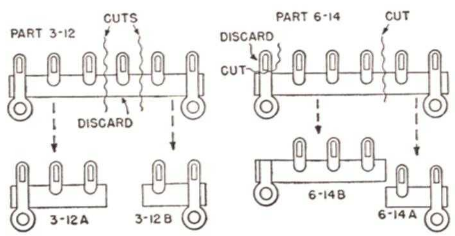


FIG. 3. Use terminal strips *3-12* and *6-14*, which were supplied in previous Kits, to form terminal strips *3-12A*, *3-12B*, *6-14A*, and *6-14B* by cutting them as shown above with a pair of sidecutters.

Terminal Strips. Use the same procedure as with the tube sockets. When you have both strips clean and dry, cut them into four strips with your side cutters as shown in Fig. *3*. Hereafter, these terminal strips will be referred to by the new part numbers given in Fig. *3*.

I.F. Transformer. First remove all excess solder from the four terminals. Be careful not to unsolder the coil leads from the terminals when you do this. When you have the terminals clean, measure the d.c. resistance of each coil. Be sure to calibrate your tester accurately for resistance measurements before you begin these tests. Since the normal resistance of the coils is between 10 and 20 ohms, you must note carefully the exact position of the meter pointer when the test clips are held together. Use the *10 × R* range.

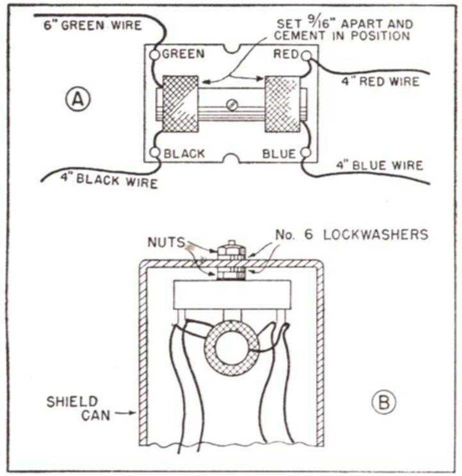


FIG. 4. Assembling the 2nd i.f transformer. First, set the coils of i.f. transformer (Part *6-6* supplied in a previous Kit) 9/16-inch apart, cement them in this position; then solder the wires to the terminals as shown. The final step, shown in B, is to put the transformer in the special shield can, Part *7-13*.

To determine whether or not the trimmers are defective (shorted), rotate each adjustment screw throughout its range from maximum to minimum while the ohmmeter is connected to check the resistance of the coils, and watch the meter. If the pointer moves all the way over to 0 at any position of the adjustment screw, the trimmer is defective, and you should get a new transformer.*

You are now ready to put the i.f. transformer into the aluminum shield can provided for it in this Kit. First, set the coils 9/16-inch apart, and cement them in place. It is preferable to use acetone or some similar quick-drying airplane or loudspeaker cement, but any good glue will work if allowed to dry properly. While the cement is drying, solder the 6-inch length of green wire (Part *7-25*) to the green terminal, a 4-inch length of the blue wire (Part *7-26*) to the blue terminal, a 4-inch length of the red hookup wire (Part *7-24*) to the red terminal, and a 4-inch length of the black hookup wire (Part *7-27*) to the black terminal. Use closed hook joints. After you have soldered the wires in place, push the insulation on each wire right down to the terminal, and tighten the mounting bolt so that the dowel rod won't turn. The transformer should now appear as shown at *A* in Fig. *4*.

Now place the transformer in the can with one of the small (No. 6) lock washers (Part *7-30*) on the mounting stud inside the can, and the other No. 6 lock washer under the nut outside the can as shown at *B* in Fig. *4*.

Position the trimmers under the large holes in the top of the can, and tighten the top nut securely. This assembly will hereafter be referred to as the *2nd i.f. transformer*.

Oscillator Coil. (This is the 3-pie coil, Part *6-5*.) Here, again, the first procedure is to remove all excess solder from the terminals, taking care not to unsolder the coil leads from the terminals. Straighten the terminals if they are bent, and measure the d.c. resistance of each winding. Use

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*NOTE: These tests apply only to the old i.f. transformer, Part *6-6*. Do not touch the factory-sealed unit supplied in this Kit.

the $10 \times R$ range of your tester. The feedback coil (L_7) which terminates at the red and blue colored lugs should have a resistance of approximately 2 ohms—just about half that of the main winding (L_6) which terminates at the green and black colored lugs, and has a resistance of about 5 ohms.

You should also make sure that continuity does *not* exist between the two windings, by measuring the d.c. resistance between the red and black terminals. The $10{,}000 \times R$ range of your ohmmeter should be used this time, and there should be no meter pointer movement.

Power Transformer. After you have thoroughly cleaned the terminals, examine carefully the leads from the various windings to the terminals to make sure they don't touch each other, and that you have not accidentally unsoldered a lead in cleaning a terminal. If a lug is broken, make a neat lap joint between the remaining portion of the lug and the lead from the windings to that terminal.

The d.c. resistance of the 115-volt primary winding, and of the high-voltage secondary winding should now be checked. As in Step 12 of the power pack assembly instructions of Manual 4RK, the d.c. resistance of the primary should be between 10 and 20 ohms, and the resistance of the high-voltage secondary should be between 500 and 800 ohms (measured directly between terminals *22* and *24*).

The normal d.c. resistance of the filament windings is too low to be measured accurately on the $10 \times R$ range of your tester, but you can check for continuity by testing across terminals *17* and *18*, and between terminals *19*, *20*, and *21*. You will get a full-scale reading if the windings are not open.

Electrolytic Condenser. It should not be necessary to remove the dual 10-mfd. electrolytic condenser from the Bakelite mounting wafer, unless, of course, the wafer is broken, and you want to replace it. You should, however, check both sections of the condenser with your ohmmeter after you have cleaned the excess solder from the terminals. Use the $10{,}000 \times R$ range, and make sure your red test lead is plugged into jack *27*, and the black test lead is plugged into jack *26*. Fasten the red test clip to any one of the lugs which are a part of the condenser can, and hold the black clip onto each of the center terminals in turn, long enough for the pointer to swing to the right, then drop back to the left, and come to rest. If the resistance of either section is less than 100,000 ohms, discard the condenser, and get a good one.

Potentiometers. Both the 1000-ohm potentiometer and the 250,000-ohm potentiometer (with the attached ON-OFF switch) will be used in the 7RK-AC receiver. All you will need to do is to clean the terminals, and check the resistance between the two outside terminals and then between the center terminal and either outside terminal, as you rotate the control shaft throughout its range. If the control is good, the resistance will vary smoothly. On the other hand, if the meter pointer jumps back and forth as the control is varied, the potentiometer is defective and should not be used in the receiver. Since the ON-OFF switch on the 250,000-ohm potentiometer has not been used, it should be in good working order.

Pilot Lamp Socket. As you remove the solder from the pilot lamp socket terminals, be careful not to allow solder to bridge the small gap between terminals at the base of the socket. If necessary, measure the d.c. resistance between the two terminals (without the pilot lamp in place). You should get no reading on the $10{,}000 \times R$ range of your ohmmeter.

Keep the rubber grommet in place around the socket.

Condensers and Resistors. Remove all excess solder from the leads, and straighten them. You can check the lead lengths as you use the parts in the actual assembly of the receiver. If you find any of the leads too short to permit you to position the part as shown in the assembly sketch accompanying the instructions covering that part, splice additional lengths of bare hookup wire to the existing leads.

You should check each condenser carefully with your ohmmeter to make sure it is not open, leaky, or completely short-circuited. If you use the *MEG.* range, even the .0005-mfd. condenser will make the pointer of your ohmmeter swing sharply to the right a small amount as soon as you connect the test leads to the condenser leads, and then gradually drop back to the left of 15 megs. if the condenser is good. A continuous full-scale reading, of course, indicates a shorted condenser; and a continuous partial-scale reading indicates excessive leakage. Remember, these are paper condensers that do not normally pass direct current.

Replacing Defective Parts

You should now know exactly which parts from previous Kits must be replaced. Get the parts *before* you proceed with the actual assembly of the receiver so that once you get started you won't have to stop for lack of material.

Such parts as tubes, resistors, condensers, potentiometers, sockets, terminal strips, bolts, nuts, lock washers, and soldering lugs may be obtained from any wholesale radio parts supply company. The variable coupling i.f. transformer (Part *6-6*), the 3-pie oscillator coil (Part *6-5*), and the power transformer are made exclusively for NRI. A special order blank is enclosed with this Kit for your convenience in obtaining these special items from NRI at current prices if your tests of these parts prove that you need new ones. The order blank also lists all the parts from previous Kits so that in case you can't get them elsewhere, you can get them from us in the shortest possible time.

ASSEMBLING THE RECEIVER

The only tools you will need are a medium-sized screwdriver, a small screwdriver for the control knob set screws, a pair of all-purpose pliers (sometimes called automobile pliers), a pair of long-nosed pliers, a pair of side-cutting pliers, a 12-inch rule, and a hot, well-tinned soldering iron. A knife and a ¼-inch socket wrench will be useful, but are not absolutely essential.

Provide plenty of working space, and place the materials and tools you are going to work with in a convenient position. If you must stop before completing the receiver, be sure to put away all of your materials carefully.

Be careful in handling the parts, especially the loudspeaker. It is very easy to ruin the cone by sticking a finger or screwdriver through it. In fact, since the loudspeaker is one of the last items to be put on the chassis, you can set it aside, face down on a shelf, out of danger until you are ready to mount it.

Correctly identify the parts as you use them. If there is any question, refer to the illustrated parts list in the front of the Manual or to the guide figure you are using. In particular, it will be necessary that you identify correctly the terminal strips, the various tube sockets, and the i.f. transformers. In identifying tube-socket terminals, form the habit of counting from the terminal immediatly to the *left* of the aligning key, around the socket in a clockwise direction to the desired terminal, rather than of relying on the numbers stamped in the base.

Refer frequently to the pictorial diagrams to be sure you are making the proper connections.

It is a good plan to place small check marks (√) with a colored pencil on the symbols of the wires and parts on the pictorial diagrams as the wires and parts are placed in the chassis, and also to mark each connection as it is soldered. If you follow this plan without exception, you can see the progress of the wiring and soldering at a glance, note any unfinished portions immediately, and thus automatically eliminate errors in wiring.

Don't cut the leads of your resistors and condensers too short. Instead, make them *slightly* longer than necessary so that the parts can be positioned exactly as shown in the pictorial diagrams. If any of your resistor and condenser leads are too short to begin with, splice additional wires to them.

You must not permit bare leads or excessive amounts of solder to touch the chassis, adjacent terminals, or other leads. To avoid this, position the resistors and condensers exactly as shown in the pictorial diagrams, and use only enough solder to make a clean bond. Whenever possible, push the insulation on the hookup wire right up to the joints *after* they have been soldered.

To avoid incompletely soldered connections, test each joint after it has become *cold* by wiggling *each lead* with a pair of long-nose pliers. This is necessary, for many of the terminals in your receiver will have a number of leads on them, and *all,* not just the top one or two wires, must be securely soldered to the terminals.

Most important of all, don't rush through the job of assembling the receiver. *Take your time.* As you wire up a circuit, review in your mind how it works and its purpose in the receiver. This will help you to understand the operation of the receiver as a whole. You are now ready to begin the actual assembly work.

Step 1. To identify the various holes in the 7RK-AC receiver chassis,

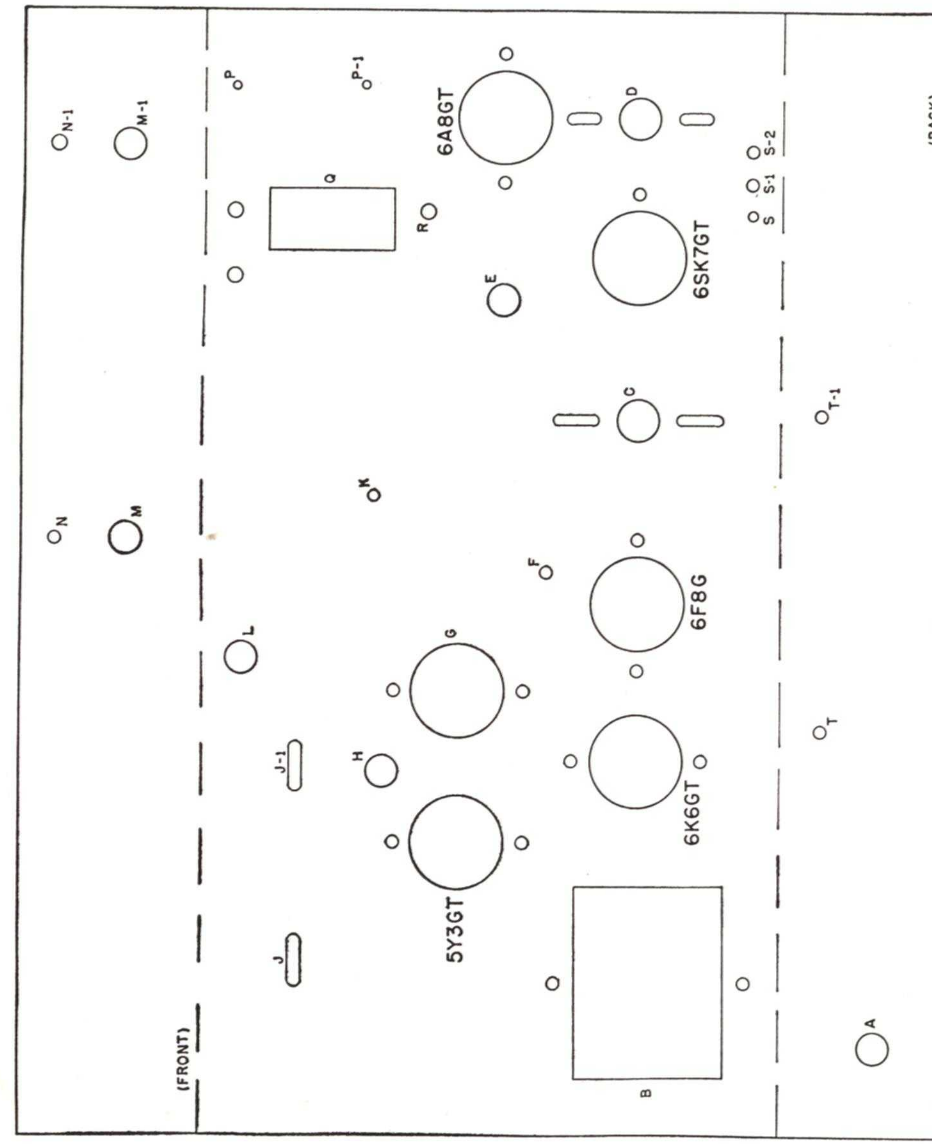


FIG. 5. Layout of the 7RK-AC receiver chassis, drawn to show you what you would see if you looked at the bottom of the chassis as a flat sheet (before bending the sides). The dotted lines show the position of the bends at the top of the chassis. Neatly mark the holes of your chassis exactly as shown here. Only those holes which have special significance in the assembly of the receiver are identified.

carry out the following instructions carefully:

(a) Place the chassis in front of you, upside down, as shown in Fig. *5.* Position it so that the transformer cut-out is in the left-hand corner nearest you.

(b) Neatly identify the holes, exactly as shown, with a soft lead pencil. Make your letters about ⅛-inch high.

(c) When you have each hole inside the chassis identified, turn the chassis over, and neatly mark the tube

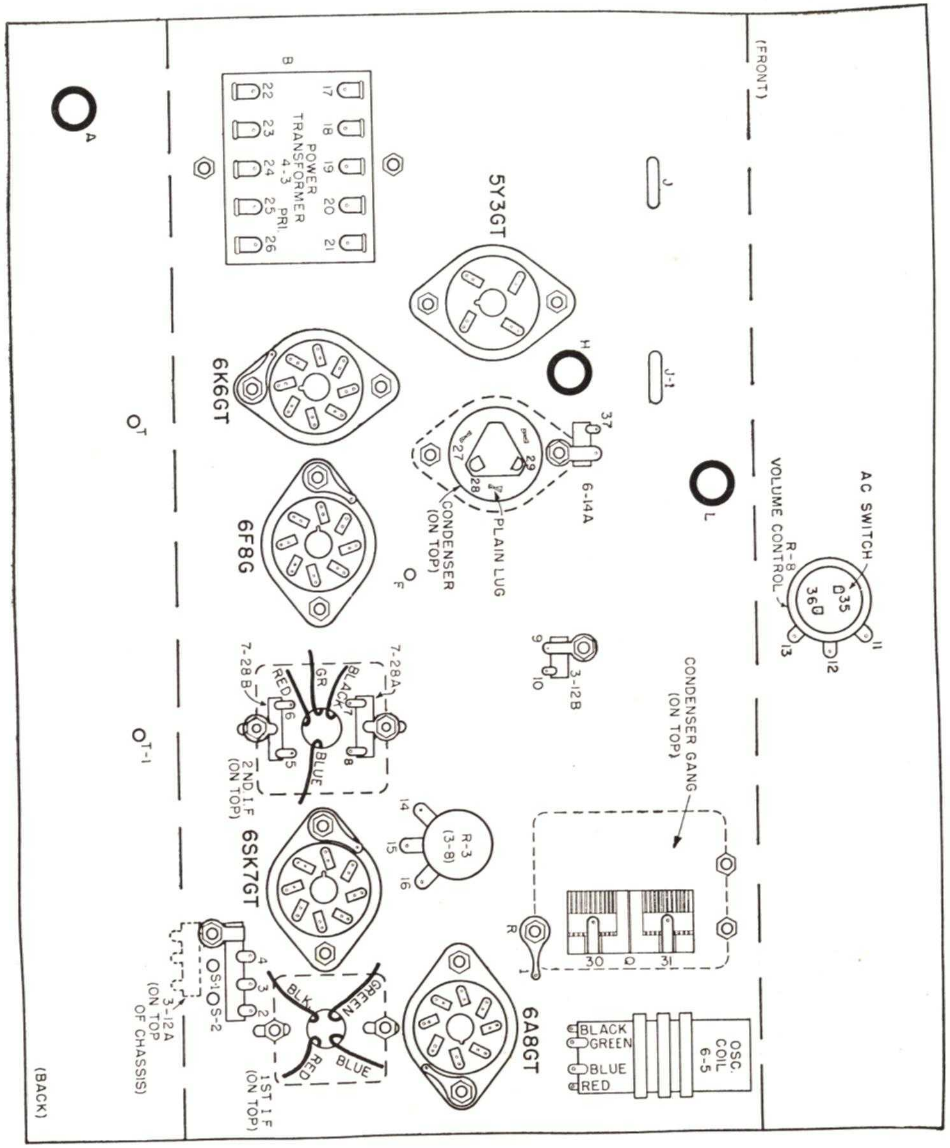


FIG. 6A. Bottom view of the chassis with the sides spread out, showing the exact position of all parts that are mounted directly on the chassis, and showing all the terminal identification numbers you are to place on the chassis. As explained in the text, the tube sockets usually carry their own terminal identifying numbers. All sockets are to be attached to the underside of the chassis.

socket holes on top of the chassis so that you can tell where to put the tubes (see Fig. *6B*). This time you may make the figures and letters slightly more than 1/8 inch high if you wish, but be sure to do a neat job.

Step 2. Proceed to mount on the chassis the parts listed below, in the order given, and in the positions shown in Figs. 6A and 6B.

(a) *Tube sockets and ground lugs.* On all but the rectifier tube socket, put a ground lug on the bolt adjacent to terminal *1* as shown in Fig. *6A*. Bend the solder lugs up at an angle of approximately 60° so that the eyelet in the solder lug will be as close as possible to terminal *2* of the socket. Check the socket aligning keys to make sure they are positioned as shown in Fig. *6A*.

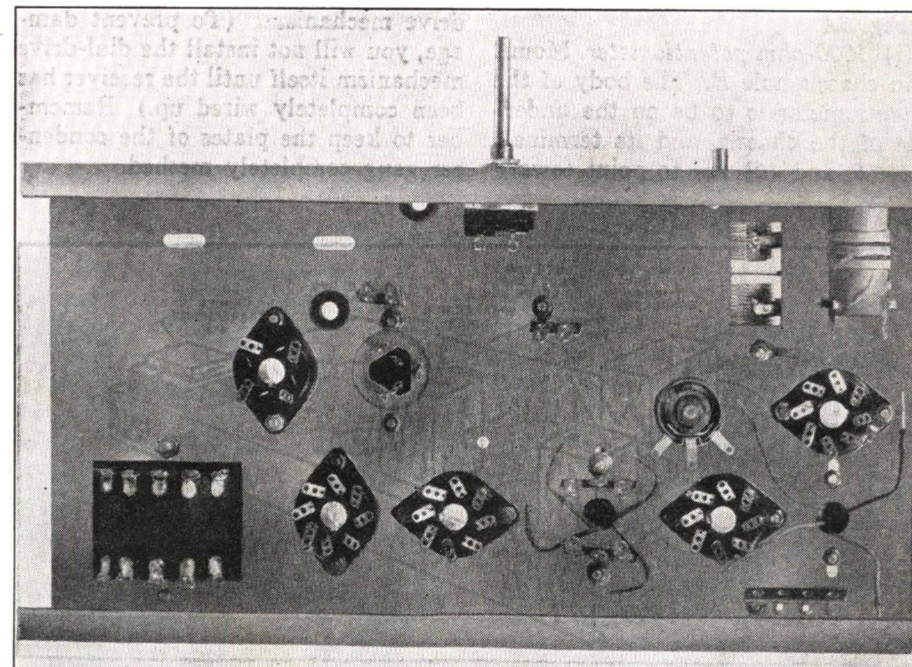
(b) *Filter condenser and mounting wafer.* The filter condenser should still be in the mounting wafer, as you used it in your 4RK power pack. If it was broken, and you now have a new wafer, put the condenser on the wafer so that the two positive (center) lugs are in the position shown in Fig. *6A*. Twist the three outside (negative) lugs slightly with heavy pliers so as to hold the condenser firmly to the wafer. Install the filter condenser and wafer over the chassis hole *G* with the insulating wafer *on top* of the chassis. It should be positioned so that the positive terminals are nearest the center of the chassis, exactly as shown in Fig. *6A*.

Put the 2-lug terminal strip *6-14A* on the condenser-mounting bolt nearest the front of the chassis as shown in Fig. *6A*.

(c) *Oscillator coil* (Part *6-5*). Mount this part underneath the chassis in holes *P* and *P-1* so that the terminals extend toward the 6A8GT tube socket.

(d) *Combined volume control and power switch.* Install this in hole *M* on the front of the chassis. Position the control so that its terminals (*11*, *12*, and *13*) face toward the oscillator coil.

(e) *Terminal strips 3-12A and 6-14B.* Mount these by means of a 6-32 bolt through hole *S* so strip *3-12A* is *on top* of the chassis as shown



This is how your chassis will look after you have finished mounting the parts. Note that the loop antenna and the loudspeaker have not as yet been mounted on the chassis. These will be added later, as will the dial mechanism.

in Fig. *6B,* and the terminal strip *6-14B* is *underneath* the chassis as shown in Fig. *6A.*

(f) *Two-lug terminal strip* (*Part 3-12B*). Mount it in hole *K* so that it is underneath the chassis. The insulated terminal should be toward the oscillator coil exactly as shown in Fig. *6A.*

(g) *Factory-sealed i.f. transformer.* Put this on the top of the chassis over hole *D* so that the green and black leads will be adjacent to the 6SK7GT tube socket. Be sure the leads project freely through the hole. Tighten the nuts on the mounting bolts securely.

(h) *The 2nd i.f. transformer.* Fasten it on top of the chassis over hole *C* so that the green and black leads will be adjacent to the 6F8G tube socket, and all leads project freely through the chassis hole. On the mounting bolts of this transformer shield can place the 2-lug terminal strips (Parts *7-28A* and *7-28B*) exactly as shown in Fig. *6A.*

(i) *1000-ohm potentiometer.* Mount it in chassis hole *E.* The body of the potentiometer is to be on the underside of the chassis, and its terminals (*14, 15,* and *16*) are to point toward the 6SK7GT tube socket as shown in Fig. *6A.* The lock washer should be placed between the potentiometer and the chassis. Only the nut should be above the chassis.

(j) *Rubber grommets.* Put them in chassis holes *L, H,* and *A* to protect the pilot lamp leads, the speaker leads, and the power cord.

(k) *Two-gang tuning condenser.* Mount this on top of the chassis over the rectangular hole *Q.* The shaft should extend out over the front edge of the chassis. Underneath the chassis, place a solder lug on the mounting bolt which projects through chassis hole *R.* Bend the lug to an angle of approximately 60° as you did those on the tube sockets, and position it as shown in Fig. *6A.* Tighten the nuts on the mounting bolts only enough to hold the condenser in place. Later you must be able to move it about somewhat so as to position the condenser tuning shaft with respect to the dial-drive mechanism. (To prevent damage, you will not install the dial-drive mechanism itself until the receiver has been completely wired up.) Remember to keep the plates of the condenser gang completely meshed.

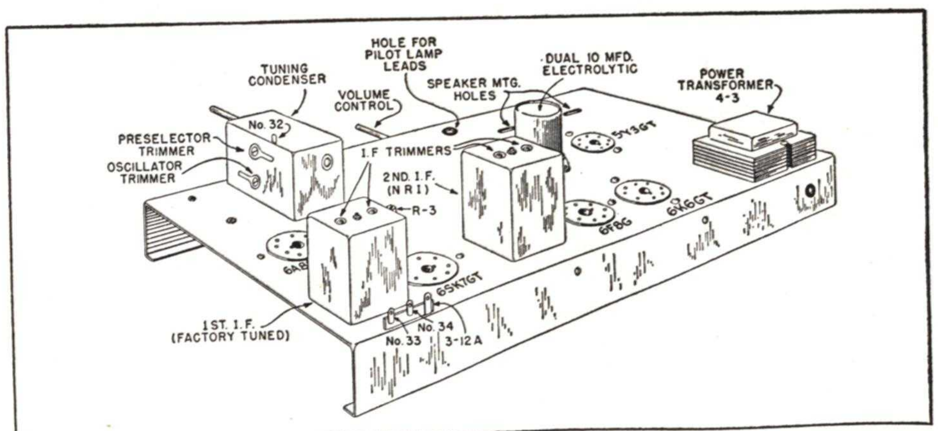
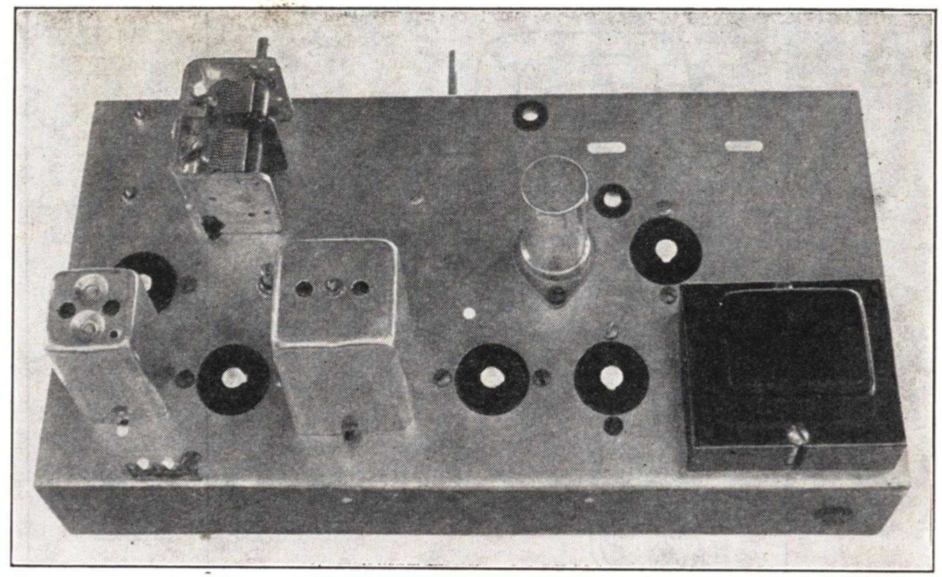


FIG. 6B. This shows the parts which are mounted on top of the chassis. Place identifying marks for only the tube sockets and the loop-antenna terminal strip on the top of your chassis. The other designations are shown here as a guide to help you test and align the receiver. The dial frame and loudspeaker are not shown, for they are added later.



Top view of the chassis after Step 2 of the assembly procedure is completed. The loudspeaker, the dial mechanism, and the loop antenna will be added later.

(l) *Power transformer.* Attach it to the top of the chassis over the large cut-out hole so that the primary terminals *25* and *26* are near the back of the chassis. Tighten the mounting bolts as securely as possible to avoid excessive vibration of the laminations.

Fig. *6B* shows how the top of the chassis should appear at this stage of assembly.

Step 3. Number all of the terminals neatly, exactly as shown in Figs. *6A* and *6B.* Use a soft lead pencil and make your figures about ⅛-inch high. Terminal *32* is on top of the large section of the tuning condenser gang, and terminals *33* and *34* are on top of the chassis alongside the 3-lug terminal strip *3-12A.* Mark the various potentiometer terminals on the chassis rather than on the potentiometer cases.

Notice that you do not number the lugs of the various tube sockets. As already explained, identify these by counting from the aligning key in a clockwise direction to the desired terminal. Each socket (except the rectifier socket) will have eight lugs.

You are now ready to begin wiring the receiver. Follow instructions *exactly,* particularly those about soldering. Check your work against the pictorial diagrams as you go along. NOTE—the diagrams show only a few Steps at a time—connections made in earlier Steps are omitted on later diagrams for clarity in wiring. Thus, Fig. *9* does not repeat the wiring shown in Fig. *7.*

Get your soldering iron hot now, and collect all the remaining resistors and condensers, and all the hookup wire. Place the material within easy reach, and proceed as follows:

Step 4. To wire the filament circuit of the rectifier tube, use Fig. *7* as your guide, and proceed as follows:

(a) Connect transformer terminal *17* to terminal *2* of the rectifier-tube socket with black hookup wire. Solder both terminals.

(b) Connect transformer terminal *18* to terminal *8* of the rectifier tube socket with black hookup wire. Solder only terminal *18.* Dress (place) the

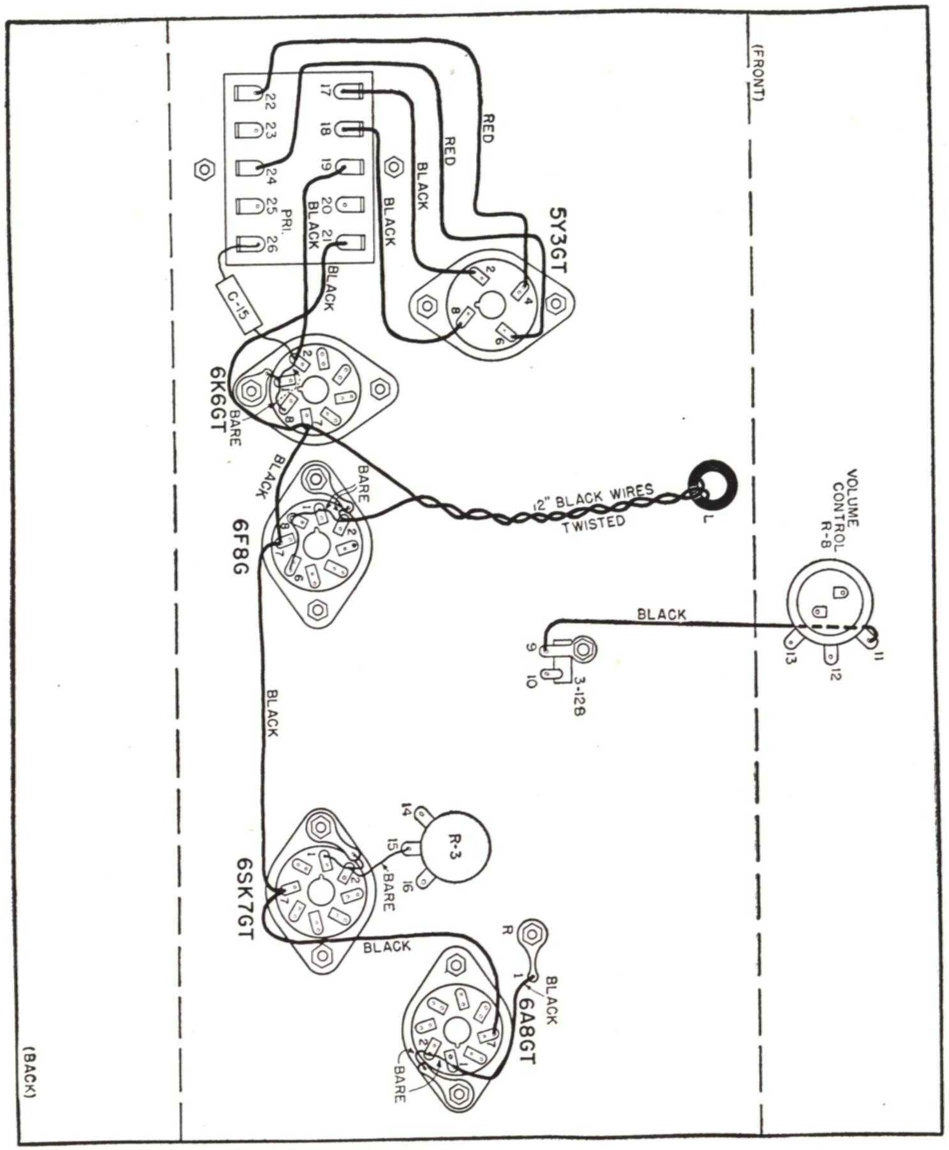


FIG. 7. Pictorial wiring diagram of the filament and ground connections in the 7RK-AC receiver. The wiring for the plate circuit of the 5Y3GT rectifier tube is also shown. The socket for the pilot lamp, which is attached to the wires passing through chassis hole L to the top of the chassis, is not shown.

wires exactly as shown in Fig. 7. (Terminals that are not soldered now, like *8* of the rectifier socket, will have other wires or parts connected to them and will be soldered later. Make permanent hook connections so that the wires cannot slip out of the lugs when they are not soldered.)

Step 5. Wire the high side of the r.f. and a.f. filament circuits, using black hookup wire and with Fig. 7 as your guide, in the following manner:

(a) Connect transformer terminal *21* to terminal 7 of the 6K6GT socket.

(b) Connect terminal *7* of the

6K6GT socket to terminal *7* of the 6F8G socket.

(c) Connect terminal *7* of the 6F8G socket to terminal *7* of the 6SK7GT socket.

(d) Connect terminal *7* of the 6SK7GT socket to terminal *7* of the 6A8GT socket.

(e) Attach a 12-inch length of black hookup wire to terminal *7* of the 6K6GT socket.

(f) Solder transformer terminal *21* and terminal *7* of all the tube sockets.

Step 6. Complete the filament circuit wiring as follows:

(a) Connect power transformer terminal *19* to terminal *2* of the 6K6GT socket. Use black hookup wire, and do *not* solder the terminals.

(b) Using bare hookup wire, connect together the ground lug and terminals *1*, *2*, and *8* of the 6K6GT socket. Solder only the ground lug and terminal *1*.

(c) On the 6F8G socket, connect the ground lug to terminals *2*, *1*, *8*, and *6*.

(d) Attach a 12-inch length of black hookup wire to terminal *2* of the 6F8G socket. Solder only the ground lug and terminals *1* and *2* of the 6F8G socket.

(e) Twist together the 12-inch black wires from terminal *2* of the 6F8G socket and terminal *7* of the 6K6GT socket, pass these through the grommet in chassis hole L, turn the chassis over, and solder the pilot-lamp socket to these two leads. (Note: the pilot lamp socket is *NOT* mounted in hole *L;* the wires pass through the hole and connect to the socket *above* the chassis.)

(f) Connect together with bare wire the ground lug, terminals *2* and *1* of the 6SK7GT socket, and terminal *15* of the 1000-ohm potentiometer. Solder only the ground lug, socket terminal *2*, and terminal *15*.

(g) Connect together the ground lug and terminal *2* of the 6A8GT socket. Do not solder either connection yet.

Step 7. Complete the ground circuits, still using Fig. 7 as your guide, as follows:

(a) Connect one of the .01-mfd. condensers as C_{15} between power-transformer terminal *26* and terminal *2* of the 6K6GT socket, and solder terminal *2*.

(b) Connect volume-control terminal *11* to ground lug *9* on terminal strip *3-12B* with black hookup wire. Solder only terminal *11*.

(c) Using black hookup wire, join terminals *1* and *2* of the 6A8GT socket, and connect them to solder lug

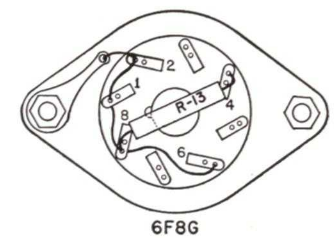


FIG. 8. Bottom view of the 6F8G socket with the 200-ohm resistor R_{13} soldered between *4* and *8*.

1 (on the condenser mounting bolt which projects through chassis hole *R*) exactly as shown in Fig. 7. Solder only terminals *1* and *2* of the 6A8GT socket. Do not solder either the ground lug at the 6A8GT socket or ground lug *1* on the variable-condenser mounting bolt.

Step 8. Wire the plate circuit of the 5Y3GT rectifier, again using Fig 7 as your guide.

(a) Using red hookup wire, connect power-transformer terminal *22* to terminal *4* of the 5Y3GT rectifier socket.

(b) Again using red hookup wire, connect transformer terminal *24* to terminal *6* of the 5Y3GT socket.

(c) Solder all four connections.

Step 9. Wire the cathode circuit of the 6F8G tube as shown in Fig. 8

by connecting your 200-ohm resistor between socket terminals *4* and *8* as R_{13}. Solder both terminals, and position the resistor over the socket just as shown in Fig. *8*.

Step 10. To wire the cathode circuits of the 6SK7GT and 6A8GT tubes, proceed as follows, checking your work against Fig. *9:*

(a) Connect terminal *8* of the 6A8GT socket to terminal *3* of the 6SK7GT socket with the remaining piece of blue hookup wire. Push the insulation back far enough on the end of the wire entering terminal *3* of the 6SK7GT socket so that it can reach terminal *5* without interfering with (touching) terminal *4*. Solder only terminal *5* of the 6SK7GT socket. Check your work carefully against Fig. *9* so that you'll be sure you have it right.

(b) Connect terminal *14* to terminal *16* on the 1000-ohm potentiometer with a short piece of black insulated wire, and then connect terminal *16* to terminal *3* of the 6SK7GT socket. You may use bare wire for this last connection if you wish. Solder only terminal *16* of the potentiometer.

(c) Connect one of the .25-mfd. condensers as C_4 to terminal *14* of the 1000-ohm potentiometer, and fasten the other end of this condenser to ground lug *9* of terminal strip *3-12B*. Solder only terminal *14*.

(d) Place the wires and condenser C_4 exactly as shown in Fig. *9*.

Step 11. Make i.f. transformer connections as follows, using Fig. *9* as your guide, before proceeding to wire the plate and screen-grid circuits:

(a) Run the blue lead of the first i.f. transformer to terminal *3* of the 6A8GT socket. Run this lead in the shortest, most direct manner, but don't pull it tight; keep it down against the chassis. Cut off any excess wire, and solder the lead to terminal *3*.

(b) Run the green lead of the first i.f. transformer to terminal *4* of the 6SK7GT socket. This lead also should be as short as possible without being pulled tight, and should be kept down against the chassis. Cut off any excess wire, and solder the lead to terminal *4*.

(c) In like manner, solder the blue lead of the second i.f. transformer to terminal *8* of the 6SK7GT socket.

(d) Solder the green lead of the second i.f. transformer to terminal *5* of the 6F8G socket. As in the case of the grid lead of the first i.f. transformer, make this lead as short as possible without pulling it tight, and keep it down against the chassis.

Step 12. Now wire the plate-supply and screen-grid supply circuits as follows, using Fig. *9* as your guide:

(a) With red hookup wire, connect terminal *6* of the 6K6GT socket to lug *6* of terminal strip *7-28B*.

(b) Connect lug *6* of terminal strip *7-28B* to lug *2* of terminal strip *6-14B*, again using red hookup wire.

(c) Run the red lead of the second i.f. transformer to lug *6* of terminal strip *7-28B*, keeping it as short as possible without pulling it tight, and as far away from the green i.f. transformer lead as possible. Cut off any excess wire, and solder the leads to lug *6*.

(d) Attach the 18,000-ohm resistor to lugs *2* and *3* of terminal strip *6-14B*.

(e) Run a red wire from lug *3* of this terminal strip to the red terminal of the oscillator coil. Solder only lug *3*.

(f) Connect the red lead of the first i.f. transformer to lug *2* of terminal strip *6-14B*. Keep it down against the chassis and as far away from the green lead as possible. Cut off any excess wire.

(g) Connect terminal *4* of the 6A8GT socket to terminal *6* of the 6SK7GT socket with red hookup wire. Do not solder either terminal.

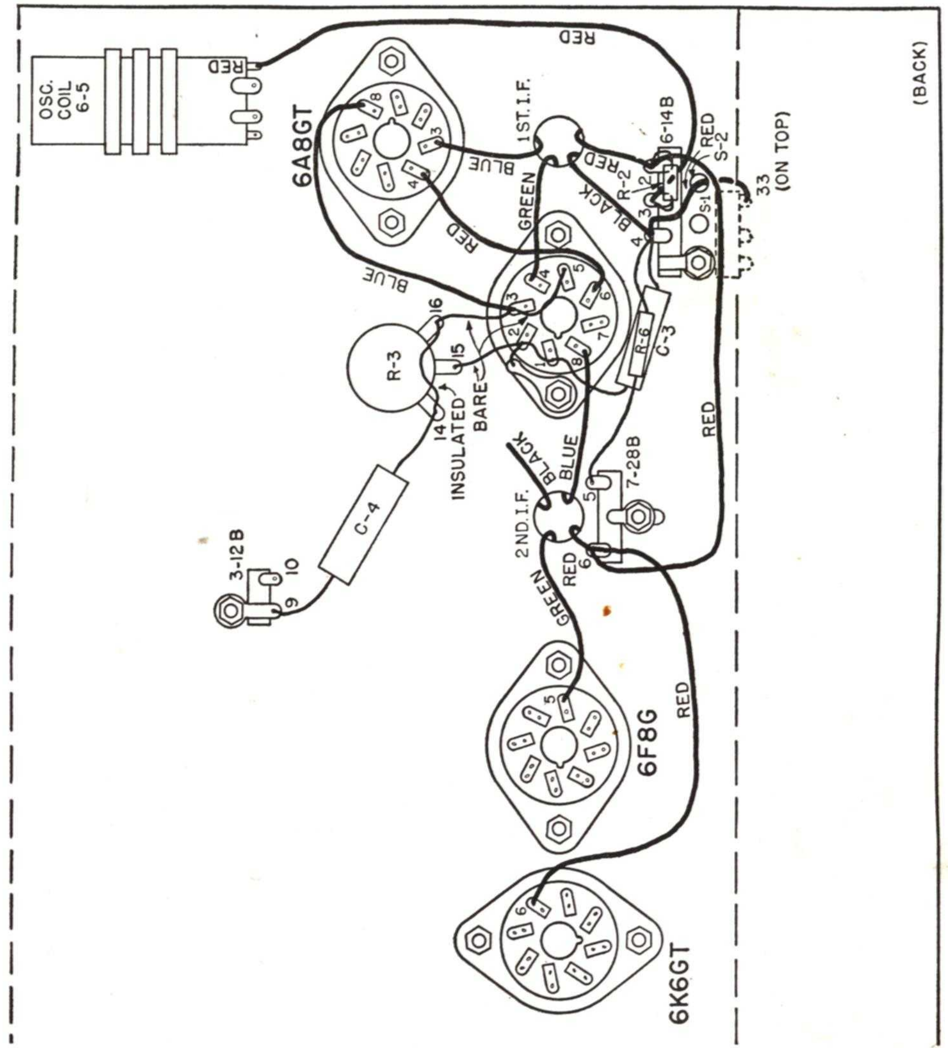


FIG. 9. In this pictorial diagram you will find the plate supply leads for the r.f. stages, the grid circuit of the i.f. stage, and the cathode circuit for both r.f. stages. The filament wiring previously shown in Fig. 7, as well as all parts not directly associated with Assembly Steps 10, 11, 12, and 13 are not shown here to simplify the diagram.

Step 13. Before you complete the plate and screen circuits, make the following connections, using Fig. *9* as your guide:

(a) Connect the black lead of the first i.f. transformer to lug *4* of terminal strip *6-14B*. Keep this lead down against the chassis, and cut off any excess wire.

(b) Run a short length of red insulated wire from lug *4* of this terminal strip, through chassis hole *S-2*, and connect it to lug *33* of terminal strip *3-12A* on top of the chassis.

(c) Connect one of the .05-mfd. condensers as C_3 between terminal *1* of the 6SK7GT tube socket and lug *4* of the terminal strip *6-14B*. Solder terminal *1* of the 6SK7GT socket.

(d) Connect the 2-megohm resistor

as R_6 between lug *4* of terminal strip *6-14B* and lug *5* of terminal strip *7-28B*. You may solder lug *4* (terminal strip *6-14B*) now.

(e) Recheck all of your work for Steps 10, 11, 12, and 13 carefully against Fig. *9* before going further.

Step 14. You can now complete the plate and screen-grid supply circuits. Use Fig. *10* as your guide for this.

(a) Connect two of the 40,000-ohm resistors in parallel between terminal *6* of the 6SK7GT socket, and lug *2* of terminal strip *6-14B* as resistor R_5. Solder both these terminals; be sure lug *2* is *completely* soldered, for it has five leads attached to it. No solder should be allowed to run

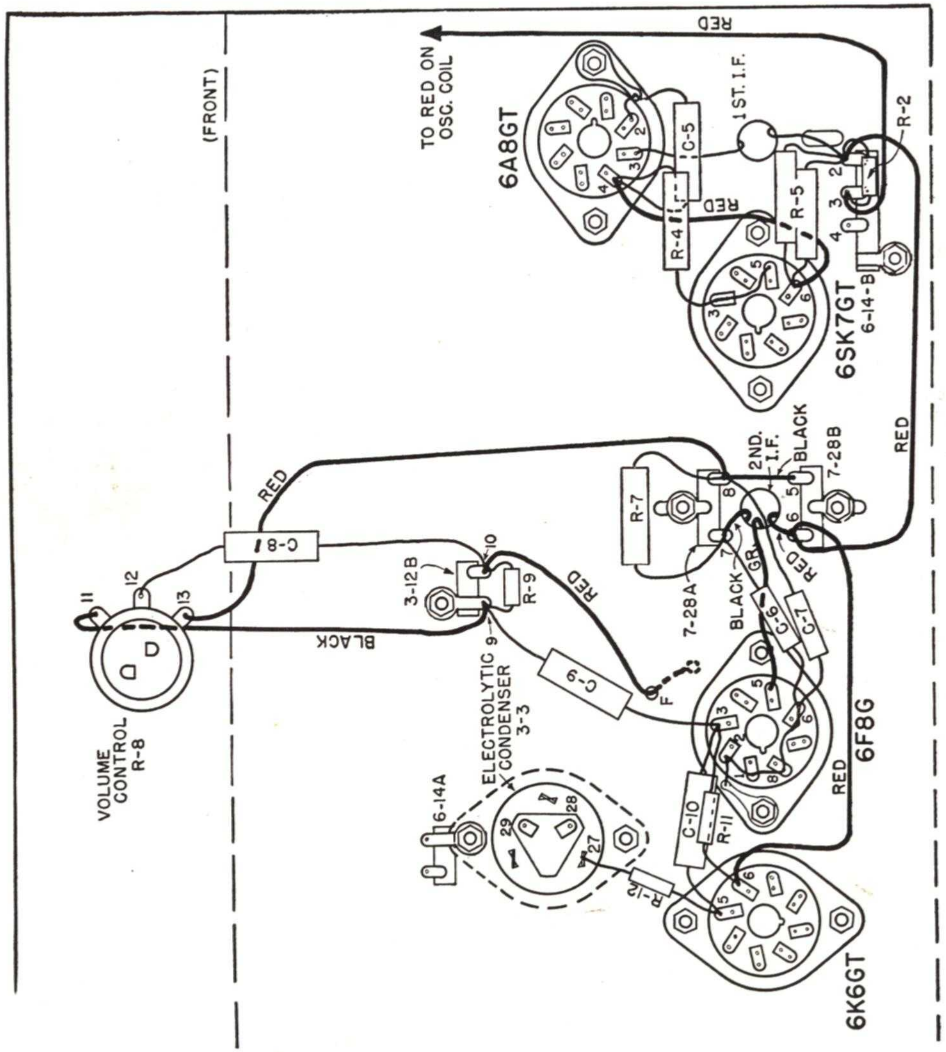


FIG. 10. Use this pictorial diagram to check your work for Assembly Steps 14, 15, and 16. As you see, the screen circuits of the r.f. stages are now complete, and the diode detector-1st a.f. grid circuits and the R-C coupling network between the 6F8G and the 6K6GT tubes have been added. Note how the plate resistor for the 1st audio stage (R_{11}) has been placed almost on top of grid coupling condenser C_{10}.

down and touch the chassis at this point.

(b) Connect a .01-mfd. condenser as C_5 from terminal *4* of the 6A8GT tube socket to the ground lug at the 6A8GT socket.

(c) Connect a single 40,000-ohm resistor as R_4 from terminal *3* of the 6SK7GT socket to terminal *4* of the 6A8GT socket. Solder terminal *3* of the 6SK7GT socket and terminal *4* and the ground lug of the 6A8GT socket. Position the parts exactly as shown in Fig. *10*.

Step 15. Now wire the 2nd detector and 1st a.f. grid circuits, again using Fig. *10* as your guide.

(a) Connect the black lead of the second i.f. transformer to solder lug *7* of terminal strip *7-28A*, cutting off any excess wire.

(b) Connect one of the .0005-mfd. condensers as C_6 from lug *7* of terminal strip *7-28A* to terminal *6* of the 6F8G tube socket. Connect another .0005-mfd. condenser from lug *8* of terminal strip *7-28A* to terminal *6* of the 6F8G tube socket as condenser C_7. Solder only terminal *6* of the 6F8G socket.

(c) Interconnect lugs *8* and *5* of terminal strips *7-28A* and *7-28B* at the second i.f. transformer, with black hookup wire, and solder lug *5*.

(d) Run a red wire from lug *8* of terminal strip *7-28A* to terminal *13* on the volume control. Solder only terminal *13*.

(e) Connect your 50,000-ohm, 3-watt resistor as R_7 between lugs *7* and *8* of terminal strip *7-28A*. Solder both terminals.

(f) Connect your 10-megohm resistor as R_9 between lugs *9* and *10* of terminal strip *3-12B*. Do not solder these terminals yet.

(g) Connect a .01-mfd. condenser as C_8 between lug *10* of terminal strip *3-12B* and terminal *12* of the volume control. Solder only terminal *12*.

(h) Put one of the grid caps onto the 6F8G tube, and insert the tube into its socket. Run a red wire from lug *10* of terminal strip *3-12B* through chassis hole *F* for the top-cap connection to the 6F8G tube. Estimate the length of the grid wire carefully by running it up the side of the tube to the top cap. The wire must be long enough to permit the top cap to be removed without straining the wire, yet it should not have a great amount of slack in it. When you have found the correct wire length, solder the wire to the top cap, bend the pointed tabs around the insulation, and solder terminal *10*. Remove the 6F8G tube, and then continue with your assembly procedure.

Step 16. Wire the plate circuit of the 6F8G tube and the grid circuit of the 6K6GT tube, still using Fig. *10* as a guide, as follows:

(a) Connect your .001-mfd. condenser as C_9 from terminal *3* of the 6F8G socket to ground lug *9* of terminal strip *3-12B*. You may solder lug *9* now. Since it has a number of leads on it, be sure you solder it well.

(b) Connect a .05-mfd. condenser as grid coupling condenser C_{10} from terminal *3* of the 6F8G socket to terminal *5* of the 6K6GT socket.

(c) Connect your 100,000-ohm resistor between terminal *3* of the 6F8G socket and terminal *6* of the 6K6GT socket as plate load resistor R_{11}. Solder only terminal *3* of the 6F8G socket at this time.

(d) Connect your 1-megohm resistor between terminal *5* of the 6K6GT socket, and filter-condenser terminal *27* as R_{12} to complete the grid circuit of the 6K6GT tube. Do not let the resistor lead touch the chassis at terminal *27*. Solder only 6K6GT socket terminal *5*.

(e) Recheck the placement of parts and wires against Fig. *10*. If you find any mistakes, correct them at once.

Step 17. Now complete the C-bias circuit of the 6K6GT output tube. Place the parts and wires exactly as shown in Fig. *11*.

(a) Run a black wire from filter condenser terminal *27* to power transformer terminal *23*, and solder terminal *27*.

(b) Connect a .25-mfd. condenser between power transformer terminal *23* and terminal *8* of the 6K6GT tube socket as condenser C_{11}. Solder terminal *8* only.

(c) Connect all three 1000-ohm resistors in parallel between power transformer terminals *23* and *19* as resistor R_{10}. Solder both terminals.

Step 18. To wire the oscillator circuit, proceed as follows, using Fig. *12* as your guide:

(a) Connect the blue terminal of the oscillator coil to terminal *6* of the 6A8GT socket with a short piece of red hookup wire.

(b) Connect a .01-mfd. condenser to serve as by-pass condenser C_2, between the red terminal of the oscillator coil and ground lug *1*.

(c) Connect the black terminal of the oscillator coil to ground terminal *1* with a short piece of bare wire, and solder the black, the red, and the blue terminals of the oscillator coil, and ground terminal *1*. Also solder terminal *6* of the 6A8GT tube socket.

(d) Connect a 40,000-ohm resistor as R_1 to terminals *5* and *8* of the 6A8GT socket.

(e) Connect a .0005-mfd. condenser from terminal *5* of the 6A8GT socket to the green terminal of the oscillator coil as coupling condenser C_1.

(f) Connect terminal *31* of the oscillator section of the tuning condenser (the one nearest the front of the chassis) to the green terminal of the oscillator coil, with red wire. Now solder terminal *31*, the green terminal of the oscillator coil, and terminals *5* and *8* of the 6A8GT tube socket.

(g) Recheck your connections carefully against Fig. *12*.

Step 19. Connect the antenna section of the tuning condenser (terminal *30*) to lug *34* of terminal strip *3-12A* on top of the chassis, using black hookup wire, and solder terminal *30*. This lead should be run along the bottom of the chassis and through hole *S-1* to reach the top of the chassis, as shown in Fig. *12*.

Step 20. Fasten the loudspeaker to the chassis using two of the 3/8-inch, 8-32 screws. Place the two large lock washers on the screws between the chassis and the nuts. Run the leads from the loudspeaker and the output transformer through the grommet in chassis hole *H* as shown in Fig. *13*. Connect these leads and a .01-mfd. condenser as follows:

(a) Connect the .01-mfd. condenser, C_{12}, to terminals *3* and *4* of the 6K6GT socket in such a manner that the lead to terminal *4* may be made

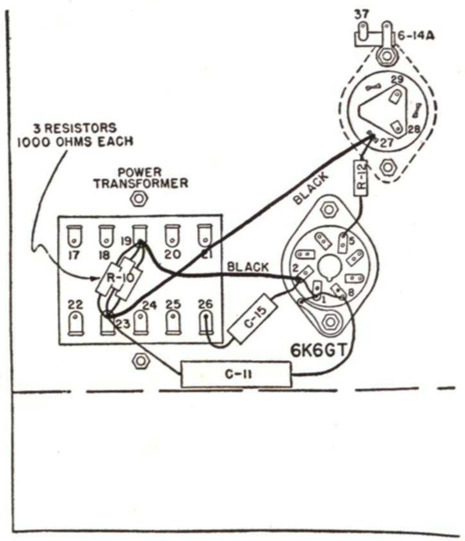


FIG. 11. Here we show the wiring and parts necessary to complete the C-bias circuit of the 6K6GT output tube. Since the bias resistor R_{10} is connected between the high-voltage center tap and the chassis, you must be careful not to ground the can of the electrolytic condenser.

to project through this terminal and connect to terminal *6* of this socket without shorting to terminal *5*. Refer to Fig. *13* for this arrangement.

(b) Connect the blue lead from the output transformer on the speaker to plate terminal *3* of the 6K6GT socket, and solder terminals *3* and *4* of the 6K6GT socket.

(c) Connect the black lead of the speaker field coil to lug *37* of terminal strip *6-14A*.

(d) Connect both the remaining speaker leads (one red, one yellow) to filter-condenser terminal *28*.

(e) Connect terminal *6* of the 6K6GT socket to condenser terminal *28* with red hookup wire, and solder both connections. Run this lead underneath coupling condenser C_{10}.

(f) Connect the 1500-ohm, 3-watt resistor *7-29* as R_{14} between terminal *8* of the 5Y3GT rectifier-tube socket and terminal *37* of terminal strip *6-14A*. Solder only terminal *37*.

(g) Run a short red wire from terminal *8* of the 5Y3GT tube socket to terminal *29* of the electrolytic condenser, and then solder both terminals.

Check the connections and lead dress against Fig. *13*.

Step 21. Finish the under-chassis wiring as follows:

(a) Put the power cord through the grommet in chassis hole *A*, and after determining how much is necessary to reach the on-off switch on the volume control, tie a knot in it.

(b) Carefully split the cord back to the knot. Remove the insulation from about 1/2-inch of one lead, and tin the strands. Now solder this lead to switch terminal *35*. This is wire *A* in Fig. *13*.

(c) Cut the other lead off so that it will conveniently reach transformer terminal *26*, and again remove about 1/2-inch of the insulation. Tin this lead, and solder it to terminal *26* as shown in Fig. *13*.

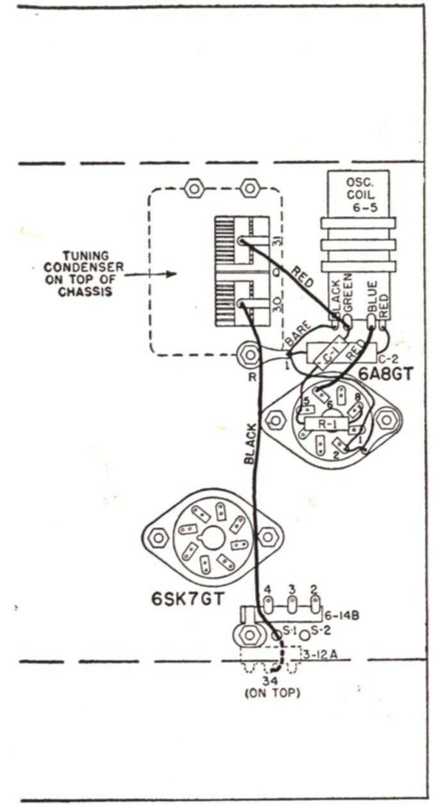


FIG. 12. This pictorial diagram shows the addition of condensers C_1 and C_2, resistor R_1, and the leads to the oscillator coil *6-5* which completes the wiring for the local oscillator of this superheterodyne receiver. The terminal strip for the loop antenna is sketched in with dotted lines because it is on top of the chassis. Only the outline of the 6SK7GT socket is given to show the proper position for the lead going from terminal *30* of the gang condenser to terminal *34* on the loop antenna terminal strip.

(d) Interconnect switch terminal *36* and power transformer terminal *25* with black hookup wire, and solder both terminals. Run this lead under R_{14} and around terminal strip *6-14A*, keeping it close to the chassis. Check the assembly against Fig. *13*.

Step 22. Install the loop antenna. Fasten the loop-mounting brackets (Parts *7-8A* and *7-8B*) to the chassis as shown in Fig. *14A*, using holes *T* and *T-1*, with two of the 3/8-inch, 8-32 screws and 8-32 hex nuts. This done, place the flat fiber washers

(Part *7-9*) on the remaining ⅜-inch 8-32 screws, and push these through the two small holes nearest the bottom edge of the loop. (The Fahnestock clips are adjacent to the top edge.) These holes are spaced the same dis-

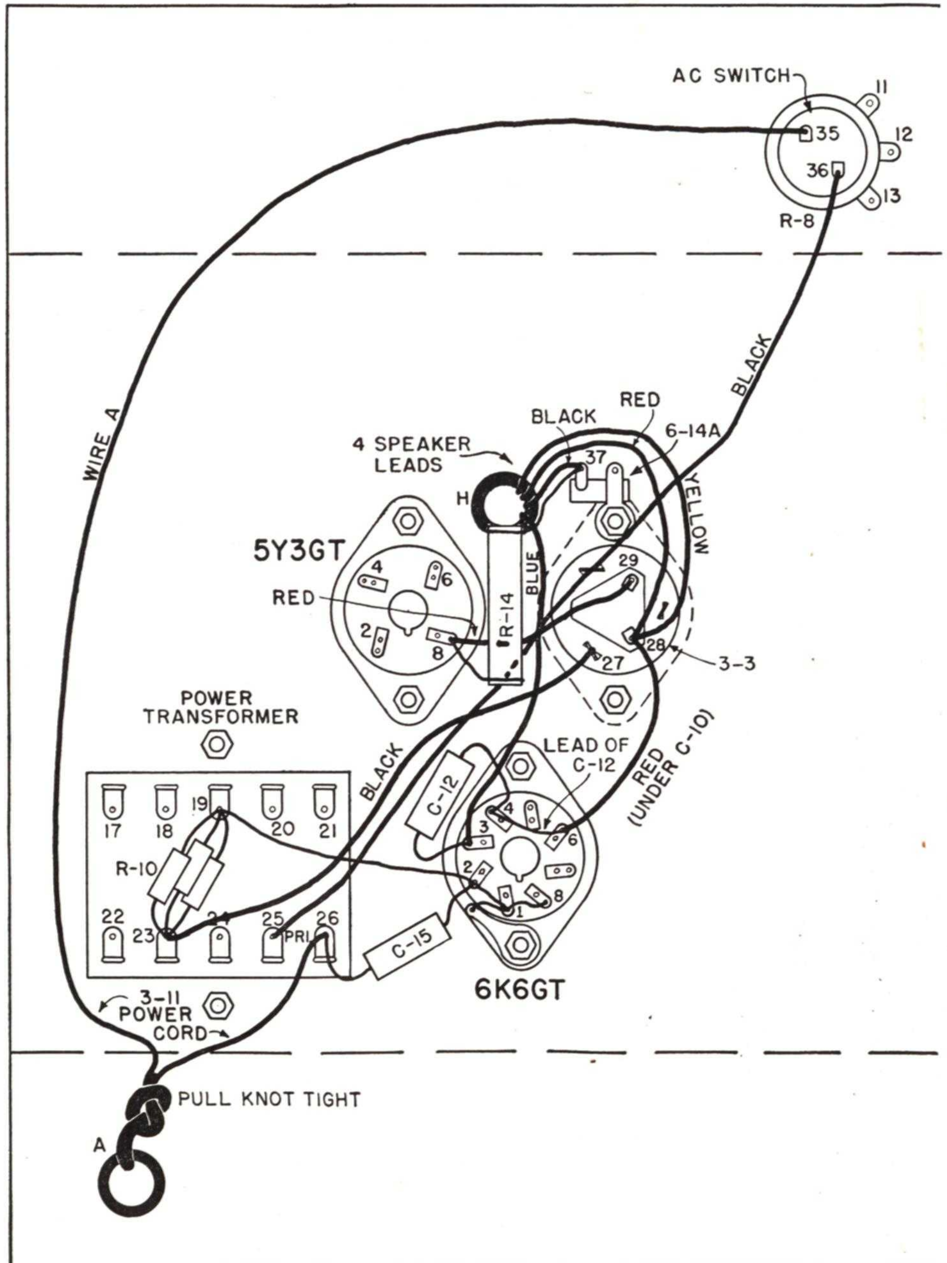


FIG. 13. Here we show the wiring necessary to complete the work under the chassis. Note the position of resistor R_{14}, and the fact that the blue lead from the output transformer passes underneath the leads of C_{12} and R_{14}.

tance apart as the holes in the mounting bracket, and the heads of the screws should be on the same side of the loop as the Fahnestock clips. Now fasten the loop to the brackets with the two remaining 8-32 hex nuts. When assembled, the Fahnestock antenna and ground clips will be on the outside of the loop, and the bottom of the loop should not touch the surface on which the chassis rests.

Solder the inside lead from the loop (the lead nearest the loop center) to terminal *33* of terminal strip *3-12A*. If this lead is too short to reach terminal *33*, solder a short piece of wire onto terminal *33*, and solder this wire to the loop lead. Solder the outside loop lead to terminal *34* of this terminal strip as shown in Fig. *14B*.

Step 23. Solder a piece of black hookup wire to terminal 32 on top of the antenna section of the gang condenser (the section farthest from the front of the chassis), cut the lead so that it will conveniently reach the top cap of the 6A8GT tube when the tube is in its socket, and then solder the remaining grid cap to the free end of this lead. This connection is shown in Fig. *14C*.

Step 24. To assemble the tuning-dial mechanism, the dial scale, and the cover, slip the scale (Part *7-4A*) under the dial pointer so that the four holes in the scale match up with the mounting holes in the dial frame. (The complete dial assembly is shown in the picture opposite page 1. Place the dial-scale cover (Part *7-4B*) over the dial scale so that its mounting holes line up with the others, and so that the cut-out portion is at the top for the dial pointer to pass through. Put the four mounting screws (Part *7-5A*) through all the holes so that they project through to the back of the dial frame. Put nuts on each screw, and tighten all four screws and nuts. When you turn the tuning shaft, the pointer should move back and forth. Do not turn the shaft so that the pointer hits the cut-out ends on the dial cover.

Step 25. You may now mount the

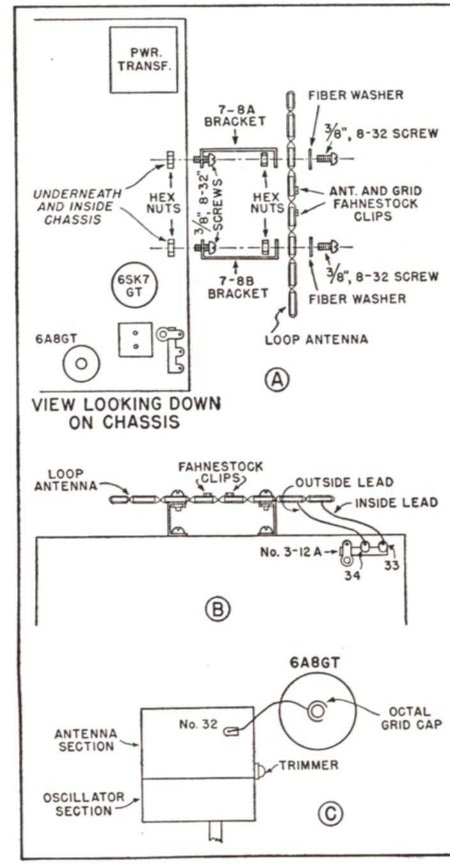


FIG. 14. The method of mounting the loop antenna is shown in sketch A, and its associated wiring in sketch B. The Fahnestock clips on the antenna framework must be on the side away from the chassis. No lock washers are used here, so draw the nuts up tight. Sketch C shows the lead necessary to interconnect the stator plates of the antenna section of the gang condenser and the control grid element of the 6A8GT tube.

tuning-dial mechanism. First, open the condenser gang so that the plates are out of mesh as much as possible. Then, loosen the set screw in the big pulley on the tuning assembly. Now put the dial assembly in place so that the volume control shaft protrudes through the hole in the left-hand bracket, and the large-pulley hub fits on the tuning condenser shaft. Put two ¼-inch, 6-32 screws through the mounting holes in the brackets, place the flat washers (Part *7-31*) on the screws inside the chassis, and start the 6-32 nuts on the screws until they just begin to tighten up.

Now rotate the large drive pulley until the set screw is in a vertical position (slide the pointer along the cord if necessary, to avoid its striking the scale cover), and tighten the set screw *securely* on the condenser shaft. Slide the pointer along the dial cord to the left, and, with the condenser gang completely out of mesh, set the pointer directly over the last vertical line at the left-hand end of the calibrated scale, as shown in Fig. *15*. Close the pointer clamp *lightly* on the cord. Put the control knobs on both shafts, and rotate the tuning shaft clockwise to close the condenser plates. When the plates are fully closed, the pointer should be over the last mark at the right-hand end of the calibrated scale.

Make sure that the tuning control runs free; then draw up the nuts holding the dial frame to the front of the chassis, and those holding the tuning condenser in place. Keep the condenser and the dial mechanism in alignment while tightening the nuts so that the condenser plates won't be pulled out of position.

Next push the pilot-lamp socket and grommet down into the slotted bracket on the back of the dial mechanism so that the inside edges of the grommet slot engage the slot in the mounting bracket.

The final assembly step* is to screw the pilot lamp into its socket, and to insert all tubes into their sockets, checking their positions against Fig. *6B*, and to place the top-cap connectors on tubes 6A8GT and 6F8G. *DO NOT PLUG THE SET INTO A POWER OUTLET UNTIL INSTRUCTED TO DO SO.*

* You should have a 10,000-ohm and a 100,000-ohm resistor left over. Don't worry about this, for these are to be used in Experiments and Report Statements. Be sure to save them.

PRE-OPERATION TESTS

As a serviceman, you will first confirm the customer's complaint, make an inspection for surface defects, and use effect-to-cause reasoning to isolate the receiver defect to a given stage. Next, you will use a voltmeter and an ohmmeter to locate the defective circuit and part. By properly blending effect-to-cause reasoning with your electrical tests you can greatly reduce the number of tests required to locate a particular trouble. However, this procedure is not practical to use on a new receiver which has never been operated. Here you must make point-to-point resistance measurements of both power supply and signal circuits to make sure that B+ is not grounded, that each power supply circuit has continuity, and that the signal circuits are O.K. Unless you do so before trying the receiver out, there is a very real possibility that you will damage one or more receiver parts.

The tests about to be described are more elaborate and numerous than those you will use on any one service job. Actually, they embody all the types of tests you will use from time to time in general service work. Thus, you get much valuable experience for future work as well as determining whether or not it is safe to apply power to your set.

Notes on Using the NRI Tester For Experiments in General Service Work

The methods described in previous Instruction Manuals (2RK-1 and 4RK-AC) for calibrating the NRI Tester are based on the assumption that the tube characteristics exactly match the meter scale, and that the batteries provide the correct voltages under all conditions. Actually, however, this ideal condition seldom exists because of the normal variations in tubes and meters, and the decrease in battery voltage as the instrument is used. Errors in measurement due to tube and meter characteristics are held to a minimum by careful selection of these items. Errors due to low A and B battery voltages can be

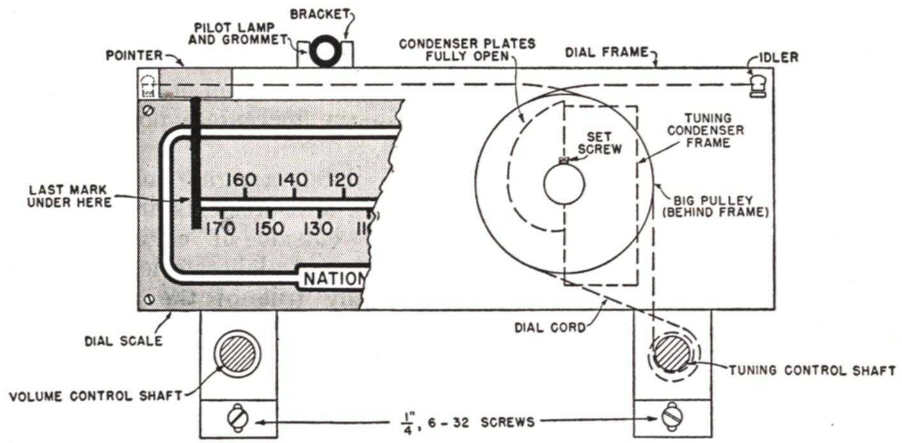


FIG. 15. Phantom view of the dial-drive mechanism. Only a portion of the calibrated dial scale is shown, so you can see the position of the big pulley and the rotor plates of the condenser gang. The condenser must be fully opened up; the set screw in the hub of the big pulley must be in a vertical position; and the pointer must be placed directly over the last mark at the left end of the calibrated scale, as explained in Step 25.

reduced by a slight change in the calibration procedure.

Although a slightly low B battery will have little or no effect on the 0 and 1.5 calibration points, the error at full-scale may be appreciable. Greater over-all accuracy will be obtained if the error is averaged over the entire scale rather than lumped at one end. This is done by calibrating at 0 and 3 on scale *DC*, using the *—9C* and *—6C* terminals of the C battery respectively. This procedure reduces the error at the right end of the scale, introduces a small error at the left end of the scale, and insures maximum accuracy at the center of the scale, where you should take your readings whenever possible.

Under ideal conditions, the tester could be used as an ohmmeter without further adjustment. Here again, however, changes in battery voltage introduce a certain percentage of error. The ohmmeter calibration procedure given in Instruction Manual 4RK-AC assumes that only a small adjustment of the potentiometer need be made to swing the meter pointer to 0 on scale *R*. A partially exhausted B battery or a weak tube requires considerable adjustment to get 0 on the *R* scale. This of course upsets the balance previously achieved at the left end of the scale, so the left end of the scale no longer indicates resistance values accurately.

Here again you may average the error over the entire scale by using *—9C* and *—6C* to calibrate the tester at 0 and 3 respectively on scale *DC*. When you have done this, put your test probes in the *R* jacks, and short the test clips together. The position the meter pointer assumes under these conditions is the zero ohms position regardless of whether it is one half a scale division, one scale division, two scale divisions, or some other value away from zero on the *R* scale. The difference between this pointer position and 0 on scale *R* represents the amount of error. Since it is to the left of 0, the meter reading is that much too high. Don't forget, however, that the amount of error will be different for each different range, so correct your readings accordingly.

Somewhat more accurate results can be obtained by calibrating at 0 and 1.5 on scale *DC* to make the portion of the *R* scale between 10 and 100 the most accurate, and then choosing a range which will bring the meter pointer into this more accurate portion of the scale. For instance, use *10* × *R* instead of *100* × *R* to measure a 300-ohm resistor so that the meter will read 30 instead of 3 which would be in the inaccurate portion of the scale.

Absolutely accurate voltage and resistance measurements are seldom required outside of engineering and development laboratories. This is especially true of the radio-service profession where the wide tolerances to which standard receiver components are made will usually prevent you from exactly duplicating a given set of measurements no matter how accurate your measuring instrument. Therefore, from a practical standpoint, if you can measure to within ±20% of a given value, you will have sufficient data for purposes of analysis.

Keep these facts in mind as you make the required series of resistance and voltage tests on your NRI receiver. In the instructions which follow, we will simply tell you to use your tester as a voltmeter or an ohmmeter. You will be required to determine for yourself what range to use, and the best method of calibrating your instrument for the particular series of measurements required. In so doing you will be making the same decisions you will have to make time

and again as you service commercially manufactured sets.

Continuity Tests

Before measurements of any sort can be made, certain reference points must be chosen. The reference points for the continuity tests about to be described are the filament (cathode) of the 5Y3GT rectifier tube socket, and the chassis. All positive tube electrodes will be traced back to the filament of the 5Y3GT, and all negative tube electrodes will be traced back to the chassis. Proceed as described in the following steps:

Step 1. To prepare your tester, put your black test probe into jack *26*, your red test probe into jack *27*, and calibrate your tester for ohmmeter measurements.

Step 2. Check the continuity of the positive side of the voltage supply circuits by fastening the black test lead clip to terminal *8* of the 5Y3GT tube socket, and holding the clip of the red lead onto the terminals listed in Step 2 of Table *A*, in the order given. Thus, for *a*, the red clip goes on terminal *3* of the 6K6GT socket; for *b*, the red clip goes on terminal *4* of the 6K6GT socket, etc. Use an appropriate range of your ohmmeter for each test, according to the values to be read. Record the values you get for the various tests in the blank spaces provided in Table *A*. For practice in reading diagrams, and to check your circuits, trace out the circuit paths each test includes, using the complete receiver schematic diagram given on page 28.

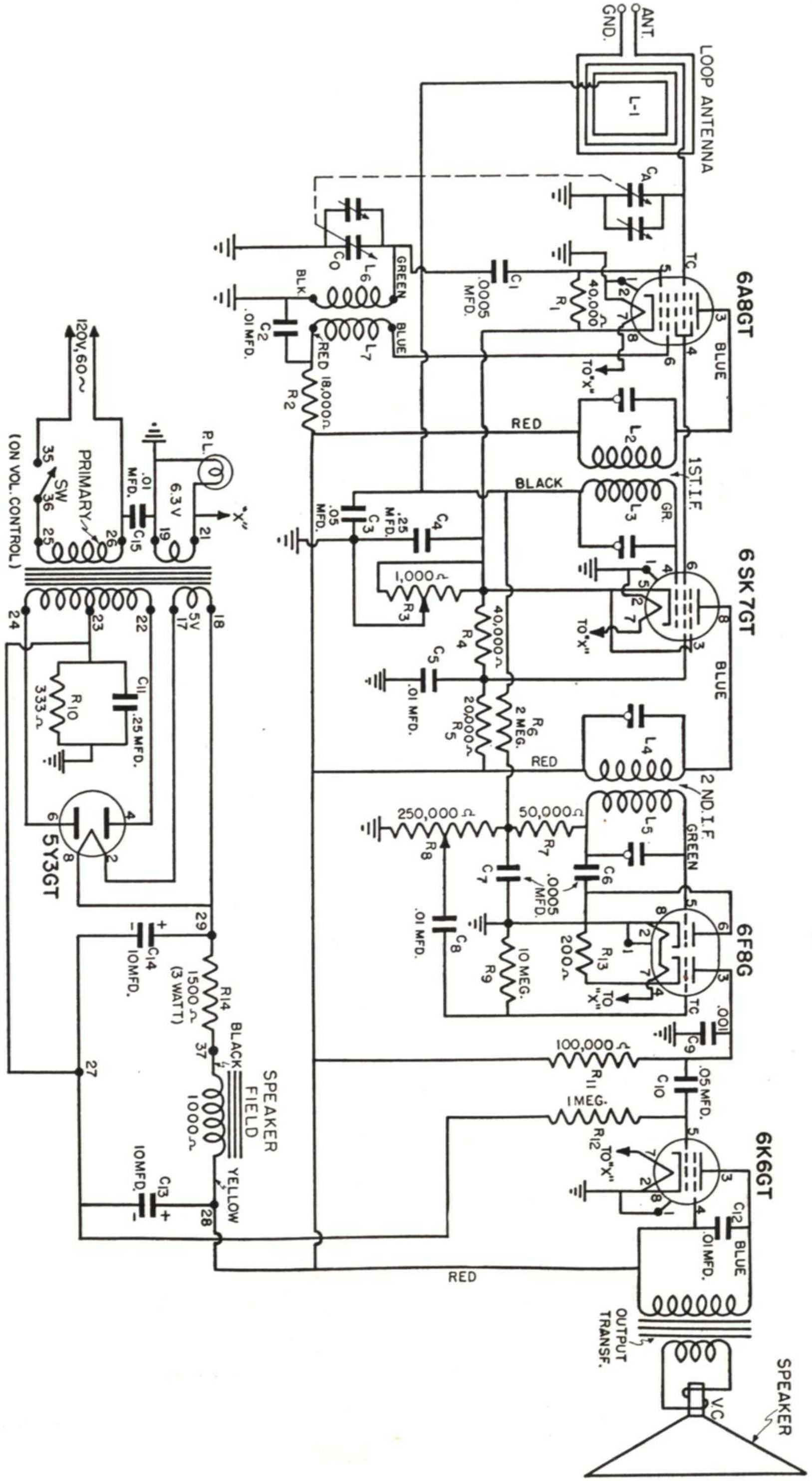
Step 3. To check the continuity of the negative side of the supply circuit, proceed as follows: First, set the r.f. gain control (R_3) at approximately its mid point. Next, move the black ohmmeter lead from terminal *8* of the 5Y3GT socket to the chassis. Hold the red lead clip onto the terminals listed in Step *3* of Table *A*, in the order given. As before, change the range of your ohmmeter as may be necessary for the circuit you are checking, and record your test results in Table *A* under Step *3*.

Step 4. Check for short circuits. The above tests checked continuity in

TABLE A

STEP		TEST POINTS	RESISTANCE IN OHMS: YOUR VALUE	RESISTANCE IN OHMS: NRI VALUE
2	A	8 OF 5Y3GT TO 3 OF 6K6GT		2,900
	B	8 OF 5Y3GT TO 4 OF 6K6GT		2,500
	C	8 OF 5Y3GT TO 3 OF 6F8G		100,000
	D	8 OF 5Y3GT TO 6 OF 6SK7GT		23,000
	E	8 OF 5Y3GT TO 8 OF 6SK7GT		2,500
	F	8 OF 5Y3GT TO 3 OF 6A8GT		2,500
	G	8 OF 5Y3GT TO 4 OF 6A8GT		23,000
	H	8 OF 5Y3GT TO 6 OF 6A8GT		20,000
3	A	CHASSIS TO 4 OF 5Y3GT		600
	B	CHASSIS TO 6 OF 5Y3GT		600
	C	CHASSIS TO 8 OF 6K6GT		0
	D	CHASSIS TO 4 OF 6F8G		195
	E	CHASSIS TO 8 OF 6F8G		0
	F	CHASSIS TO 3 OF 6SK7GT		230
	G	CHASSIS TO 8 OF 6A8GT		230
4		8 OF 5Y3GT TO CHASSIS		60,000

TABLE A. Here are the test points and the approximate values you should get in testing the d.c. supply circuits of your receiver. Enter your values in the blank spaces.



Complete circuit diagram of the NRI receiver. As you install and wire up the various parts, locate the symbols that represent them. This will be valuable experience for you in comparing a circuit diagram with actual wiring.

each side of the supply circuit, but we want to know whether or not B+ is grounded before power is turned on, so with the black ohmmeter lead still on the chassis, hold the red lead clip onto terminal *8* of the 5Y3GT rectifier tube socket. Because resistors R_4 and R_5 act as a voltage divider and bleeder for the screen grids of the r.f. tubes, you will get a continuous reading for this test, which does not necessarily mean a short circuit. The normal resistance for this test, as shown in Table *A*, is around 60,000 ohms. Enter your reading in Table *A*.

As we have already pointed out, some variation may be permitted between your readings and ours to allow for ohmmeter errors, and for variations in the values of the parts themselves. If your results differ *radically* from ours, look for the cause, and correct the trouble.*

Step 5. Check the signal circuits, now that you have made sure that the power supply circuits are all right. The various test points are listed in Table *B*, and appropriate space is given for you to write in your results for each test. As you carry out the tests, be sure to allow for variations between your results and ours caused by normal manufacturing tolerances, and differences between your tester and ours. Your readings may vary as much as 20% above or below ours. Of course, if you get no reading at all when you are supposed to get a "full-scale" reading, you can be sure something is wrong. Locate the reason for any radically different test results, and correct it before going further.

* By this time you should be able to analyze your readings and determine what could cause the variations you have noted. However, if your are unable to explain radical differences, proceed with Step 5 so as to get a complete set of point-to-point resistance measurements, and then send us an exact copy of the results you entered in Tables *A* and *B* so that we can help you figure out what's wrong before you apply power to the receiver.

Checking the Operating Voltages

A measurement of the operating voltages applied to the tubes in your receiver is an added precaution against damage, because incorrect voltages point to errors in the assembly of the receiver. You will seldom make such a complete series of measurements in general service work, because you will usually be working with only one stage, which has been selected by an isolation procedure or by effect-to-cause reasoning. However, since you will be working on many different receivers over a period of time, and will use all of these tests, you are getting the experience you need to become an expert Radiotrician.

As in the case of resistance measurements, there must be a definite reference point for voltage measurements. Here, however, we are interested in only one reference point—the negative one. For a single stage, this is the cathode of the tube in that stage; but for a rapid over-all check of the entire receiver, we can use the receiver chassis whenever it forms a part of the voltage supply circuit for a number of stages, as it does in this receiver.

Step 1. Preparing to make d.c. voltage measurements.

(a) First, check the calibration of your tester for voltage measurements.

(b) Before you put your test leads into the jacks, make sure that the meter pointer remains at zero when the selector switch is turned to the *30* × *V*, *3* × *V*, and *V* ranges, respectively. If you get appreciable deflections on the *3* × *V* and *V* ranges, either leakage is present in your tester, or you have a gassy 1C5GT tube. Reduce such leakage as described in your 4RK-AC Instruction Manual, and then, if necessary, try a new tube.

(c) Put the *black* test lead probe into jack *28*, the *red* test lead probe into jack *29*, and return the selector switch to the *100* × *V* position.

(d) Plug the power cord into a 115-volt, 50-60-cycle wall power outlet, and turn the volume control to the ON position. Make sure that all tube filaments light up, and that the pilot lamp works O.K. Watch the rectifier tube carefully. If you see an intense blue glow *inside the plates*, if its plates become red hot, if any of the tubes fail to light up, or if you notice smoke coming from underneath the chassis, turn the power OFF immediately and find out what's wrong before going further.

(e) If you notice nothing unusual, carefully turn the receiver upside down, while continuing to operate it, and fasten your black test clip to the chassis. You are now ready to make the series of voltage tests listed in Table *C*. If you are interrupted before you finish this series of tests, turn OFF both the receiver and the tester. When you begin again, wait for a half minute or so for the receiver to warm up, and then continue your tests where you left off.

Step 2. Take your measurements now. The test points to be used are given in Table *C*, but the various meter ranges are not. You should know by this time what to do when you don't know exactly what voltage to expect, and how to follow up for a more accurate measurement when you find the meter deflection too small for an accurate reading. Enter your readings in Table *C* as you make them.

Be sure to turn OFF the set and the tester when you are through making these measurements.

If you are operating your receiver on an a.c. line voltage between 115 volts and 120 volts, the results of your measurements should be within ±20% of ours. If your results compare favorably with ours, proceed to the alignment instructions in the next section; if they are *radically* different from ours, find out why, before going further.

TABLE B

STEP 5	TEST POINTS		RESISTANCE IN OHMS	
	RED PROBE ON	BLACK PROBE ON	YOUR VALUE	NRI VALUE
A	5 OF 6K6GT	CHASSIS		1 MEGOHM
B	7 OF 6K6GT	CHASSIS		0
C	5 OF 6F8G	CHASSIS		300,000
D	6 OF 6F8G	CHASSIS		0
E	7 OF 6F8G	CHASSIS		0
F	TOP CAP OF 6F8G	CHASSIS		10 MEGOHMS
G	TOP CAP OF 6F8G	10 OF STRIP 3-12B		0
H	4 OF 6SK7GT	CHASSIS		2.25 MEGOHMS
I	7 OF 6SK7GT	CHASSIS		0
J	5 OF 6A8GT	CHASSIS		40,000
K	7 OF 6A8GT	CHASSIS		0
L	TOP CAP OF 6A8GT	CHASSIS		2.25 MEGOHMS
M	31 OF GANG CONDENSER	CHASSIS		5

TABLE B. This series of measurements checks the continuity of the signal circuits in your receiver. Record your values in the appropriate blank spaces. Of course, the 0 ohms values in this table are indicated by the movement of the meter pointer to the full-scale (right-hand) end of the *R* scale.

TABLE C

MEASUREMENT	RED CLIP ON	BLACK CLIP ON	YOUR VALUE	NRI VALUE
B+	8 OF 5Y3GT	CHASSIS		360
6K6GT (SG)	4 OF 6K6GT	CHASSIS		225
(P)	3 OF 6K6GT	CHASSIS		215
6F8G (P)	3 OF 6F8G	CHASSIS		45
6SK7GT (P)	8 OF 6SK7GT	CHASSIS		225
(SG)	6 OF 6SK7GT	CHASSIS		85
(K)	5 OF 6SK7GT (R-3 IN MID POSITION)	CHASSIS		3.5
6A8GT (P)	3 OF 6A8GT	CHASSIS		225
(SG)	4 OF 6A8GT	CHASSIS		85
(OP)	6 OF 6A8GT	CHASSIS		140
(K)	8 OF 6A8GT (R-3 IN MID POSITION)	CHASSIS		3.5
6K6GT BIAS	CHASSIS	23 OF POWER TRANSF.		16.5
A.C. LINE VOLTAGE	26 OF PWR. TRANSF.	35 OF VOL. CONTROL		120
A.C. FILAMENT VOLTAGE	7 OF ANY SOCKET	CHASSIS		6.2

TABLE C. Record here your values for the voltage tests you make in Step 2 of the section on "Checking the operating voltages."

ALIGNING THE RECEIVER

The normal alignment procedure makes use of a signal generator and an output meter. However, since the first i.f. transformer of the NRI receiver has been set to the desired 456 kc. i.f. by the factory (to provide a tie-down point), satisfactory alignment may be accomplished without a signal generator. Both alignment procedures will be fully described, the method of alignment without a signal generator being considered first. If you have an accurately calibrated signal generator, providing tone-modulated test frequencies of 456 kc., 600 kc., 1400 kc., and 1700 kc., you may skip the following section and proceed with the section "Alignment With a Signal Generator." If you have no signal generator, proceed as described in the following section.

Alignment Without a Signal Generator. You must correctly identify each trimmer (see Fig. *6B*), and thoroughly understand each step. Therefore, read the following instructions carefully before you make any adjustments. When you have done this, and before you turn ON the receiver, proceed as follows:

Step 1. Preliminary adjustment of trimmers.

(a) Turn both trimmers of the *second* i.f. transformer (the one between the 6SK7GT and 6F8G tubes) to the full clockwise position for maximum capacity, then back each one off 3/8 of a turn. This sets the *second* i.f. close enough to the desired 456 kc. i.f. frequency so that a signal will be passed by the transformer. DO NOT TOUCH THE TRIMMERS OF THE FIRST I.F. TRANSFORMER.

(b) Turn the oscillator trimmer to the full clockwise position, and then back it off 1/2 of a turn. This approximately sets the frequency of the local oscillator for the reception of stations at the high-frequency end of the dial.

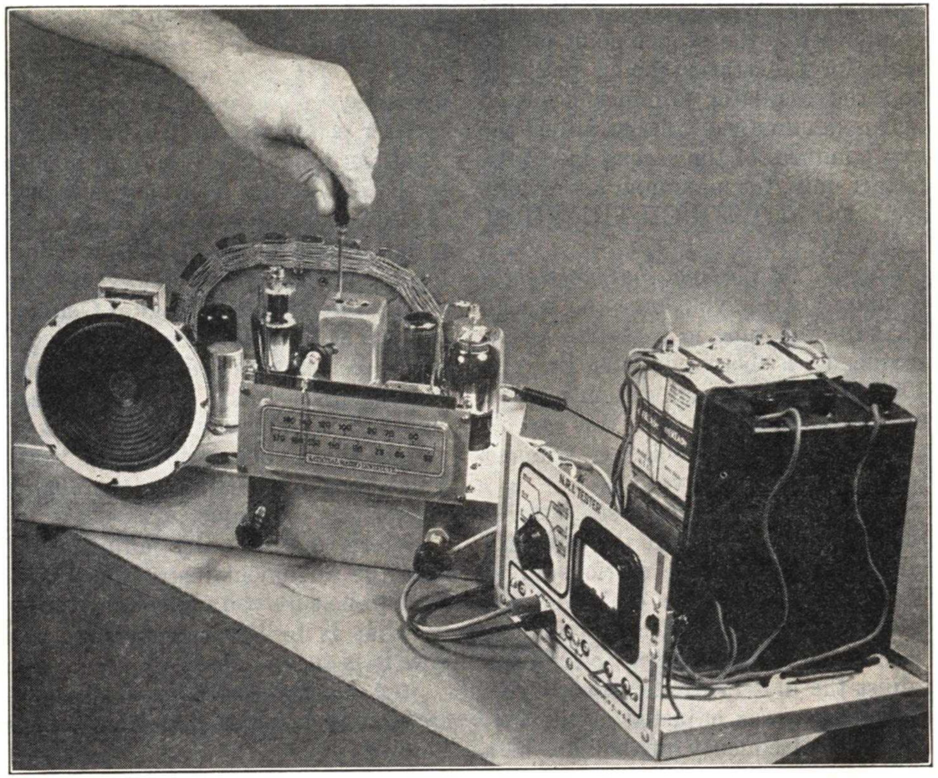
(c) Turn the preselector trimmer to the full clockwise position, and back it off 1/2 of a turn, to achieve reasonable tracking for the initial adjustments.

(d) Turn the r.f. gain control (R_3) either all the way to the right or all the way to the left.

Step 2. Recheck the position of the big dial-drive pulley. It must be as shown in Fig. *15* or the pointer travel will be incorrect, and you will be unable to turn the condenser gang throughout its entire range. Rotate the tuning knob until the tuning condenser gang is fully open, and make sure that the dial pointer is set at the mark on the dial scale which indicates the limit of pointer travel to the left, as shown in Fig. *15*.

Step 3. Use your NRI Tester as a d.c. voltmeter to measure the a.v.c. voltage, and thus indicate when absolute maximum output has been obtained for any adjustment. Connect the red test clip (from jack *29*) to the chassis, and the black test clip (from jack *28*) to a.v.c. terminal *33* on top of the chassis directly behind the first i.f. transformer. Set the selector switch at the *V* position.

Step 4. Tuning in a station. Plug the receiver power cord into the wall outlet, turn the combination power switch and volume control knob as far as it will go to the right, and wait for a half minute or so for the tubes to warm up. Tune in the highest-frequency broadcast-band station you can get. If you live in a locality where radio signals are comparatively weak, it may be necessary to connect an antenna to one of the Fahnestock clips on the loop in order to get enough signal for the initial adjustments. However, if you have strong local stations, the loop will be sufficient,



Adjusting one of the trimmers of the 2nd i.f. transformer. The NRI Tester is being used to measure the a.v.c voltage and thus indicate when peak response has been obtained.

and the addition of an antenna might cause overloading.

Determine the frequency of the station you have tuned in by listening to its call-letter announcement and then looking it up in a radio station log.*

Now that you know the frequency of the station being received, note whether the dial pointer is to the right or the left of the point on the scale where the station should be tuned in.

Note that the calibration points on your scale run from 55 to 170. This corresponds to a frequency range of from 550 kilocycles to 1700 kilocycles. Therefore, if the station you pick up operates on 1400 kilocycles, your dial pointer should be directly over the mark underneath 140.

Step 5. If the pointer is not on the correct dial setting, tune the receiver towards the proper setting until the station can just barely be heard. Then adjust the *oscillator trimmer* on the tuning condenser gang (see Fig. *6B*) for maximum output. If necessary, again tune the receiver towards the correct dial setting, and re-adjust the oscillator trimmer for maximum output. When the repeated adjustments cause the pointer to reach the correct dial position for the station being received, adjust the oscillator trimmer for maximum reading on your NRI meter.

Step 6. Re-adjusting the second i.f.

* Most newspapers carry program logs of local stations which not only give the call letters of the stations, but their authorized operating frequencies as well.

transformer. When you have the dial pointer set to the proper point on the scale for the station being received, and the oscillator trimmer adjusted for maximum a.v.c. voltage, adjust the two trimmers of the *second* i.f. transformer only, for maximum a.v.c. voltage.* DO NOT TOUCH THE FIRST I.F. YET.

Step 7. Adjusting the preselector trimmer. After you have the second i.f. adjusted, tune in a station whose frequency is between 1300 kc. and 1500 kc. (the original station may be used if its frequency is in this range), and adjust the preselector trimmer for maximum a.v.c. voltage.

Step 8. Adjusting the first i.f. transformer. When you have the oscillator adjusted to bring the stations in at correct points on the dial, and the second i.f. and preselector trimmers adjusted for maximum a.v.c. voltage, adjust the first i.f. transformer. This transformer was adjusted at the factory to a frequency of 456 kc. in a test jig which approximates as closely as possible the stray capacities and inductances of normal circuit wiring. However, if there is any difference between the positions of your circuit wiring and parts, and those of the circuit in which the transformer was adjusted, the result will be that the transformer is incorrectly tuned for your circuit. This difference can be tolerated for the initial adjustments, since it is usually a very minor mistuning. For peak response, however, the first i.f. transformer may require some adjustment to fit exactly into your circuit. You may make this adjustment now by tuning in any station, removing the seal which covers the trimmer adjustment holes, and adjusting the trimmers of the first i.f. for maximum a.v.c. voltage. *Note: Only a slight re-adjustment should be necessary, so go easy.*

After you have completed the alignment, securely clamp the dial pointer to the dial cord. You may now proceed to the performance tests listed in the section following the procedure for alignment with a signal generator.

Alignment With a Signal Generator. The procedure for aligning your NRI receiver with the aid of a signal generator is standard in every respect. You will use it many, many times as you go about your radio service work. You should, therefore, thoroughly master this technique.

Before making any adjustments, read the alignment instructions carefully to be sure you understand exactly what is to be accomplished, and how it is to be done.

Step 1. Prepare your signal generator and receiver for alignment as follows:

(a) Turn the signal generator power switch ON so as to give the tubes a chance to warm up and reach stable operating conditions.

(b) Set the frequency control of the signal generator to produce a modulated r.f. signal of exactly 456 kc.

(c) Connect the "hot" lead of the signal generator to the top cap of the 6A8GT tube through a suitable blocking condenser (about .001 mfd.) as shown in Fig. *16,* to prevent short-circuiting of the a.v.c. voltage. The grid lead from the antenna section of the tuning condenser to the top cap of the 6A8GT tube need not be removed.

(d) Fasten the ground lead of the signal generator to the receiver chassis.

(e) Set the attenuator controls on the signal generator for maximum r.f. output, and the r.f. gain control (R_3)

* *NOTE:* If the receiver goes into oscillation while you are aligning the second i.f. transformer, turn the r.f. gain control R_3 toward the mid position to a point just beyond the point of oscillation. Oscillation will not always occur, but R_3 is provided to control it when it does.

of the receiver all the way to the right or all the way to left.

(f) Turn both trimmers on the second i.f. transformer to maximum capacity, and then back each one off 3/8 of a turn. This sets the transformer close to the desired i.f. frequency, and makes alignment faster and easier. The first i.f. has been set at the factory to 456 kc., so you need not make any change in the adjustment of its trimmers until you have the second i.f. correctly aligned.

Step 2. Use your NRI Tester as a d.c. voltmeter to measure the a.v.c. voltage, and thus indicate when absolute maximum output has been obtained for any adjustment. Connect the red test lead clip (from jack *29*) to the chassis, and fasten the black test lead clip (from jack *28*) to a.v.c. terminal *33* behind the first i.f. transformer on top of the chassis. Set the selector switch of your tester to the *V* position.

Step 3. Check the position of the dial pointer on the calibrated scale with respect to the position of the tuning condenser rotor. With the condenser fully opened up, the pointer must be directly over the mark on the dial scale which indicates the limit of pointer travel to the left as shown in Fig. *15.* Also, check the position of the large drive pulley to make sure the set screw in the hub of the large pulley is in a vertical position on top of the hub as shown in Fig. *15.* If it is not, you will not be able to turn the condenser through its complete range.

Step 4. Align the second i.f. transformer. Turn the NRI Tester ON, plug the power cord of the receiver into a wall outlet, and turn the receiver full on. If a station signal is heard, tune the receiver to some point on the dial where no broadcast station is picked up, and no squeal is heard. If necessary, turn R_3 towards its mid point to eliminate oscillation. When the modulation tone of the signal generator is heard clearly, adjust first one trimmer of the second i.f. transformer for maximum tone volume and meter reading; then adjust the other trimmer likewise. As the signal gets louder, reduce the output of the signal generator so as to keep the meter

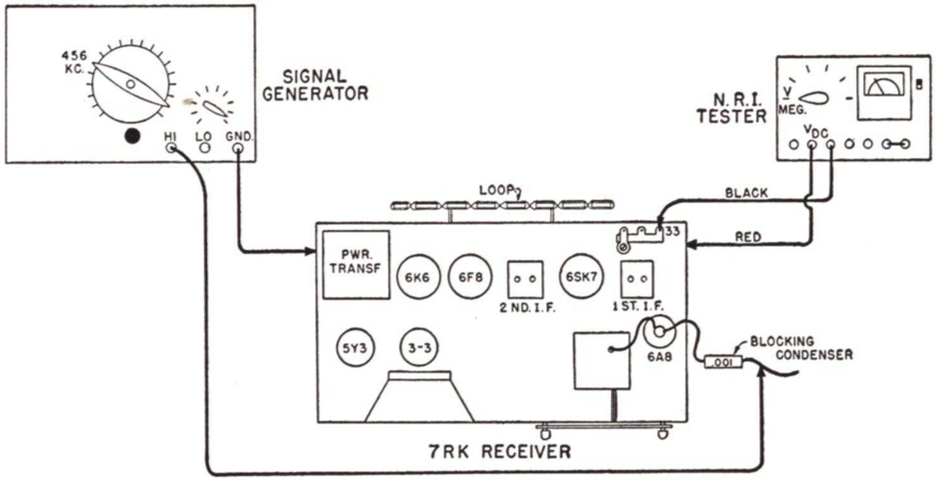


FIG. 16. This sketch shows the connections to be made when aligning the i.f. stages with the aid of a signal generator. The signal generator you use probably won't look at all like the one shown, but it will have a frequency control, some sort of output attenuator, and one or more "output" jacks. Set the frequency control exactly to 456 kc., and use full output for the initial adjustment. Note how the NRI Tester has been connected to act as an "output" indicator.

pointer slightly less than 3 volts (half-scale deflection on scale *DC*). You thus avoid overloading the tester, and at the same time keep the signal level low enough so that the a.v.c. action of the receiver won't appreciably affect the accuracy of the alignment.

After you have made the initial adjustments, go over both trimmers carefully again, because there is a certain amount of interaction between the primary and secondary windings which you cannot overcome without going over the adjustments several times.

Step 5. Align the first i.f. transformer. The first i.f. transformer was adjusted by the factory to the desired 456 kc. i.f. frequency to provide the students who have no signal generators a tie-down point for alignment. Because of differences between the stray capacities and inductances of the factory test jig, and of your receiver, it will be necessary to touch up the alignment of the first i.f. to peak it exactly at 456 kc. in your receiver. Do this now, after removing the seal covering the trimmer holes, in the same manner that you adjusted the second i.f. You will not have to turn the trimmers very much. When you have finished with the first i.f., go back to the second i.f., and make a final adjustment for peak output.

Step 6. You must now adjust the oscillator of the receiver so that the stations come in at the correct points on the dial. Proceed as follows:

(a) Set the receiver dial pointer exactly at 1700 kc.

(b) Set the frequency control of the signal generator exactly at 1700 kc.

(c) Transfer the "hot" signal generator output lead to one of the Fahnestock clips on the back of the loop antenna, as shown in Fig. *17*. It makes no difference which clip you use. You need not use a blocking condenser this time.

(d) Adjust the oscillator trimmer condenser for maximum volume and maximum meter reading (a.v.c. voltage). Keep the r.f. input low enough to maintain the meter pointer at about mid-scale of the *V* range for greatest accuracy in tuning.

Step 7. Tune the signal generator and receiver to some frequency near 1400 kc. where no station is picked up, and adjust the preselector trimmer for maximum output.

Step 8. Now tune in other stations (at both ends of the dial). If they come in at the correct points on the calibrated scale, the alignment has been completed satisfactorily, and the dial pointer may be securely clamped onto the dial cord.

Judging Receiver Performance

The receiver you have just built is typical of many commercially manufactured sets. You should devote several evenings and some part of a day to determining its capabilities. Tune in local and distant stations; compare its selectivity and sensitivity with that of other receivers you have operated.

To evaluate its performance fairly, you must take certain important factors into consideration. For one thing, you cannot compare its sensitivity and selectivity characteristics with those of eight- and ten-tube receivers, for such sets may have two i.f. stages and a stage of tuned r.f. amplification preceding the frequency - converter stage. Your receiver, like most commercially manufactured receivers, especially the table types, has but a single i.f. stage, and the loop antenna is tuned and its signal fed directly into the converter.

A great number of tubes, however, does not insure a high degree of either selectivity or sensitivity in a receiver. A glance at the circuit diagram of any of the more expensive receivers re-

veals the fact that not all the tubes amplify the desired signal. Some are used for automatic frequency control, as a separate oscillator, for noise suppression, automatic volume control, and phase inversion purposes. On the other hand, selectivity depends on how the various tuned circuits are adjusted. That is to say, whether they are peaked for sharp response, or band-passed for high-fidelity reception.

The various factors which govern the quality of reproduction must also be considered in evaluating the performance of a given receiver. In the first place, the small 4-inch and 5-inch loudspeakers are not capable of reproducing the low range of frequencies obtainable from the large 12-inch units. Furthermore, low-frequency reproduction suffers further by the limited baffle area available in midget and table model receivers. Other things being equal, better low-frequency reproduction is obtained from a 12-inch speaker mounted in a console type of cabinet.

Many of the smaller sets use special circuits to attenuate the high-frequency response, and thus create a false impression as to the actual amount of low-frequency response obtained. In the larger sets you will usually find much more elaborate and flexible "tone" control circuits which make it possible either to amplify or to attenuate high, medium, or low frequencies, thus suiting the taste of practically any customer.

Distortion in the larger receivers is kept at a minimum by providing for considerably more power output than is ever used under average home conditions. This makes it possible to operate the output stage conservatively, eliminating over-driving and the consequent distortion which is produced under such conditions. Midget receivers, on the other hand, usually operate very nearly at full output, and are thus constantly at or past the point where distortion becomes noticeable.

There are, of course, other factors which make for convenience in operation but which rarely enter into the final judgment of the performance.

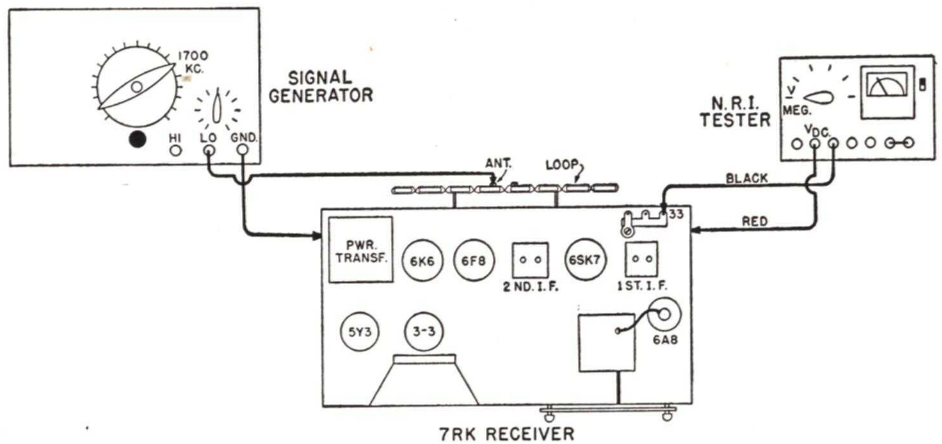


FIG. 17. Here the output of the signal generator has been shifted to one of the Fahnestock clips on the loop, and the frequency control set for 1700 kc. It makes no difference which Fahnestock clip is used. Note that now the "low" output jacks of the signal generator are used to keep from over-loading the r.f. stages.

The customer or set owner is primarily interested in knowing whether or not the set will tune adjacent-channel stations in and out with a minimum of interference, whether or not it will pick up distant stations, and if the quality of reproduction is pleasing.

All the factors which influence receiver performance are not confined to the set itself. The successful serviceman realizes that such things as location and time of reception have a very direct bearing on performance. For instance, if you live in an industrial or commercial neighborhood, you can expect the noise level (man-made interference) to be rather high, and reception of distant stations to be somewhat limited. This is especially true in the case of midget receivers which probably will not bring in anything but powerful locals under such conditions. On the other hand, you can expect reasonably satisfactory reception in strictly residential and rural locations, if they are not too far from broadcast stations.

The shielding effect of a steel-frame building often appreciably reduces the signal level and results in generally unsatisfactory reception. Remember this fact when you are called to modern apartment houses to service midget receivers using loop antennas, especially when the complaint is "weak" reception.

Every radio man recognizes the fact that weather conditions and the season of the year have much to do with radio reception. Electrical storms, by their very nature, produce severe static in all types of receivers designed to reproduce amplitude-modulated signals. You will also find that the natural atmospheric noise level is considerably higher during the summer months. The winter months are generally recognized as being more favorable for good reception.

It is also a fact that there is a considerable difference between day and night reception at any time of the year. You are most likely to receive distant stations on midget receivers at night. In fact, the difference may be so great as to prevent the smaller sets from satisfactorily reproducing anything but comparatively powerful local stations during the daytime.

Once you have learned how to evaluate the performance of different sets, you are in a better position to service them effectively. In other words, you'll not waste time trying to get a given receiver to do something it was not designed to do in the first place. This will allow you to concentrate on the basic defects, and thus turn out more sets per day.

BASIC RECEIVER DEFECTS

As you would expect, the defects you will encounter in servicing receivers and electronic equipment are directly associated with the individual parts used in the equipment. Thus you will actually be dealing with various types of defects in tubes, resistors, condensors, controls, loud speakers, transformers, and their associated wiring. Now that we have a typical receiver that is working, we will introduce various types of defects, and show you the effect they have on receiver performance. This practical experience will help you to recognize the symptoms of these common defects when you meet them in general service work.

Do not expect to be able to introduce *all* defects into this receiver, for there are some defects that don't apply to this type of circuit. You should, however, carry out as many of these tests as you can in other receivers as you get them in for repair, and thus gain additional experience. Let us first consider the usual part failures and their symptoms.

Tube Defects. Tubes fail in a number of different ways. For one thing, the filament may burn out as a result of excess voltage (in a.c.-d.c. sets), or, in the case of tubes whose filament is also the cathode, from too much plate current. You will also find that both the directly and the indirectly heated cathodes lose their emission and thus produce what is popularly known as a "weak" tube. It is also not uncommon to find tubes with short-circuited elements and excessive gas.

There is another type of tube defect which will affect receiver performance. This is leakage between elements, especially between the heater and the cathode in tubes which have a comparatively high filament voltage.

Fixed Resistor Defects. Many receiver troubles can be traced to a resistor whose value has changed radically, or which may have opened up entirely. You will also find resistors, particularly of the wire-wound type, in which a loose connection introduces noise into the circuit as it expands and contracts with temperature changes. In some types of resistors, especially the commercial types known as "Candohms," a breakdown of the insulation will cause an undesirable ground.

The effects of an "open" resistor depend, of course, on the particular circuit in which the open occurs. In general, the resistors which are most apt to become open are those in the circuits carrying current to the plate, screen grid, and cathode elements of the various tubes. The result of an open in these circuits is usually a dead receiver. It is possible, of course, for an open cathode resistor in an audio output stage to introduce severe distortion rather than kill the receiver entirely. In such instances, the receiver continues to play because of a flow of current to the cathode of the output tube through the electrolytic by-pass condenser across the open resistor.

The effects of a *permanent* change in resistor value are not so pronounced, and are seldom the cause for a clear-cut complaint.

Fixed Condenser Defects. Defective condensers will produce many different effects. Depending on its position in the circuit, an open condenser may cause weak reception, oscillation, hum, and motorboating as well as completely kill the receiver. On the other hand, a leaky condenser can cause distortion, as well as weak reception. A completely shorted condenser would be most likely to make the receiver dead. Variations in capacity may affect the alignment, or produce hum and oscillation.

► So much for the ordinary troubles. You will find, however, that successful servicing involves more than the location and replacement of defective tubes, resistors, and fixed condensers. Variable condensers and variable resistors, r.f. and audio transformers, together with the loudspeaker and the associated wiring, all produce their own share of troubles.

Variable Condenser Defects. The plates of the variable gang tuning condenser may become bent and rub together thus shorting out the associated stage, and making the set dead at certain spots on the dial. Dirt and dust will also clog the air gap between the plates, and the wiping contacts will become dirty, thus causing undesirable resistance and noise together with a general over-all reduction in r.f. gain.

Upon close examination you may find that the mica insulation in r.f. and i.f. trimmer condensers is cracked, and that the plates of the trimmers have lost their springiness and so fail to open up as they should during adjustment.

Variable Resistor Defects. Volume controls become noisy and occasionally open up; either condition necessitates replacement. Whether or not an open volume control would make the receiver dead depends entirely on how the control of volume is achieved. In your NRI receiver, for instance, it is doubtful that an open volume control would make the receiver completely inoperative, because there is usually sufficient coupling within the 6F8G tube itself to continue the receiver in operation at a low volume level. This same effect could also occur in receivers using type 6SQ7 and 12SQ7 tubes in a combined second detector and first audio stage.

Tone controls of the continuously variable type, on the other hand, may become noisy, but they rarely open up.

R.F. Coil Defects. There are three general kinds of trouble associated with r.f. coils of all types. First, of course, we have the case of an open winding; next, we have low Q factor; and finally, we have shorted turns. An open winding in an r.f. transformer, an oscillator, or an antenna coil normally makes the set dead. You probably won't notice the effects of low Q and shorted turns from listening to a given receiver unless you are quite familiar with the performance of the set.

Iron-Core Coil Defects. In the course of your service work you will run across various defects in iron-core coils (audio and power transformers and chokes). Here you will find such defects as open circuits, shorted turns, and grounds to the core. As a general rule, any of these defects makes a replacement mandatory.

Loudspeaker Defects. Loudspeakers are also subject to a variety of defects. In the electrodynamic types, you will encounter open field coils, and you will occasionally find that the field coil has become grounded to the frame. All types of loudspeakers are subject to open voice coils, dirt and dust in the air gap between voice coil and center pole-piece, off-center voice coils, warped voice coils, and rattles of various sorts caused by stiff and aging cones.

Mechanical Troubles. You will find troubles of a mechanical as well as of an electrical nature. In this classification we have defective tube sockets, worn contacts in wave-band switches and push-button tuning assemblies, broken dial-drive mechanisms, poor connections, leakage between circuits due to defective insulation, etc. The proper method of clearing such defects is usually self-evident. By that we mean the installation of new dial-drive cords in place of those that are worn or broken completely, the resoldering of loose connections, the cleaning and lubrication of dirty contacts, etc.

But even if you find every part of the receiver electrically and mechanically normal, it can be out of alignment or can operate in such a way as to give the owner cause for complaint. You have already aligned your receiver so we need not take this matter up again. You will, however, want to demonstrate some of the effects of improper operation so that you will recognize them when you come to them in general service work.

► The experiments and demonstrations which follow are designed to give you practical experience in recognizing basic defects by their characteristic symptoms. This is the experience that you need to become a successful Radiotrician. Work out each experiment carefully and completely; don't pass over a single one of them.

EXPERIMENT 61

***Purpose:* To show that cathode-to-heater leakage produces hum.**

Step 1. To simulate cathode-to-heater leakage, solder one end of a short piece of hookup wire to terminal *4* of the 6F8G socket. Arrange the other end of this wire so that it can be conveniently pushed down against filament terminal *7* of the 6F8G socket with the eraser end of a pencil, a small stick of wood, or an insulated screwdriver. When this lead is held in contact with filament terminal *7*, an a.c. voltage will be applied between the cathode of the audio section of this tube and ground.

Step 2. To prove that hum is originating in an audio stage, turn the receiver *on,* wait a half minute or so for the tubes to warm up, and then push this lead down onto filament terminal *7*. As you do this, you should hear a strong, low-frequency hum coming from the loudspeaker. Tune in several stations, and note that the hum is heard at all times, although very powerful local stations may mask it somewhat. This proves that the hum is originating in an audio stage, otherwise it would be heard only when a station was tuned in.

Step 3. To measure the hum voltage at the grid of the 6K6GT output tube when the receiver is operating normally, lift the wire which you used for simulating cathode-to-heater leakage in Step 2 off terminal *7* of the 6F8G socket, and prepare to measure the a.c. grid-to-cathode voltage at the 6K6GT socket. Fasten your black test lead to the chassis, and your red lead to grid terminal *5* for this measurement.

Turn the receiver *on,* tune to a spot on the dial where no station or noise is heard, and then turn the tester *on* and check the voltage. Make a note of your reading.

Step 4. To measure the a.c. voltage applied to the 6K6GT grid with cathode-to-heater leakage in the 6F8G tube, set your tester switch at *100 × V,* push the shorting lead down against terminal *7* of the 6F8G socket, and read the meter. If necessary, turn the selector switch of the tester to a lower range for a more accurate reading. Make a note of your reading.

Instructions for Report Statement No. 61. Turn now to Report Statement No. 61, and enter in the correct blanks the two readings you obtained in Steps *3* and *4*. Then check the box that most nearly represents your observations.

Before going ahead with the next experiment, completely remove the wire you soldered to terminal *4* of the 6F8G socket for the purpose of simulating cathode-to-heater leakage, and make sure that the receiver is operating normally.

EXPERIMENT 62

Purpose: **To show that reducing the value of the plate-load resistance of an R-C voltage amplifier results in weak reception.**

Step 1. To reduce the plate load to approximately 9000 ohms, solder one end of the 10,000-ohm resistor (Part *6-9*) to plate terminal *3* of the 6F8G socket. Use a temporary soldered lap joint for this connection. Arrange the other lead of this resistor so that it can be easily pushed into contact with terminal *6* of the 6K6GT socket. When this is done, the 10,000-ohm resistor parallels the 100,000-ohm resistor (R_{11}) already in the circuit, and the plate load is reduced to approximately 9000 ohms.

Step 2. Turn the receiver on, and tune in any station broadcasting a musical program (the effects of low plate-load resistance will be more noticeable with a musical program), and adjust the volume control so that you can barely hear the program.

Step 3. Push the free lead of the 10,000-ohm resistor into contact with terminal 6 of the 6K6GT socket. Use a small wooden stick or a pencil to do this, because the potential difference between the chassis and terminal *6* is over 200 volts. Do not use a metal pencil or a pair of pliers.

If you have set the volume control properly, you will no longer hear the program when you shunt R_{11} with the 10,000-ohm resistor. If you happen to set the volume a little bit too high, the program won't disappear entirely, but it should certainly go down as you bring the 10,000-ohm resistor into contact with terminal *6*.

The change in volume is the result of a change in the a.c. voltage drop across plate-load resistor R_{11}, but this isn't the only change that takes place across R_{11}. For your report on this experiment, you will show exactly what changes take place across R_{11}.

Instructions for Report Statement No. 62. To find out how the d.c. plate voltage changes, first tune the receiver away from a station, and then measure the plate voltage with the normal 100,000-ohm load resistance. Make a note of the value you get. Then, push the 10,000-ohm resistor into contact with terminal *6*, and take another reading. Enter the values you get for these two measurements in the first two blank spaces in Report Statement No. 62 on the last page of this Manual.

Check the change in a.c. voltage as follows:

First, with the set turned off, inject a steady a.c. signal into the grid of the 6F8G tube by soldering a wire to filament terminal *7* (6F8G socket) and fastening the other end of this wire to terminal *8* of terminal strip *7-28A*. Now, connect your NRI Tester to measure the a.c. voltage between the chassis and plate terminal *3* of the 6F8G socket. Adjust the volume control so that the meter reads 12 volts (*3* × *V* range, meter reading *4*). Record this value in Report Statement No. 62 as the a.c. hum voltage with normal plate resistance.

Push the 10,000-ohm resistor into contact with terminal *6* of the 6K6GT, note the new meter reading, and enter your value in Report Statement No. 62 as the a.c. hum voltage with reduced plate load.

When you have completed Report Statement No. 62, remove the wire interconnecting terminal *7* of the 6F8G socket and terminal *8* of terminal strip *7-28A*, and remove the 10,000-ohm resistor from terminal *3* of the 6F8G socket. Check to see that the receiver operates normally.

EXPERIMENT 63

Purpose: **To show that a leaky coupling condenser in an R-C amplifier will cause distortion.**

Step 1. To simulate leakage in audio coupling condenser C_{10}, solder the 100,000-ohm resistor (Part *7-32*), to terminal *3* of the 6F8G socket, and terminal *5* of the 6K6GT socket. Turn the receiver *on*, wait for the tubes to warm up, then tune in any strong local station. At low volume levels, the distortion may not be readily apparent, so turn the volume on full. You should find the distortion very severe, both on speech and on music.

Step 2. To discover if there is any direct current flowing in the grid resistor of the 6K6GT output stage, two measurements are required; one with the circuit normal, the other with simulated leakage in C_{10}. Before going further, therefore, unsolder the 100,000-ohm resistor from terminal *5* of the 6K6GT socket so as to restore the circuit to normal.

Connect your NRI Tester to measure the d.c. voltage drop across R_{12}—black lead on terminal *27* of the filter condenser, red lead on terminal *5* of the 6K6GT. Be sure your meter pointer is exactly on 0 at the left of scale *DC* before making a voltage measurement. Turn the receiver *on*, tune to a spot on the dial where no station is heard, and then turn the tester *on*, and measure the d.c. voltage drop across R_{12}. Make a note of the value you get for this test.

Step 3. To measure for d.c. with simulated leakage, leave the connections as in Step 2, and push the 100,000-ohm resistor into contact with terminal *5* of the 6K6GT socket. If you wish, you may "tack" it down with your soldering iron. (If you do, turn the receiver *off* first.) Then take another reading. You may have to use the *30* × *V* range for this measurement. CAUTION: DO NOT LEAVE THE RECEIVER OPERATING WITH THIS DEFECT ANY LONGER THAN NECESSARY TO MAKE THESE TESTS.

Instructions for Report Statement No. 63. When an experienced serviceman localizes distortion to the audio section of a receiver, he immediately checks to see if the cause is a leaky coupling condenser. You have made the very same test that an experienced serviceman would make.

Enter your two voltage values in Report Statement No. 63, then restore the circuit to normal by removing the 100,000-ohm resistor.

EXPERIMENT 64

Purpose: **To show that there is usually no reception with an open coupling condenser in an R-C amplifier.**

Step 1. To simulate an open condenser, tune in any strong local station, and then unsolder coupling condenser C_{10} from terminal *3* of the 6F8G socket. (Don't unsolder the condenser from the grid of the 6K6GT or you may not get the desired results.) With C_{10} completely off terminal *3*, the set should be entirely dead. Furthermore, it should remain dead even though you bring the unsoldered condenser lead close to the plate terminal *3* of the 6F8G.

A circuit disturbance test, consisting of pulling out the 6K6GT tube momentarily, should produce a sound in the loudspeaker, whereas touching your finger to the top cap of the 6F8G tube should have no effect.

Step 2. To restore normal operation, reconnect C_{10} to plate terminal *3* of the 6F8G socket, and again tune in a strong local station. This will serve two purposes. First, it will prove that the set is working normally once more, and second, it will allow you to determine just how loud the set will play when the volume is turned full on.

Instructions for Report Statement No. 64. There is another audio coupling condenser in your NRI receiver. It is condenser C_8, connected to the center terminal of the volume control. Let us see what happens when this is disconnected to simulate an open defect.

Unsolder coupling condenser C_8 from the volume control. Turn the volume full on, note the effect, and then check the proper answer for Report Statement No. 64.

Don't forget to reconnect C_8 to the volume control, and make sure that the receiver is still playing normally, before doing Experiment 65.

EXPERIMENT 65

***Purpose:* To show that an open screen grid by-pass condenser will cause howls and squeals.**

Step 1. To hear squeals and howls from the receiver, unsolder screen by-pass condenser C_5 from the ground lug at the 6A8GT socket, and then position the unsoldered lead as close as possible to the ground lug without actually touching it. Remember, an open paper condenser is usually one in which one of the leads has pulled free from the foil. Operate the receiver. You should hear loud squeals and howling sounds as you tune the receiver from one end of the dial to the other.

As you pass over stations, the squeals will probably change pitch and either increase or decrease in intensity, depending on conditions in your particular set. You recognize this as oscillation, but the customer is simply going to say that his set "howls" or "squeals" whenever he tries to use it.

Step 2. To measure the r.f. voltage between the screen and the cathode of the 6SK7GT stage, connect your NRI Tester between terminals *3* and *6* of the 6SK7GT socket. (The red clip should be placed on terminal *6*, and you should use the a.c. jacks.) Turn the receiver and the tester *on,* wait until the squeals and howls are heard, and then read the meter. Start with your selector switch at *30* × *V* and then go to *3* × *V* or *V*, whichever gives you the more acceptable meter pointer deflection.

Instructions for Report Statement No. 65. As you watch the meter, push the free lead of by-pass condenser C_5 into contact with the ground lug, note the effect this has on the r.f. screen-to-cathode voltage, and answer Report Statement No. 65.

Resolder C_5 to the ground lug before going further, and make sure that the receiver operates normally.

EXPERIMENT 66

***Purpose:* To show that an increase in the power factor of the input filter condenser will result in weak reception.**

Step 1. To increase the power factor of the input filter condenser, unsolder the red lead from terminal *8* of the rectifier tube socket, and solder your 10,000-ohm resistor between electrolytic condenser terminal *29* and terminal *8* of the rectifier tube socket. Arrange the unsoldered red lead so that it can be pushed down against terminal *8* when necessary.

Step 2. To short-circuit the 10,000-ohm resistor you just installed, fasten the red lead to rectifier tube socket terminal *8* (do not solder it in place), and tune in a distant station. Adjust

the volume control so that you can just barely hear the program, and then pull the red wire off terminal *8* so as to put the 10,000-ohm resistor in series with C_{14}. When you do this, the volume should decrease.

Step 3. To check the a.v.c. voltage under normal conditions, first short-circuit the 10,000-ohm resistor by fastening the red lead back on rectifier socket terminal *8*. Connect your NRI Tester as a d.c. voltmeter by clipping the black (negative) lead to terminal *33* on the terminal strip *3-12A* on top of the chassis, and connecting the red lead to the chassis. Turn on the receiver, and tune in a strong local station. Watch your voltmeter, and tune for *maximum* a.v.c. voltage. Make a note of your reading.

Step 4. To check the a.v.c. voltage with the 10,000-ohm resistor in the circuit, turn off the set, and pull the red lead off terminal *8* of the rectifier socket. Turn on the set, and repeat the measurement of Step *3*. Be sure you have the same station. Make a note of your reading.

Step 5. To check the normal B supply voltage, reconnect the red lead to rectifier socket terminal *8* and your NRI Tester to measure the d.c. voltage between the chassis and terminal *6* of the 6K6GT socket.

Step 6. Remove the short-circuit from the 10,000-ohm resistor, and take another measurement of the B supply voltage.

Instructions for Report Statement No. 66. Record both a.v.c. voltage measurements and both d.c. plate supply voltage measurements in Report statement No. 66.

Before going to the next experiment, unsolder the 10,000-ohm resistor from terminal *29* and *8*, reconnect the red wire to terminal *8* of the rectifier tube socket, and make sure the receiver operates normally.

EXPERIMENT 67

***Purpose:* To show that high power factor in the output filter condenser can make a receiver "motorboat."**

Step 1. To simulate high power factor in the output filter condenser (C_{13}) unsolder the three leads on condenser terminal *28*, and solder your 10,000-ohm resistor between terminal *28* and the 3-lead junction so that it is *in series* with condenser C_{13}. Also solder a short piece of hookup wire to terminal *28*, so that the resistor can be short-circuited when necessary.

Step 2. To hear the motorboating, turn the receiver on, wait for the tubes to warm up, and then try to tune in stations. With the 10,000-ohm resistor in series with C_{13}, you should hear loud "putt-putt" sounds coming from the loudspeaker, and the program should be severely distorted. Tune the receiver from one end of the broadcast band to the other to prove that this "motorboating" effect does not depend on the setting of the tuning condenser.

Step 3. To detemine the a.c. voltage change, short-circuit the 10,000-ohm resistor by fastening the free end of the wire you soldered to terminal *28* onto the junction of the 10,000-ohm resistor and the three leads. This should stop the motorboating. With a station tuned in at normal room volume, measure the *a.c.* voltage developed between the chassis and the screen (either terminal *4* or terminal *6*) of the 6K6GT tube. Make a note of this voltage. Then introduce the 10,000-ohm resistor into the circuit by taking the shorting wire off the junction point of the three leads, and measure the a.c. between screen and chassis again.

Step 4. To determine the effect of the high power factor on the B supply voltage, use your tester now as a d.c. voltmeter. Measure the output of the power supply (red on screen terminal *4* of the 6K6GT socket, black on the chassis). Make this measurement with the short circuit removed, to determine the effect of the high power factor.

Instructions for Report Statement No. 67. Normally, the output filter condenser keeps signals out of the power supply in addition to reducing the a.c. ripple of the rectified B supply voltage. In your earlier experiments on power packs you proved that increasing the power factor of the output filter condenser increases the a.c. ripple output. You have now found out what happens to the signal voltage across the output filter condenser. Record your measurements for Step *3* and Step *4* in Report Statement No. 67.

Remove the 10,000-ohm resistor and the extra lead (on terminal *28*), and reconnect the three leads to condenser terminal *28* so as to restore the receiver to normal.

EXPERIMENT 68

***Purpose:* To show that if the Q factor of an i.f. transformer is reduced, weak reception, especially on distant stations, will result.**

Step 1. To simulate low Q in an intermediate-frequency transformer, shunt one of the windings with a reristor. For this experiment, solder one end of your 10,000-ohm resistor to terminal *7* of terminal strip *7-28A*, and arrange the other end of the resistor so that it can be pushed into contact with terminal *5* of the 6F8G tube socket.

Step 2. Tune in a distant station. Try to select one that makes it necessary for you to turn the volume control full on. If you can't do this, use the weakest station you can pick up, and cut the volume down until you can barely hear the program.

Now push the 10,000-ohm resistor into contact with terminal *5* of the 6F8G socket, and note the effect on the volume. When you do this it should no longer be possible to hear the station at all. We shall now find out what happens on a strong local station.

Instructions for Report Statement No. 68. Lift the 10,000-ohm resistor off terminal *5*, tune in a strong local station, and measure the a.v.c. voltage. Connect your red test clip to the chassis, and the black test clip to terminal *33* on terminal strip *3-12A*. Use the tester as a d.c. voltmeter for this measurement. Record the result in the first blank space of Report Statement No. 68.

Now push the 10,000-ohm resistor into contact with terminal *5* of the 6F8G socket, note the effect on the volume level, and adjust your tester selector switch to get an accurate indication of the new a.v.c. voltage. Record your new voltage value in the second blank space of Report Statement No. 68, and check the box which most nearly describes what happened to the volume as the transformer was loaded with the 10,000-ohm resistor.

When you have completed your report, unsolder the 10,000-ohm resistor from terminal *7* of terminal strip *7-28A*.

EXPERIMENT 69

***Purpose:* To show that when an a.c. ripple voltage is introduced into an r.f. stage, hum will be heard only when the receiver is tuned to a station.**

Step 1. To measure the output of your receiver with no station tuned in, use your tester as an a.c. voltmeter, with the black test clip fastened to the chassis and the red clip fastened to plate terminal *3* of the 6K6GT tube socket. Remember these connections, because this is the way to use the tester as an output meter for general receiver alignment work. When you have the tester connected, turn the receiver on, wait for the tubes to warm up, and then check the a.c. output voltage *with no signal* coming through the set. You should get no voltage.

Step 2. To get a reference output reading when a signal is tuned in, tune in a station, and adjust the volume control as best you can so that the maximum meter swing on modulation peaks does not exceed 12 volts (4 on scale *AC* with *3* × *V* range). This voltage value represents the signal output with the receiver operating normally.

Leave the volume control exactly in this position for Steps *3* and *4* which follow. Turn the receiver *off* and *on* by pulling the power cord plug out of the wall outlet and re-inserting it.

Step 3. Now inject an a.c. ripple voltage into the r.f. stages of your NRI receiver by soldering your 100,000-ohm resistor to terminal *7* of the 6SK7GT tube socket, and terminal *4* of terminal strip *6-14B*. Don't let the leads of this resistor touch any other resistor or condenser leads, or terminals. Plug the receiver cord into the outlet, and tune to a point where no signal is heard so as to keep the signal level at zero, and measure the a.c. output with hum injected into the r.f. stage. Again no meter reading should be obtained. (The reading should be the same as for Step 1.)

Step 4. To determine the effect of the ripple voltage on a signal, tune in the same station you had in Step 2, and measure the signal output now. Make a note of the meter range you have to use for this measurement. Listen carefully to the signal.

Step 5. To see what happens on other signals, tune in several other stations. Hum should be heard only when a station is tuned in, and the programs should be greatly distorted.

Instructions for Report Statement No. 69. You already have enough information to make a report on this experiment. In Step 2 you measured the signal voltage when there was no hum voltage injected into the r.f. system. In Step 4 you measured the output of both the normal signal voltage and the hum voltage. Check the box in Report Statement No. 69 which indicates which range of your tester you had to use to measure the voltage in Step 4.

Remove the 100,000-ohm resistor before going on to Experiment 70, and make sure that the receiver is operating normally.

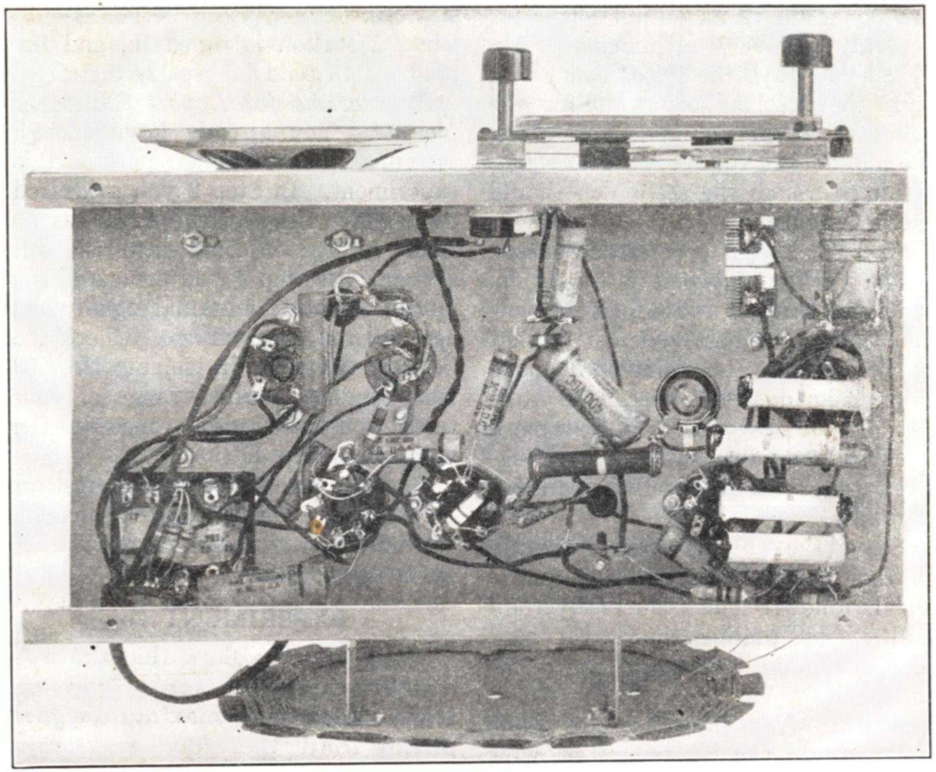
EXPERIMENT 70

***Purpose:* To show that there is a definite position for a loop antenna which gives maximum signal pickup and therefore maximum volume.**

Step 1. Connect your NRI Tester to measure the a.v.c. voltage (*d.c.*) *between terminal 33* (*on strip 3-12A*) *and the chassis,* and tune in a medium-distant station. Try to select a station which will give a meter reading of about 3 on scale *DC* when the *V* range is used for the initial position of chassis and loop.

Step 2. Turn the chassis around slowly, one complete turn, and watch the meter. There should be two positions which give maximum a.v.c. voltage and maximum volume; also two positions of minimum a.v.c. voltage and minimum volume, thus proving that the loop is directional. Set the receiver in one of the two positions which give *maximum* a.v.c. voltage and *maximum* volume output.

Instructions for Report Statement No. 70. When you turned the chassis around, you probably noted that there



When you have finished all the wiring and installed the loop antenna, your chassis should look something like this. Don't worry if your parts don't look exactly like these. The important thing is to place them so that adjacent leads won't touch each other.

was a definite amount of spacing between the maximum and the minimum a.v.c. voltage position. With the receiver positioned for maximum a.v.c. voltage and maximum volume, turn the chassis until you get the minimum a.v.c. voltage and minimum volume. Note carefully how much you turned the chassis, and then answer Report Statement No. 70.

► This completes the series of experiments on your 7RK-AC receiver. Mail in your report. Then go over the connections you had to change to perform these demonstrations, and make sure the joints are soldered securely and neatly. Position the parts as nearly as possible as shown in the complete under-chassis wiring photograph above.

When you have finished all your experiments and have received a passing grade on your report, you can settle back to enjoy this receiver.

PACKING AND RETURNED MATERIAL SLIP

READ AND KEEP THIS. IT'S IMPORTANT TO YOU.

It is our policy to replace, without charge, missing parts and material which arrives in a damaged or defective condition.

To replace material which you lose, break, or damage, use the "Quotation and Order Blank" enclosed with each Kit.

Check the contents of Kit packages, item by item, against the list printed in the instruction manual.

If any parts seem to be missing, especially small ones, search carefully through the carton, packing, and envelopes, and be on the lookout for substitute parts. If, after a thorough search, a part cannot be found, write us. Do not use this form to report missing Kit parts.

THIS FORM MUST BE INSIDE EVERY PACKAGE OF MATERIAL RETURNED TO US

Sometimes, due to rough handling, a part may arrive in a damaged condition. Sometimes a part will prove to be defective — you discover this when you do your experiments. However, don't conclude that a part is defective just because you don't get the results you expect from an experiment. Unless examination shows a defect present, write first and tell us why you think a part is defective. You may have made a mistake in your experiment.

DEFECTIVE MATERIAL AND ANY THAT MAY BE DAMAGED UPON ARRIVAL MUST BE RETURNED BEFORE A REPLACEMENT CAN BE MADE. Pack carefully; fill out and enclose this form in the package.

If you feel an explanation in addition to this form is required, write a separate letter and attach it to the outside of the parcel post package with tape or paste. Such letter requires a three-cent stamp in addition to the regular parcel post charge. If you send your package by first-class mail, you can enclose a letter without paying extra postage.

FROM THE ABOVE YOU WILL UNDERSTAND THAT TWO THINGS MUST BE WITH EVERY PACKAGE OF MATERIAL YOU RETURN TO US:

(1) YOUR NAME, ADDRESS, AND STUDENT NUMBER.
(2) YOUR REASON FOR RETURNING IT.

BE SURE TO FILL OUT AND ENCLOSE ONE OF THESE FORMS IN EVERY PACKAGE OF MATERIAL RETURNED TO US.

(See other side for detailed explanation.)

National Radio Institute
16th & U Streets, N.W.
Washington 9, D. C.

Gentlemen: I am returning the enclosed material for the reason I have checked below.

1. ☐ Broken on arrival.

2. ☐ It is defective.

3. ☐ I believe it is defective for the reasons stated in my letter herewith.

4. ☐ You asked me to return this. See your letter. S RK CK

5. ☐ This is extra material which you sent me.

Name ____________ Student No. ____________

Address ______________________________

City ____________ Zone ____ State ____________

DO NOT WRITE IN THIS SPACE

SPECIAL INSTRUCTIONS FOR POTENTIOMETER, PART 3-8

The potentiometer included in this Kit as Part 3-8 is a substitute for the one shown in the Instruction Manual. Although its physical appearance is different, it has the same electrical characteristics as the original part.

When you come to Experiment 27, you are told to put numbers on the potentiometer to identify its terminals as an aid in wiring up the various experimental circuits. It is impossible to put these numbers on the new potentiometer as shown in Fig. 23, and again in Fig. 24, in the 3RK-1 Instruction Manual. Therefore, in Experiment 27, place the potentiometer exactly as shown in Fig. 23. When you wire up the a.c. power supply circuit described in Experiment 28, mount the potentiometer with the lugs pointing straight up exactly as shown in Fig. 24. This will place the terminals of the substitute potentiometer in exactly the same position as the numbered terminals in Figs. 23 and 24, and in other diagrams. Wire the potentiometer into the circuits accordingly.

QUOTATION AND ORDER BLANK FOR PARTS IN THIS KIT

Here is a list of the parts in THIS Kit. Use this list ONLY to ORDER REPLACEMENTS. You do not have to pay extra for the parts in this package -- they are included in your Course. But, if you happen to damage or lose one or more of the parts needed for your experiments, we shall be glad to furnish you replacements at the prices quoted. Be sure to enter the quantity and the total price of each item you want, and to send full payment, including the 25¢ Service Charge which covers the cost of handling your order. At these low prices, we cannot ship C.O.D. or on account.

THIS OFFER IS LIMITED TO NRI STUDENTS who may need replacement parts for their experiment. We cannot sell to outsiders or in quantities greater than actually needed for the NRI experiments.

Quantity	Part No.	Description	Price Each	Total	Please do not write in space below
	3-1	Condenser, .05-mfd., 400-volt	.12		
	3-2A	Condenser, .25-mfd., 400-volt	.16		
	3-3	Condenser, dual 10-mfd. electrolytic	1.11		
	3-3A	Condenser, mounting wafer	.05		
	3-4	Resistor, 220-ohm, 1-watt, 10%	.09		
	3-5A	Resistor, 1000-ohm, ½-watt, 10%	.07		
	3-6A	Resistor, 40,000-ohm, 3-watt 20%	.12		
	3-7	Resistor, 1 megohm, 10% tolerance	.07		
	3-8	Potentiometer, 1000-ohm wire wound	.63		
	3-9	Mounting bracket for potentiometer	.05		
	3-10	Choke coil, 10-henry	.88		
	3-11	5' power cord	.15		
	3-12	6-lug terminal strip	.04		
	3-13	#6 wood screws, 3/8" long (3)	.02		
		Plus Service Charge of		.25	
		Total amount of order $			

National Radio Institute,
16th and You Sts., N. W.,
Washington 9, D. C.

Date ____________________

Dear NRI:--Please send postpaid the material ordered above for which I enclose $ ____________

Name STEAM POWERED RADIO.COM ____________ Student No. ____________

Address ____________________________

City ____________ Zone No. ________ State ____________

T83-1248

Return this ENTIRE SHEET. Do not tear off any of it.

Do not write on the back of this form--use a separate sheet for questions or other requests.

Special Note Concerning the 10-henry Choke, Part 3-10

The choke coil supplied in this Kit is rated as a 10-henry, 25-milliampere choke. Its actual inductance value, however, may be either more or less than 10 henrys, due to normal manufacturing tolerances.

A considerable variation in inductance values can be tolerated when the choke is used in the power pack you will build in the next group of experiments. In Experiments 28, 29, and 30 of this group, however, you deal with resonant circuits and any deviation from the rated 10-henry value will be reflected in your voltage measurements across the choke. Thus, if the actual inductance of your choke is less than 10 henrys, your voltage values across the choke will be less than those shown in the Manual. On the other hand, if your choke has an inductance greater than 10 henrys, your voltage values will be greater than ours.

We take the effects of these variations in parts values into account when grading the Report Statements, so don't worry if your values are somewhat different from ours.

3RK/3-10